



**MAX PLANCK INSTITUTE
FOR PSYCHOLOGICAL RESEARCH**

**GENETIC VS. ENVIRONMENTAL DETERMINANTS OF TRAITS, MOTIVES,
SELF-REFERENTIAL COGNITIONS AND VOLITIONAL CONTROL IN OLD AGE:
FIRST RESULTS FROM THE MUNICH TWIN STUDY (GOLD)¹**

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¹ GOLD = Genetic Oriented Lifespan Study on Differential Development. The authors gratefully acknowledge the assistance of Marina von Bernhardt in improving the English text.

ABSTRACT

Usually, the central focus of behavior genetical twin studies has been intelligence and personality traits, such as extraversion and neuroticism. Personality characteristics in a broader sense were hardly not studied. These variables, however, are in the focus of the Munich Twin Study "GOLD" (Genetic Oriented Life Span Study on Differential Development), started by Kurt Gottschaldt in 1937 and continued and expanded in Munich since 1992. In addition to personality traits (1) motives, (2) social cognitions, such as self concept of one's own competence, internal and external control beliefs, (3) persistence and flexibility in coping behavior, and (4) volitional control of action were examined.

Three topics of research are addressed: (1) A systematic longitudinal analysis from middle childhood to late adulthood, (2) a cross-sectional analysis of age differences in adults between the ages of 65 and 85, and (3) the estimation of genetic and environmental determination relying on the comparison of mono- and dizygotic twins.

The present report examines two kinds of influence on individual differences in motives and social cognitions: age, and genetic/environmental determination. One can argue that age impacts motives and social cognitions in a specific way: Very old subjects should have lower scores in achievement and power motives, they should complain of loss of control, and should doubt their own abilities. On side of genetic vs. environmental determination we hypothesized that - in contrast to more genetically determined basic personality traits - personality dispositions such as motives and social cognitions are more strongly determined by environmental variables.

The results of 135 pairs of twins are presented (the data collection is still in progress). A decrease in extraversion and conscientiousness, in the achievement motive as well as in the persistence of goal attainment can be shown. This, however, comes not true for the self-concept of one's own competence. The only increase can be found in external fatalistic control-related beliefs. Most of the age effects are gender-specific.

Individual differences in the achievement and power motives are less determined by genes than differences in the basic personality traits extraversion and neuroticism. For the affiliation motive, however, genetic determinants play quite a prominent role. The same holds true for differences in competence- and control-related beliefs, and in flexibility and persistence which are genetically determined to a higher degree than differences in the fundamental traits.

INTRODUCTION

A general overview of twin studies shows a concentration of previous research on cognitive abilities and global personality traits, such as extraversion and neuroticism (Bouchard & McGue, 1981; Loehlin, 1992). This present study, however, took an extra step. In addition to those fundamental traits, this study which involved identical and fraternal twins between 65 and 85 years of age, examined genetic and environmental influences on other personality characteristics, such as motives, coping strategies, control beliefs, and volitional control. Also, for some of these personality characteristics, this study is the first one, which is concerned with age differences in individuals older than 65 years of age.

Traits. In personality research trait concepts, which are based on factor-analytical consolidation predominate (Cattell, 1943, 1965) and focus on a few, mostly psycho-biologically founded trait dimensions (Eysenck, 1947). During the last years studies repeatedly focused on five factors (the "Big Five"), which are assumed to be sufficient for the description of one's personality in questionnaires and ratings, regardless of whether it is based on self-reports or on evaluations of others (Digman, 1990). These traits are neuroticism, extraversion, openness to experience, sociability/

agreeableness, and conscientiousness. They represent temperament aspects of personality that have a strong genetic component (Eaves, Eysenck, & Martin, 1989). For the assessment of these traits Costa and McCrae (1985, 1989, 1992a) developed a self-report questionnaire which we used in our study.

Motives. Motives are fundamentally distinct from traits and are particularly necessary for an understanding of the dynamic aspects of personality (Winter, John, Steward, Klohnen, & Duncan, 1998). Motives and traits are complementary concepts that refer to different aspects of personality and predict different kinds of behavior. McClelland (1951, p. 215) argued that the trait concept will account for the consistencies and recurrences, whereas the motive concept for inconsistencies and sudden, irrational changes in behavior. Motives refer to people's wishes, desires, and goals, that is, to the "why" of behavior. In contrast, traits are often described as referring to people's "stylistic and habitual patterns of cognition, affect, and behavior" (Emmons, 1989, p. 32) and are seen as characterizing the "how" of behavior. A further distinction can be made between traits as qualities that people "have" and motives as what people "do" (Cantor, 1990).

Furthermore, on the one hand, motives are experienced as conscious intentions and goals, thus leading researchers to the assumption that people can give reasonably accurate accounts of their values, goals, and desires (Cantor & Zirkel, 1990; deCharms, Morrison, Reitman, & McClelland, 1955). A lot of questionnaires were constructed to collect these self-report data as easily as trait questionnaires. On the other hand, motives are seen as unconscious and not easily accessible to awareness, and therefore they are measurable only by indirect means (Greenwald & Banaji, 1995), for example the Thematic Apperception Test (TAT), devised by Morgan and Murray (1935).

Based on the distinction between the two measurement methods McClelland (McClelland, Koestner, & Weinberger, 1989) proposed two different motive systems: an "implicit" one representing "a more primitive motivational system derived from affective experiences" - usually assessed via the TAT - and a "self-attributed" one - measured via questionnaire - representing "more cognitively elaborated constructs" (p. 690). In our study the TAT measure as well as a questionnaire-based measure were implemented to assess the three core motives of achievement, affiliation, and power.

Coping strategies. The discussion of achievement and efficiency in the aging process requires the examination of additional personality characteristics, which are primarily focused on getting and maintaining control of one's own actions. These are related to coping strategies which aim at eliminating discrepancies between life perspectives and salient concerns of personal development. Brandtstädter and Renner (1990) distinguished between two alternative, but complementary strategies to keep the balance of gains and losses favorable: (1) active adjustment of life circumstances to personal preferences (*assimilative persistence*), and (2) passive adjustment of personal preferences to situational constraints (*accommodative flexibility*). The assimilative style describes an active coping process reflecting personal control and agency. If a person evaluates an actual life perspective negatively, a tendency to alter the situation is induced. If personal resources and competencies are considered sufficient, corrective actions are planned and executed. The accommodative mode of coping, on the other hand, which is activated when assimilative attempts to change the situation become ineffective, should be considered as a neutralization of rather than as an active solution of problems. The structure of individual cognitions and evaluations is modified by the person to make the given situation appear less negative or more acceptable through adjustments of aspiration levels, revisions of value priorities and standards, or neutralization of negative evaluations.

Competence- and control-related beliefs. Other aspects of personality reflect attitudes and opinions about one's own competence and about who is controlling one's activities. These competence- and control-related beliefs (Krampen, 1987, 1991) are generalized expectancies about the contingencies of actions and their consequences.

In our effort to collect data about control beliefs of the participants in our study we followed the theory of control by Rotter (1955, 1982), in which generalized expectancies (e.g., internal vs. external locus of control of reinforcement) are conceived as central personality variables affecting behavior especially in novel or ambiguous situations. The discussion of control-related behavior was innovated in the last decade by Rothbaum, Weisz, and Snyder (1982), who considered control as a two-process construct consisting of primary and secondary control. Primary control involves attempts to change the world so that it fits the needs of oneself, whereas secondary control brings oneself in line with the environment (Heckhausen & Schulz, 1995). Obviously, the concept of primary and secondary control bears some conceptual overlapping with assimilative vs. accommodative coping strategies (see above; for a discussion of the differences see Heckhausen, 1999). Control beliefs in the sense of Rotter are primarily examples of secondary control, including attributions to limited competence which serve to protect against disappointment, or construing luck and fate or powerful others as agents of control to compensate when primary control has failed.

Volitional control. The final group of variables we assessed refers to volitional processes of action control. Kuhl (1984, 1987) proposed a series of mediating processes which facilitate an intention's access to action. These can be active strategies as well as automatic strategies that are implemented without the actors' awareness. Kuhl's studies of individual differences in control strategies led to the identification of two modes of action control: action-orientation and state-orientation. Action-orientation presses for transforming an intention into action, while state-orientation perseveres in ruminations related to the past, the present or the future. Action- or state-orientation can be elicited by particular situations. But there are also individual differences in the disposition towards action- or state-orientation. The functional significance of action/state-orientation will mainly be explored with regard to its debilitating effects on individuals' volitional abilities to plan, initiate, and complete intended activities (Kuhl, 1994a).

Developmental Aspects

There exists a nearly indeterminable amount of studies on gender differences in personality (cf. the meta-analysis by Feingold, 1994); concerning age differences, however, the situation is somewhat more complicated. Although much research was done on adult personality development over the life span (cf. McCrae & Costa, 1990; Schaie & Willis, 1991), most studies focused on changes from adolescence to adulthood or from the middle to the advanced age, that is, on the transition to retirement. Our study, however, examined developmental changes in personality *within the age-span of 65 to 85*, for which there is only scarce evidence from other studies. We merely have an insecure basis for the extrapolation of findings on personality development in adulthood to form hypotheses concerning this late period in life. The basic question, therefore, is whether there is a substantial change in old age at all or whether personality characteristics remain stable after having reached a certain level.

Traits. Only a few studies dealing with the effect of aging on personality traits are longitudinal and involve large sections of life (Costa & McCrae, 1988, 1992b; McCrae & Costa, 1990; overview of older studies: Conley, 1984). Over a period of six years, Costa and McCrae (1988,

1992b) found high stability coefficients for neuroticism, extraversion and openness ranging between $r=.63$ and $r=.83$ and only marginal changes in the mean values. Another longitudinal study which extended for over 10 years and involved age groups between 24 and 88 years revealed a slight decrease with age for the three “NEO” factors neuroticism, extraversion, and openness (Costa, McCrae, Zonderman, Barbano, Lebowitz, & Larson, 1986). Earlier longitudinal studies with other personality factors over a period of six and twelve years (Costa, McCrae & Arenberg, 1980) confirmed the hypothesis of high stability and exhibited only minor differences between different age groups (age 17 to 85 years). Cross-sectional results with the German Big-Five version (Borkenau & Ostendorf, 1993) point to lower neuroticism, extraversion and openness values in older adults (only 10% of the participants were older than 46 years of age) and higher values for agreeableness and conscientiousness, but, probably there is less intra-individual change than cross-sectional results suggest. These general findings with high stability and little change over age led Costa and McCrae (1994) to maintain that from the age of 30 onwards there is stability of personality factors in most cases and there is no change any more.

In contrast to global traits it seems reasonable to expect some developmental trends for motives, coping strategies, competence- and control-related beliefs, and volitional control since these variables can be assumed to be sensitive to environmental changes and challenges to a higher degree than traits.

Motives. Studies on general and differential development of motives deal mainly with early childhood, or with school-age and are often restricted to the realm of the achievement motive. The ontogenesis and further development of other motives such as power and affiliation/intimacy is virtually unknown. It is maintained that the strength of the achievement motive is learned, and so are the achievement motive tendencies of “Hope of Success” and “Fear of Failure”. But it is apparently unknown if and how motive development continues in adulthood, although (1) earlier cross-sectional studies (for example, Veroff, Depner, Kulka, & Douvan, 1980) revealed some epochal changes for the achievement, affiliation and power motives between 1957 and 1976, and (2) one is aware that the achievement motive can be modified by appropriate methods of training in adulthood (McClelland & Winter, 1969; Heckhausen, 1980).

If the assumption that motives are learned is correct, one can argue that they should become stronger with age as seeking out motive-corresponding situations continually strengthens them. It is also possible, however, that their intensity diminishes, if they are no longer challenged by situational incentives. The latter assumption seems to be more valid concerning the retirement age: When comparing retired people with people who are still working, one usually finds a decline in all three motives, namely the achievement, affiliation, and power motives (cf. McClelland, Scioili, & Weaver, 1998).

Coping strategies and control beliefs. Unlike motives, more definite results exist with respect to developmental change of coping strategies in the elderly. Brandtstädter, Wentura, and Greve (1993), for example, found in a cross-sectional study, with participants from 18 to 89 years of age a gradual shift from assimilative-offensive to accommodative coping strategies in middle and later adulthood. The assimilative persistence decreases while the accommodative flexibility increases, thus leading to the assumption that with advancing age, accommodative processes become increasingly important aspects of coping and life-management.

For competence- and control-related beliefs some age trends are also usually found. Several studies indicate that older people to a greater degree extent than younger people perceive their life as being dependent on factors they are unable to influence (Baltes & Baltes, 1986). Krampen

(1991) also reported that competence-related beliefs and internal control-related beliefs decrease with age, while fatalistic, external control-related beliefs increase.

Heredity and environment

Behavior genetics apply diverse research strategies such as twin and adoption studies to investigate the relative influence of genetic and environmental factors on behavior. Several genetic and environmental sources are distinguished. There are additive and nonadditive genetic effects, and, on the part of the environment, a distinction is drawn between influences of the shared (common) and the nonshared (individual) environment.

The additive effect of genes is the extent to which the effects sum up according to the gene dosage (Plomin, DeFries, McClearn, & Rutter, 1997). Ideally, this results in a linear relation between gene dosage and genotype. Nonadditive genetic effects, such as dominance and epistasis, result from gene interaction. If the genes interact with each other - this is the cause of dominance - the prediction of genotypic values from gene dosage is slightly off, i.e., dominance is the deviation of the actual genotypic value from the linear (additive) relation between dosage and genotype. While dominance is the nonadditive interaction of genes at a single gene locus (intra-locus interaction), epistasis is the interaction between several gene loci (inter-locus interaction) in a polygenic model. The consequence of dominance or epistasis is important because the offspring will to some extent be genetically different from the parent.

The basic idea for environmental effects is that parents provide the family environment and siblings resemble each other because they share that family environment. But environmental influences also tend to make siblings (in the same family) different. Environmental aspects, which affect individual differences in this way, are called nonshared and refer to variance not explained by heredity or by shared family environment (for details see Borkenau, 1993; Plomin et al., 1997).

A substantial degree of genetic determination of individual differences in personality traits has repeatedly been proven (Bouchard, Lykken, McGue, Segal, & Tellegen, 1990). Loehlin (1992), for example, attributed 35 to 40 percent of the phenotypical variance of extraversion to genetic effects. For openness to new experience the genetic influence is well above 50 percent, which is probably due to the proximity to intelligence (Bouchard & McGue, 1981; McGue, Bouchard, Iacono, & Lykken, 1993), whereas the rest of the Big Five are below the rate of extraversion. However, the similarities, that is, the intra-pair correlations, are often more than twice as high in identical twins as compared to nonidentical twins, particularly if the data are based on self-descriptions. Therefore, nonadditive genetic variance components (Lykken, McGue, Tellegen, & Bouchard, 1992) as well as nonshared influences of the environment of identical and nonidentical twins also have to be taken into account. Regarding the variance partition to the different sources for personality traits (in contrast to intelligence) the influence of the individual environment usually predominates over the shared environment (Heath, Neale, Kessler, Eaves, & Kendler, 1992). Emphasis on the maximal dissimilarity of non-identical twins leads sometimes to contrast effects (Loehlin, 1986; Plomin, Chipuer, & Loehlin, 1990), which can be identified by the negative intra-pair correlations within dizygotic twins. Extraversion and neuroticism seem to differ with regard to their gene/environment etiology. In extraversion it is rather nonadditive genetic effects that play an important part, whereas the effect of the shared environment recedes. In neuroticism it is the other way round. Here additive genetic effects and shared environment are in the foreground (Baker, Cesa, Gatz, & Mellins, 1992; Eaves et al., 1989).

Genetic studies on motives, coping strategies and control-related beliefs seem to be lacking. One study (Kästele, 1988) compared MZ and DZ twins with regard to extraversion, neuroticism,

and action control. In contrast to the personality traits Kästele did not find a greater concordance in MZ twins with regard to action control. Thus, it is assumed that for these personality characteristics, as Nichols (1978) surmises, it is shared and individual environment rather than genetic influences that play the decisive part in the genesis of individual differences.

There is another point of interest which comes from studies concerning occupational and leisure interests (Carter, 1932; Grotevant, Scarr, & Weinberg, 1977; Lykken, Bouchard, McGue, & Tellegen, 1993; Moloney, Bouchard, & Segal, 1991; Vandenberg & Stafford, 1967; Waller, Kojetin, Bouchard, Lykken, & Tellegen, 1990). Lykken et al. (1993) pointed out that professional interests are genetically determined to a degree of nearly 50 percent, which can be explained by indirect effects of the qualifications and personality features that underlie professional interests and which were developed partly under genetic influences. In a similar vein we have to control the redundancies among our measures when genetic influences on them will be detected.

In summary, our study was directed at two goals: (1) to examine age and gender differences in global traits and specific personality variables within old age, and (2) to estimate the degree of the gene-environment determination of inter-individual differences in those variables.

METHOD

Sample

The Munich twin study was started by Kurt Gottschaldt in 1937 with 180 participants - 47 monozygotic (MZ) and 43 dizygotic (DZ) pairs of twins - between 6;2 and 18;3 years of age (mean age = 11;8 years). With two follow-up studies in 1950/1951 and in 1965 to 1968 Gottschaldt, who died in 1991, continued his longitudinal study (Weinert, Geppert, Dörfert, & Viek, 1994). In the last measurement wave, which was started in 1995 by a research group of the Max Planck Institute for Psychological Research, only 20 surviving "Gottschaldt twins" and 10 singles could again be tested. For this reason the sample was extended with new pairs of 65- to 85-year old twins (Weinert & Geppert, 1996, 1998). The participants from all over Germany were invited to Munich for one week of examination.

Only results of this last measurement wave will be reported here. Two hundred eighty participants, 94 males and 186 females, were tested up till now. The mean age of the sample was nearly 71 years (70;9). Female participants were significantly older (71;4) than male participants (69;2). Among the older participants there were more females than males, thus, both age and gender were not equally distributed. The sample was split into three age groups: 65 to 67 years of age ($N=73$), 68 to 71 years of age ($N=108$), and 72 years and older ($N=99$).

The 135 pairs (10 of the 280 participants were singles) were divided into 44 male and 91 female pairs of twins. Ninety eight pairs (35 male and 63 female) were identical/monozygotic (mean age=70;9), 37 pairs (9 male and 28 female) were fraternal/dizygotic (mean age=70;2). Pairs of mixed gender were not invited to the study.

Measures

Traits. We used the German adaptation of the Costa and McCrae (1992a) personality questionnaire, which encompasses the "Big Five": neuroticism, extraversion, openness to experience, agreeableness and conscientiousness (Borkenau & Ostendorf, 1993).

Motives. The self-attributed motives were measured by means of Jackson's Personality Research Form (PRF; Jackson, 1984; German version: Stumpf, Angleitner, Wieck, Jackson, & Beloch-Till,

1985), a multi-motive-questionnaire, which is designed according to Murray's personology, trying to measure "needs". Six out of 22 needs were selected: achievement, affiliation, dominance/power, endurance, play, and understanding. Only the first three "core" motives will be considered here. The Thematic Apperception Test (TAT) as an instrument of an implicit motive measurement was also conducted in our project; however, the transcription and coding have not yet been completed, and for this reason these data are not included here.

Coping strategies. The coping strategies of "assimilative persistence" and "accommodative flexibility" were measured by means of a questionnaire (Brandtstädter & Renner, 1988, 1990) comprising two independent scales of "Tenacious Goal Pursuit" (persistence) and "Flexible Goal Adjustment" (flexibility).

Competence- and control-related beliefs. The competence- and control-related beliefs were measured by means of a questionnaire (Krampen, 1991), which distinguishes between control by one's own actions (internal control), by external sources caused by powerful others (social control), and by chance, luck, fate (fatalistic or chance control). In addition, the self-concept of one's own competence was included. In order to complete the control aspect, Beck's hopelessness scale was added (Beck, Weissman, Lester, & Trexler, 1974, translated by Krampen, 1979).

Volitional control. The Action Control Scale (ACS), which assesses the degree of dispositional action- versus state-orientation, was implemented (Kuhl, 1994b). It consists of three subscales: the failure-related scale "disengagement vs. preoccupation", the decision-related scale "initiative vs. hesitation", and the performance-related scale "persistence vs. volatility".

Intelligence. To examine relationships between the selected personality variables and intelligence we also took general intelligence into account and applied the German version of the Wechsler Bellevue Adult Intelligence Scale (Wechsler, 1961).

RESULTS

Table 1 depicts the intercorrelations of all variables, including intelligence. There were numerous significant relationships between both, the subscales of the same questionnaires and the scales of different questionnaires. Not surprisingly, the within-questionnaire correlations all replicated the results already found in other studies. Neuroticism was negatively correlated with the other four Big Five traits which, on the other hand, were correlated positively with each other. Within motives there was a substantial correlation between achievement and power - an often found result in motivation research, which suggests that both motives share some degree of common variance. The two coping strategies of accommodative flexibility and assimilative persistence were slightly positively correlated. This is in line with Brandtstädter's (Brandtstädter & Renner, 1990) proposition that the two types of strategies are complementary and not exclusive. Competence- and control-related beliefs were also interrelated in an intelligible manner: Competence went together with internal control beliefs, and external control beliefs were correlated with hopelessness. Finally, within the action/state-orientation subscales only the failure-related and the decision-related scales were substantially correlated; this confirms the proposition that the three subscales represent measures which, although they share some common variance, are independent to a sufficient degree.

Table 1
Intercorrelations, means and standard deviations of all personality measures, including intelligence (Wechsler-IQ)

	Neur	Ext	Op	Agr	Con	Ach	Aff	Pow	Flex	Pers	Comp	Int	sExt	fExt	Hop	AOF	AOD	AOP	
Neuroticism (Neur)	--																		
Extraversion (Ext)	-.38	--																	
Openness (Op)	-.30	.24	--																
Agreeableness (Agr)	-.21	.14	.03	--															
Conscientiousness (Con)	-.36	.36	.07	.33	--														
Achievement (Ach)	-.21	.22	.27	-.13	.29	--													
Affiliation (Aff)	.01	.38	-.07	.12	.10	.14	--												
Power (Pow)	-.27	.41	.20	-.18	.24	.37	.15	--											
Flexibility (Flex)	-.52	.28	.19	.25	.22	.10	.01	.12	--										
Persistence (Pers)	-.44	.37	.34	.01	.43	.54	.05	.42	.21	--									
Competence (Comp)	-.59	.41	.31	.12	.50	.27	.11	.34	.43	.55	--								
Internality (Int)	-.26	.25	.10	.10	.35	.15	.21	.17	.27	.25	.45	--							
Social Externality (sExt)	.40	-.18	-.06	-.17	-.22	.02	.03	-.03	-.33	-.21	-.44	-.25	--						
Fatalistic Externality (fExt)	.44	-.25	-.21	-.15	-.33	-.06	.11	-.11	-.30	-.35	-.46	-.16	.54	--					
Hopelessness (Hop)	.55	-.34	-.27	-.12	-.26	-.19	-.05	-.24	-.37	-.35	-.44	-.26	.37	.39	--				
AO failure (AOF)	-.46	.27	.17	.04	.05	.12	.00	.23	.45	.23	.34	.13	-.24	-.18	-.37	--			
AO decision (AOD)	-.39	.22	.15	.16	.36	.31	.04	.24	.32	.35	.39	.17	-.19	-.16	-.31	.37	--		
AO performance (AOP)	-.19	.10	.16	.09	.18	.20	.00	-.08	.12	.23	.18	.01	-.22	-.13	-.13	.11	.15	--	
Wechsler-IQ	-.27	.12	.41	.11	.06	.13	-.12	.01	.22	.27	.25	.03	-.09	-.29	-.22	.11	.08	.20	
Mean	1.26	2.22	2.30	3.04	3.08	6.09	5.35	2.24	56.4	49.3	33.1	32.5	24.2	25.9	25.7	6.05	7.88	9.89	
Standard Dev.	.58	.51	.49	.42	.50	1.41	2.21	1.77	7.47	9.34	5.33	4.93	5.77	6.01	3.67	3.42	2.99	2.22	

Note. Bold coefficients: $p < .01$

Of the between-questionnaire correlations only the most noteworthy are mentioned here. It is remarkable that the basic traits of neuroticism and extraversion were highly correlated with nearly all other variables: Neuroticism went together with externality and hopelessness, but was negatively correlated with the achievement and power motives, with both coping strategies (flexibility and persistence), with the self-concept of competence and internality, and - last but not least - with all three action/state-orientation scales. Extraversion, on the other hand, was positively correlated with all three motives, both coping strategies, competence and internality, and the action/state-orientation scales, but negatively correlated with externality and hopelessness. The other Big Five traits, in sum, were not correlated with specific personality measures in that amount, although in some cases correlations reached a substantial degree, too. It is also worth mentioning that intelligence played a moderate role: As expected there was a substantial correlation between IQ and openness, but both of the coping strategies and feeling of competence were also positively correlated with intelligence. In contrast, neuroticism and externality were negatively correlated with the IQ. This correlational pattern has to be dealt with when estimating the genetical vs. environmental impact on the various personality measures (see below). There are many other correlation coefficients in Table 1 that invite for interpretations or even speculations concerning the relations of the various measures. But this is out of the scope of the present report.

Age and gender effects

Traits. Figure 1 shows significant gender differences for four out of the five traits (the main-effects and the interaction effect of age and gender were tested by a two factor ANOVA design). Males were more extraverted ($F_{(1,274)}=5.2$; $p<.02$), more open for new experiences ($F_{(1,274)}=7.0$; $p<.009$), and somewhat more conscientious ($F_{(1,274)}=2.8$; $p<.10$) than females. Females, on the other hand, were emotionally more unstable (neuroticism: $F_{(1,274)}=11.7$; $p<.001$) and more agreeable ($F_{(1,274)}=21.0$; $p<.001$). Age differences were found in extraversion and conscientiousness ($F_{(2,274)}=6.4$; $p<.002$ and $F_{(2,274)}=5.6$; $p<.001$): Both decreased with age. In extraversion this decrease was qualified by gender (interaction: $F_{(2,274)}=3.0$; $p<.05$). Males showed a curvilinear trend: After an increase of extraversion within the 68-71 years-old group there was a substantial decrease within the oldest group of males. For openness gender differences were also age-related (age x gender interaction: $F_{(2,274)}=3.6$; $p<.03$). The effect of a higher degree of openness within males resulted from an age-related increase whereas within females openness remained stable between the age groups.

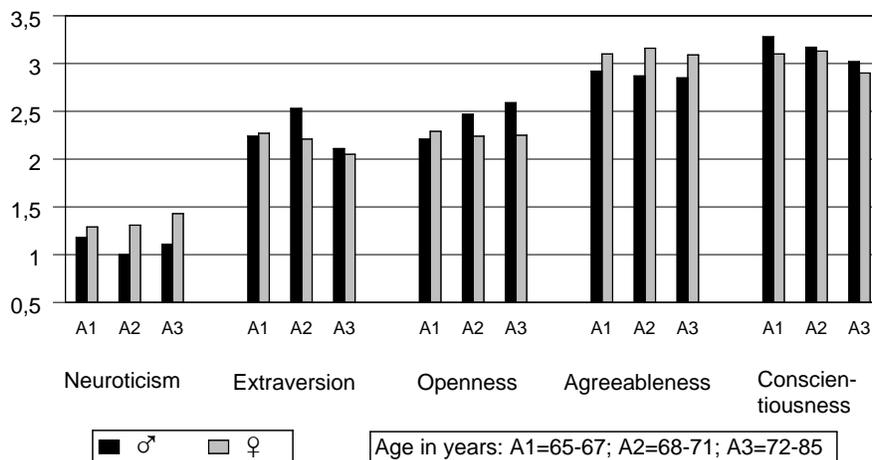


Figure 1. The Big Five as a function of gender and age

Motives. Figure 2 shows that males were achievement- and power-motivated to a higher degree than females ($F_{(1,274)}=13.0$; $p<.001$ and $F_{(1,274)}=35.0$; $p<.001$), respectively, who, in turn, were more affiliation-motivated ($F_{(1,274)}=3.8$; $p<.05$). A slight main effect of age was found in one case: The achievement motive decreased to a small degree ($F_{(2,274)}=3.1$; $p<.05$). Age-related gender differences were found for the power motive: There was an age-related increase in males, but a slow decrease in females (age x gender interaction: $F_{(2,274)}=4.0$; $p<.02$).

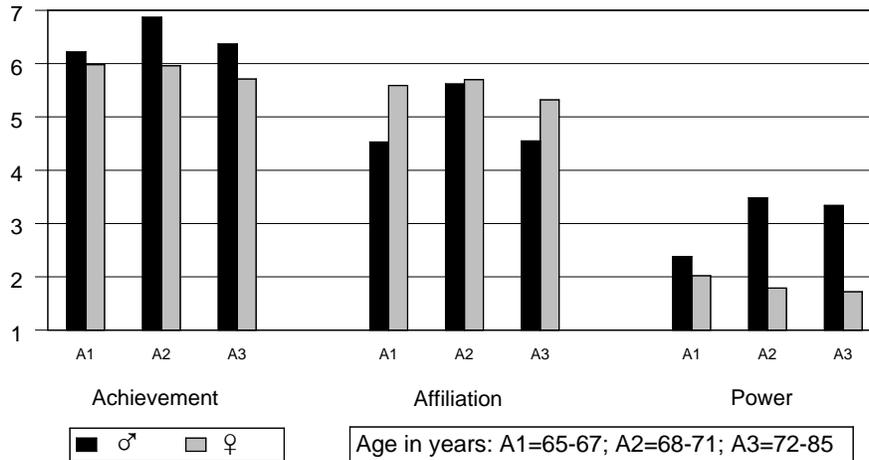


Figure 2. Achievement, affiliation, and power motive as a function of gender and age

Coping strategies. We found gender and age differences in tenacious goal pursuit (Figure 3). Males were more persistent than females ($F_{(1,274)}=28.9$; $p<.001$). This is consistent with the results by Brandtstädter and Renner (1990). In addition, corresponding with the results by Brandtstädter, Wentura, and Greve (1993), there was an age-related decrease in assimilative persistence ($F_{(2,274)}=3.6$; $p<.03$). But - in contrast to Brandtstädter et al. (1993) - there was no age-related increase in flexibility.

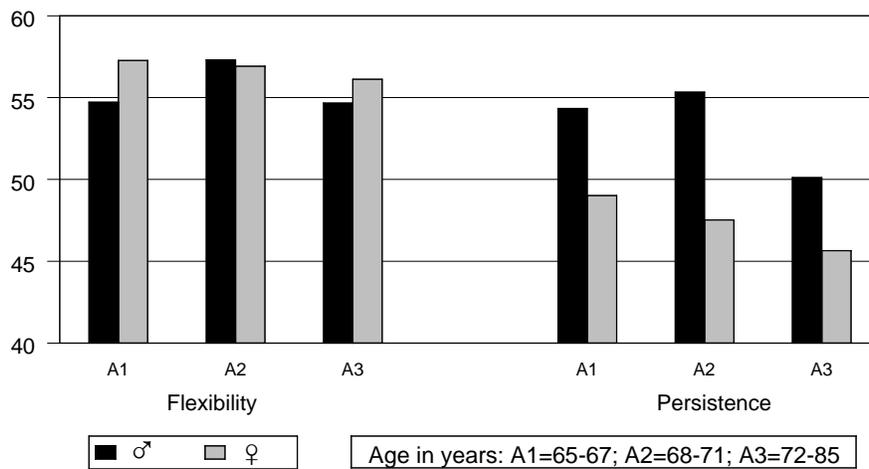


Figure 3. Flexibility and persistence as a function of gender and age

Competence- and control-related beliefs. Figure 4 shows several clear-cut gender differences but only slight age-related trends. Males described themselves as more competent ($F_{(1,274)}=15.2$; $p<.001$) and more internally determined ($F_{(1,274)}=7.7$; $p<.006$). Females - in contrast - believed that their behavior is more determined by chance, and good or bad luck (fatalistic externality: $F_{(1,274)}=6.1$; $p<.01$); they also felt more hopeless ($F_{(1,274)}=8.6$; $p<.004$). Significant age effects were found for social and fatalistic externality ($F_{(2,274)}=4.1$; $p<.02$; $F_{(2,274)}=4.7$; $p<.01$): externality increased with age.

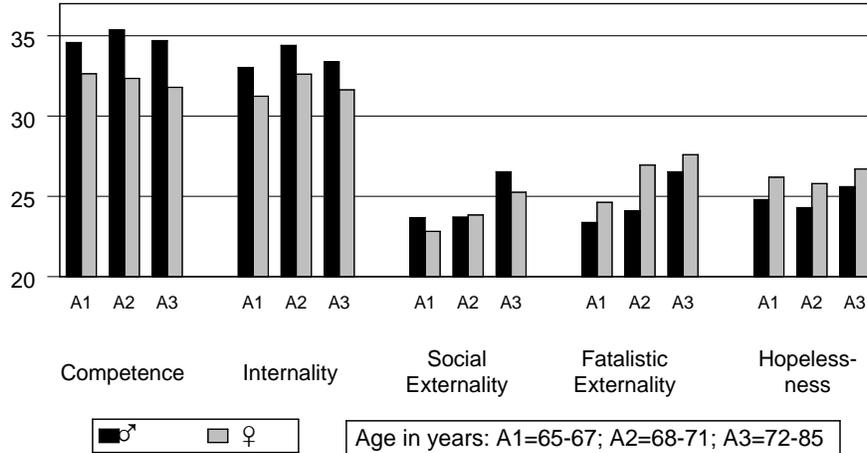


Figure 4. Competence- and control-related beliefs as a function of gender and age

Volitional control. Our analyses revealed no gender or age differences for failure-related and performance-related action/state-orientation (Figure 5). However, an age effect for decision-related action/state-orientation could be found ($F_{(2,274)}=5.6$; $p<.004$), which was qualified by gender (age x gender interaction: $F_{(2,274)}=5.2$; $p<.006$): Within males, decision-related action/state-orientation increased, whereas within females it decreased in the oldest group.

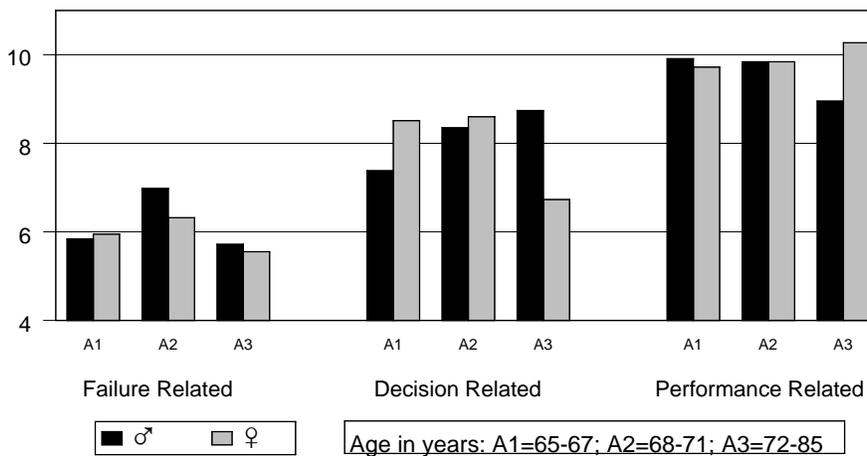


Figure 5. Action/state-orientation as a function of gender and age

Heredity and environment

Starting point of all genetic studies is the observation of resemblances, i.e., the intra-pair correlations or covariances, within identical and nonidentical twins or within identical twins growing up together or apart. With the help of structural equation models (cf. Eaves et al., 1989; Neale & Cardon, 1992), it is estimated to what degree behavior differences are determined genetically or environmentally. For this purpose, the following different genotype-environment components can be modelled for the explanation of a certain phenotype: additive (A) and nonadditive, "dominant" (D) genetic influences on the one hand, and shared/common (C) and nonshared/individual (E) environmental influences on the other. Possible interactions or covariations between the different genotype-environment components cannot be taken into account with the chosen statistical procedure (Lisrel). The four components (A, D, C, E) are modelled through latent variables and the manifest variables are usually corrected for age and gender effects (McGue & Bouchard, 1984). Therefore, the basic data are intra-class correlations of the residuals. For reasons of computability (equations with too many unknown variables), in one estimation run only models with three defining variance components can be dealt with. Therefore, the two latent variables "nonadditive genetic effect" versus "shared environment" are interchanged in order to be able to calculate maximal models (Additive-Common/shared-nonshared/Environmental [ACE] or Additive-nonadditive/Dominant-nonshared/Environmental [ADE]). They are confounded in twins reared together and cannot be estimated simultaneously. Sometimes, if the two intra-class correlations of the identical and non-identical pairs differ substantially - that is, if the DZ-intra-pair correlation is smaller than $\frac{1}{4}$ of the MZ-intra-pair correlation - only models with two defining quantities can be estimated. Errors due to lack of reliability occur at the expense of the individual environment, their influence is thus overestimated. Due to the small sample size of MZ- and DZ-pairs the split of genetic and environmental influences into their two more specific components (A, D and C, E) should be handled with care. These methodological preliminaries should be kept in mind when evaluating the results. Table 2 summarizes the statistics for estimating the variance components of genetic and environmental factors on all personality variables.

Traits. For the Big Five there was a high genetic determination of conscientiousness (56%) and extraversion (49%), and a low genetic determination of agreeableness (18%). Not only agreeableness (82%), but also neuroticism (68%) and openness (62%) were influenced by environmental determinants to a stronger degree than by genetic variables.

Within the genetic components, nonadditive genetic influence (D) determined extraversion, whereas the other traits were determined by additive genetic influence (A). Within the environmental components it was individual environment (E), not common/shared environment (C), that predominated in all traits. As proposed for neuroticism and extraversion (Baker et al., 1992; Eaves et al. 1989) the individual differences on neuroticism could be explained best by a model with ACE effects. From our results we can add that this also applied to openness, agreeableness, and conscientiousness. Extraversion, however, could be best explained by a model with ADE effects due to the high difference between the intra-class correlations of MZ- ($r=.49$) and DZ-twins ($r=.15$).

Table 2
Summary table of statistics for estimates of the genetic vs. environmental impact on personality measures

	Intra-pair correlations			Variance components (%)				Goodness of fit		
	Total	MZ	DZ	Genetic		Environmental		χ^2	df	p
	N=135	N=98	N=37	a^2	d^2	c^2	e^2			
Neuroticism	.32	.36	.20	32	-	4	64	0.00	3	1.00
Extraversion	.38	.49	.15	11	38	-	50	0.00	3	1.00
Openness	.48	.52	.36	32	-	20	48	0.00	3	1.00
Agreeableness	.43	.45	.36	18	-	27	55	0.00	3	1.00
Conscientiousness	.52	.59	.31	56	-	3	41	0.00	3	1.00
Achievement	.26	.30	.17	26	-	4	71	0.00	3	1.00
Affiliation	.32	.47	-.11	-	46	-	55	1.86	4	.76
Power	.26	.26	.25	2	-	24	74	0.00	3	1.00
Flexibility	.38	.56	-.05	-	56	-	45	1.32	4	.86
Persistence	.35	.48	.05	-	48	-	52	0.18	4	1.00
Competence	.47	.59	.15	1	58	-	41	0.00	3	1.00
Internality	.31	.36	.22	28	-	8	64	0.00	3	1.00
Social Externality	.44	.49	.29	40	-	9	50	0.00	3	1.00
Fatalistic	.47	.48	.44	8	-	40	52	0.00	3	1.00
Hopelessness	.42	.45	.27	36	-	9	55	0.00	3	1.00
AO failure-related	.43	.52	.21	32	20	-	48	0.00	3	1.00
AO decision-related	.52	.53	.48	10	-	44	48	0.00	3	1.00
AO perform.-related	.34	.45	.04	-	45	-	55	0.19	4	1.00

Note. Intra-pair correlations are corrected for age and gender; MZ= monozygotic twins; DZ = dizygotic twins; coefficients of the variance components: a = additive, d = nonadditive/dominant, c = shared, e = nonshared (squared to get the percentage); only the model with the best fit is quoted (the acceptance of a model requires a nonsignificant value of the residual χ^2); AO = Action orientation.

Motives. Nichols' (1978) assumption that motives are less genetically determined than the basic traits was only partly supported. The achievement and affiliation motives were influenced by genetic components to a substantial degree (26% and 46%, respectively). For power, however, the intra-pair correlations of identical and non-identical twins were nearly equal ($r=.26$ vs. $r=.25$), and therefore only a marginal genetic determination (2%) could be found. Despite the considera-

ble genetic impact on achievement and affiliation for all three motives nonshared environmental influences (E) prevailed. The best fit for each motive followed different models. Achievement was best explained by ACE-effects, affiliation by DE-effects and power by CE-effects.

Coping strategies. Individual differences in the coping strategies “accommodative flexibility” and “assimilative persistence” were highly genetically determined (56% to 48%, respectively). Both cases fit the simple DE model, that is, only nonadditive genetic effects (D) and nonshared environmental effects (E) are relevant. Flexibility and persistence seem to be more dominated by genetic impact than most of the traits.

Competence- and control-related beliefs. The differences in competence-related beliefs, in social externality, and in hopelessness were highly determined by genetic factors (59%, 40%, and 36%, respectively); competence-related beliefs fit the DE-model, social externality and hopelessness fit the ACE-model. Internal control and fatalistic external control, however, were less determined by genetic influences (28%, 8%), and mostly influenced by nonshared, individual environment (E). They followed the ACE-model, typically found for most of the traits.

Volitional control. The genetic determination of the three measures of action/state-orientation varied from high to moderately low. The decision-related action/state-orientation (whether someone is able to act upon decisions quickly) was only slightly determined (10%) by genetic influences (A); shared (C) and nonshared (E) environmental influences predominated. In contrast, performance-related action/state-orientation (persistence) and failure-related action/state-orientation (disengagement from past failures) were determined to a higher degree by genetic conditions (45% and 52%). In the case of the performance-related measure only nonadditive genetic sources (D) were relevant, whereas in the case of the failure-related measure additive genetic influences (A) predominated. As to environmental influence only individual environment (E) played a role for both control variables.

Search for an indirect genetic determination. The analysis of genetic vs. environmental impact surprisingly revealed that the genetic influence on some personality measures seems to be as high as for the basic traits. Before jumping to speculative conclusions on that point the relationship between these measures and the global traits or intelligence had to be examined. The correlational analysis (Table 1) depicted many significant interrelationships between global and specific personality variables. Thus, one has to prove whether, as it was, for example, in the case of professional interests (Lykken et al., 1993), the ostensible genetic impact on the specific personality measures is due to the influence of the basic traits or intelligence that are genetically determined to a substantial degree.

We tested this hypothesis by performing regression analyses of personality measures with a remarkable genetic determination ($> 40\%$). Intra-pair correlations and the variance components for heredity and environment were computed (Table 3), controlling for, not only, age and gender (as was done in the basic analyses, cf. Table 2; step 1) but, in addition, also for the Big Five traits and intelligence (step 2).

These analyses reduced the genetic variance ($a^2 + d^2$) in favor of the environmental variance ($c^2 + e^2$) for the selected variables in different degrees (Table 3). For one group of measures, namely, flexibility, social externality and failure-related action/state-orientation, the genetic influences obviously resulted from shared variance with the traits and intelligence since the heredity index decreased substantially when these basic measures were controlled. For a second set of variables, affiliation motive, persistence and performance-related action/state-orientation, howev-

er, the index of genetic determination was not reduced as considerably and was still somewhere about 40 percent. For competence-related beliefs, although the genetic variance was decreased substantially, it finally remained also on the 40-percent level. For these variables, therefore, it seems justified to conclude that they are to a moderate degree subject to direct genetic determination.

Table 3
Multiple regression analyses of the genetic vs. environmental impact on personality measures with an ostensibly high genetic determination (> 40%), controlling for the influence of the Big Five and intelligence.

Dependent variable	Step	Intra-pair correlations		Variance components (%)	
		MZ	DZ	Genetic	Environmental
Affiliation	1	.47	-.11	46	55
	2	.38	-.08	37	62
Flexibility	1	.56	-.05	56	45
	2	.26	-.28	23	77
Persistence	1	.47	.05	48	52
	2	.38	-.17	37	64
Competence-related Beliefs	1	.59	.15	59	41
	2	.44	-.18	40	61
Social Externality	1	.49	.29	40	59
	2	.42	.33	19	81
Action Orientation Failure-related	1	.52	.21	52	48
	2	.33	-.11	32	69
Action Orientation Performance-related	1	.45	.04	45	55
	2	.40	.01	40	61

Note. MZ = monozygotic twins, DZ = dizygotic twins; genetic % = $a^2 + d^2$; environmental % = $c^2 + e^2$. Step 1: controlled for gender and age; Step 2: additionally controlled for the Big Five + intelligence.

DISCUSSION

For the discussion we will first sum up the age and gender effects we found and then concentrate on the question of heritability.

Age and gender

Reviewing our results, we can confirm several main effects of gender and a few age trends which are mostly different in males and females.

Traits. The strength of four of the Big Five traits was influenced by gender. Females had higher values in neuroticism and agreeableness, and lower values in extraversion and openness than males. These results are completely in line with the usual findings on gender differences in the Big Five (Feingold, 1994) that were also replicated in a recent survey with more than 3500 participants (Goldberg, Sweeney, Merenda, & Hughes, 1998).

A clear age trend was found for conscientiousness: Both, males and females became less conscientious with growing age. As to extraversion a decline was found from 68 years on and for openness an age-related increase was shown only by males. These results are remarkable in two respects: First, taken together the age trends were, with one exception, not very pronounced and confirm the hypothesis that from 65 years on personality traits remain quite stable and are subject only to minor changes. Second, at first glance the decrease in conscientiousness appears astonishing, since it was not expected, neither from theory nor from other findings. Goldberg et al. (1998), for example, after their analysis of the pertinent literature, came up with the conclusion: "Of all the Big-Five domains, the only one that might be expected to be monotonically related to age is conscientiousness" (p. 396). This was actually the result they obtained in their survey. With age people usually become more conservative, traditional, well-organized, dependable, practical, economical and cautious - all these are facets of conscientiousness. However, according to our results, the trend seems to be curvilinear; conscientiousness *decreased* beyond the age of about 65. This decrease was accompanied by a parallel decrease in extraversion from about 68 years on.

Since our study is a cross-sectional one, this result could be due to cohort effects - which, by the way, is the case for all of our age-related findings. But we would prefer a more psychological explanation: One could argue that cultural values like love of order, diligence, punctuality, or trustworthiness become less important after retirement; people become less assertive (extraverted) and, at the same time, more lenient towards normative aspirations. This is, for the moment, of course a speculative proposition which requires more thorough analyses in the future. However, in support of our assumption Brandtstädter, Rothermund, and Schmitz (1998), for example, found in the protocols of their interviews with elderly people "the freedom to leisurely let things run their course and not believe that you can change the world" (p. 370) as a typical example of compensation with later life.

Motives. We found gender differences in the core motives of achievement, affiliation, and power which are in line with a culturally expected and a most often found result of motivation research: Males were achievement- and power-oriented to a higher degree than females who, in turn, were more affiliation-oriented. This result, incidentally, confirms the applicability and usefulness of the Personality Research Form as a tool for the measurement of self-attributed motives in old age.

The little research of adult motive development, comparing motive scores of middle aged adults with that of old adults, showed a general motive decline (McClelland et al., 1998; Veroff et

al., 1980). However, again as it was the case for traits, there is a lack of studies on motive development in very old age. Although in our participants a motive decline could, of course, have happened at a younger age, according to our results no general trend in motive development takes place in old age. For all three motives females showed, if at all, a small decrease. Somewhat more pronounced trends applied to males: an *increase* in all three motives up to the age of 71 was followed by a decrease in the achievement and affiliation motive, but not in the power motive. Obviously, power- or dominance-related incentives remain important especially for old males (see also Halisch & Geppert, this volume).

Our results rely on self-attributed motives, while Veroff's and McClelland's results with younger adults are based on the TAT measuring implicit, unconscious motives. Presumably elderly have a high esteem of goals, values and desires concerning power or affiliation, but probably these appreciations are no longer based on affective experiences which affect and sustain the corresponding motivated behavior. The hypothesis assuming a different course of the development of self-attributed and of implicit motives can be examined when our TAT data are ready for analysis.

Coping strategies. According to Brandtstädter (1992; Brandtstädter & Renner, 1990; Brandtstädter, Wentura & Greve, 1993) coping in old age is characterized by an interplay of assimilative and accommodative tendencies to keep the balance of gains and losses favorable. Based on the findings of the Brandtstädter group with data from participants, 18 to 89 years of age, we predicted an age-related decrease in assimilative strategies and an increase in accommodative strategies. This is not completely confirmed by our results: From 65 years on a continuous decline in assimilative persistence was confirmed, that is, efforts to alter one's own life circumstances decreased. Accommodative flexibility, however, remained stable. As a consequence, "net flexibility" (the difference between flexibility and persistence) *increased* with age. That sounds surprising at first, but it means that accommodative flexibility - relative to assimilative persistence - becomes more important over the years. Heckhausen (1997) reported comparable results concerning net flexibility although in her study flexibility increased and persistence remained stable with age.

Compared to males, females in all three age groups had substantially lower scores in assimilative persistence, again leading to a higher net flexibility. That is, they were ready to adapt personal preferences to situational constraints by adjusting aspiration levels, revising value priorities and standards, and neutralizing negative self-evaluations to a higher degree than males.

Competence- and control-related beliefs. Our results corroborate pronounced gender differences that are culturally expected and are usually found in the literature (Deaux, 1976; Lenney, 1977; Roberts, 1991; Ruble, Greulich, Pomerantz, & Gochberg, 1993): Males feel more competent and internally determined than females, who, in contrast, feel more externally driven (fatalistic externality) and hopeless.

Studies that aim at detecting developmental changes in control-related beliefs are characterized by a great variety of measurement tools and age samples (Krampen, 1987; Skinner, 1996). But again there is only scarce evidence for the latest period of life (Heckhausen & Schulz, 1995). Therefore, only some tentative assumptions could be made, if at all. Following the meta-analysis by Krampen (1987) one could expect an increase in internality in adulthood followed by a stabilization on a relatively high level, and also an ongoing increase in externality. This is explained by a growing realization of the restricted influence one has on one's own life circumstances. In fact, our results confirmed such a hypothesis. Competence-related beliefs and internality remained rather stable on a certain level. However, an age-related change was found in social and fatalistic externality: both of them continuously increased from 65 years on. In sum, there is some evi-

dence for a developmental change between 65 and 85 years, which points to a heightened inclination to feelings of externality, especially in the oldest participants.

Volitional control. We did not state hypotheses concerning changes in volitional control in old age neither from a theoretical perspective nor from an empirical base since there are virtually no pertinent studies available. In that respect our study enters a new territory. One result is worth mentioning: An age by gender interaction on decision-related action/state-orientation revealed that males became increasingly “impatient“ with age, that is, tended to act upon decisions more and more quickly, whereas females from 72 years on were especially prone to hesitation.

Heredity and environment

Traits. In a first step the genetic and environmental determination of the Big Five was examined as a “baseline” for the other personality characteristics. The results confirmed the variance patterns known from genetic studies in personality (Baker et al., 1992; Eaves et al., 1989): The Big Five traits were moderately to highly determined by genetic factors: The heredity coefficients differed between 56 and 18 percent: conscientiousness (56%), extraversion (49%), neuroticism (32%), openness (32%), and agreeableness (18%). Compared with other studies (Loehlin, 1992), the degree of genetic determination of extraversion and conscientiousness was quite high (expected are 35 to 40 percent or lower). This contradicts the general assumption of a decrease in genetic influences on traits with age (McCartney, Harris, & Bernieri, 1990). On the other hand, the genetic determination of openness to new experience was lower than expected from studies which found values above 50 percent (McGue et al., 1993).

With respect to the additive and nonadditive genetic effects we found that in neuroticism additive genetic effects (A) played an important role, whereas in extraversion nonadditive/dominant genetic effects (D) were in the foreground. With respect to environment the non-shared/individual environment (E) predominated over the shared/common environment, even if we consider an overestimated influence of nonshared environment due to lacking reliability of the questionnaire. The predominance of nonshared environment is in accordance with most of the studies which analyzed the different sources of environmental influence. Only for cognitive abilities and only in childhood a greater part of the variance is due to shared environment - with diminishing impact during the course of time to adolescence (Plomin et al., 1997).

According to our data the ACE-model encompassing additive genetic effects (A) and shared (C) and nonshared environmental influences (E) was most suited to represent the data for all traits, except extraversion. In the latter case the ADE model with nonadditive genetic (and without shared environment) effect was more appropriate.

Motives, coping strategies, and control beliefs. About the role of genetic and environmental determination of individual differences in motives, coping strategies, competence- and control-related beliefs, and volitional control only rough ideas exist. Compared with the more fundamental traits of the Big Five motives, strategies, and beliefs are generally expected to be less determined by genetic factors (Nichols, 1978). Above all, due to their ascribed role as learned dispositions, these personality measures should be influenced primarily by environmental factors of learning and socialization.

Taken together, the motives in fact were less influenced by genetic factors than the traits. However, the hypothesis of only minor genetic influence on motives was not confirmed in general since the genetic impact was different for each motive: affiliation (46%), achievement (26%), power (2%). All three motives were determined only, or primarily, by individual learning experi-

ences (E), but the genetic determination was diverse: additive genetic influences (A) on the achievement motive, nonadditive genetic influences (D) on the affiliation motive. Considering the different type and amount of genetic influences on the motives, a different etiology of the three motives can be assumed.

Our results are, for the present, of restricted value for the question of genetic determination of individual differences in motives, since they are based on self-report data only. For a complete analysis measures of implicit motives, which are based on projective techniques like the TAT, are lacking. First, it sounds intelligible that attitudes towards and appreciations of intentions, goals, and motive-specific behavior based on cognitively elaborated constructs are more affected by environmental influences than the implicit motives based on affective experience. Second, the self-attributed motives are correlated with the Big Five traits which, to a substantial degree, are determined by genetic factors (Table 1; see also Borkeu & Ostendorf, 1989; Paunonen, Jackson, Trzebinski, & Försterling, 1992). This could result in an overestimation of the genetic influence on self-attributed motives. Indeed, controlling for the influence of the Big Five and intelligence, the genetic impact on the affiliation motive (the motive with the highest genetic determination) was reduced (from 46% to 37%, Table 3) although it was still on quite a high level. Whether self-attributed and implicit motive measures are in fact subject to different amounts of genetic influence remains an open question - until our TAT data are ready for analysis.

Assimilative persistence and accommodative flexibility were subject to remarkably high genetic influence (48% and 56%) which surpassed the genetic determination of the fundamental traits. Again, since both coping strategies were highly correlated with the trait variables (Table 1) one can suppose an overestimation of the heredity influence on both scales. Indeed, for flexibility the genetic variance component was reduced from 56 to 23 percent controlling for the Big Five and intelligence (Table 3). However, the direct genetic determination of persistence was not reduced as substantially (from 48 to 37%). Thus it seems justified to accept persistence as moderately high and directly determined by the genes.

We found different patterns of genetic determination for competence- and control-related beliefs. There were high genetic influences on the self-concept of competence (58%), social external control (40%), and hopelessness (36%), a moderate one in internal control (28%), and a low one in fatalistic external control (8%). Again, the high genetic impact on competence and social externality could be proven by regression analyses to be in part due to the Big Five and intelligence (Table 3). Yet, especially for the self-concept of competence it still remained on the remarkably high level of 40 percent. Therefore, it seems justified to accept the self-concept of competence as partly anchored in the genetic equipment.

The scores on the three scales of action/state-orientation also differed in their genetic/environmental determination. Whereas a remarkable 52 and 45 percent genetically influenced the failure- and the performance-related action/state-orientation, the impact of heredity was low in decision-related action/state-orientation (10%). The controlling for the common variance with the trait factors and intelligence reduced the genetic determination of the failure-related scale to 32 percent and that of the performance-related scale only marginally (to 40%). Thus, especially performance-related action/state-orientation seems to be directly determined by genetic influence to a substantial degree.

SUMMARY AND CONCLUSIONS

Gender. Our results largely corroborate the findings of the vast majority of gender-related studies in personality (Feingold, 1994): Males are more extraverted, achievement- and power-motivated, persistent, and feel more competent and internally determined than females. Females, in contrast, are emotionally more unstable, agreeable, affiliation-motivated, feel more externally driven, and hopeless. These results are not surprising since they reflect culturally determined and widespread gender-related norms, values and feelings. One can assume that especially elderly people have internalised their sex-roles and adhere to gender-related norms. On the other hand, these gender differences could have their roots in the evolutionary history or even the genetic equipment of males and females. Our data, of course, provide no basis for such a debate and there is no room for speculations, which are far beyond the scope of this paper.

Personality development in old age. Concerning personality development in seniority, one has to keep in mind that our results are based on a cross-sectional study, in which age and cohort effects are interwoven. Therefore they are to be interpreted as a developmental sequence only with caution. Furthermore, our data are of somewhat restricted value for a generalisation to a psychology of the last period in life since the participants who were enrolled, were healthy enough to come to Munich for a week and to endure the strenuous experimental procedure.

As a whole, differences between the age groups confirmed the assumption that in the elderly personality characteristics remain quite stable. Nevertheless, we found a few remarkable age-related trends: Among the Big Five an unexpected decrease in conscientiousness took place from 65 years on (which was accompanied by a decline of extraversion from about 68 years on). We tentatively explained this result that contradicts developmental hypotheses concerning conscientiousness, which were based on earlier studies with younger adults, by supposing an inclination of elderly people to become more lenient towards normative values and aspirations, and an increasing tendency to let things go.

For the self-attributed motives a general decline could not be detected. If at all, a small decrease for the achievement and affiliation motives took place in the oldest participants. For power, however, there was a clear age-related gender difference. Whereas within females power became less important with age, within males power was of high importance even in the oldest group.

Contrary to the result of the Brandtstädter group, there was clear evidence in our study that from 65 years on the coping strategy of assimilative persistence decreased but flexibility remains on quite a high and stable level. However, from a theoretical standpoint these divergent results are not as incongruent as it seems at first glance. In both studies net flexibility, that is the difference between flexibility and persistence, increased with age. This confirms the hypothesis that coping in old age reacts to the challenges of life circumstances and situational and personal constraints and aims at keeping gains and losses of aging in balance.

Finally, the results confirmed the assumed developmental trend for feeling of externality: Elderly people increasingly perceive their life as dependent on factors they are unable to influence.

Heredity vs. environment: global effects. Since monozygotic as well as dizygotic pairs of twins were enrolled in our study it was possible to estimate the impact of genetic vs. environmental influences on the various personality measures. With respect to the Big Five traits general assumptions concerning the degree of genetic influence were confirmed: For the NEO Big Five (neuroticism, extraversion, openness) the variance components due to genetic factors were be-

tween 30 and 50 percent. For conscientiousness the heredity coefficient was - unexpectedly - over 50 percent and for agreeableness it was lower than 20 percent.

For the specific personality measures, taken as a whole, compared to the Big Five a somewhat lower impact of genetic determination was shown. There are, however, remarkable differences between these measures. For one group of variables environmental influences clearly predominated or an ostensibly high genetic impact could be proven due to common variance with the Big Five and intelligence. These are the achievement and power motives, flexibility, control beliefs, and decision-related action/state-orientation. For a second group, however, the heredity coefficient remained on a rather high level (about 40%) even after controlling for the moderating effect of the Big Five and intelligence. For these measures, the affiliation motive, persistence, the self-concept of competence, and performance-related action/state-orientation, our data justify the assumption that they are to some degree rooted in the genetic equipment.

Heredity vs. environment: additive and nonadditive effects. The further split of genetic and environmental influences into their specific components allows distinguishing between additive and nonadditive genetic and between shared and nonshared environmental impact. Regarding the environmental factors a clear dominance of nonshared, individual influence of learning experience and socialization was shown. The influence of shared environment seems to be irrelevant for personality variables. Concerning the genetic components, however, the situation was somewhat more complicated. For the Big Five, except extraversion, and for half of the specific personality variables, especially the achievement motive and all measures of control beliefs additive gene effects prevailed. Nonadditive gene effects (dominance, epistasis), in contrast, were active in extraversion, the affiliation motive, in persistence and flexibility, in competence beliefs, and in performance-related action/state-orientation.

We have no apt explanation why one variable is determined by additive and the other by nonadditive gene effects. First, in general, there are reasons to consider self-reports of twins reared together as problematic data. Such data may be distorted by contrast effects (negative intra-pair correlation) resulting from the underestimation of the similarity between DZ twins, and, therefore may inflate the estimates of nonadditive genetic influences (Carey, 1986; Heath et al., 1992; Lykken et al., 1992; Rose, 1995). Possibly, the various self-report measures are subject to such distortion effects in a different amount.

Second, it might be possible that any confounding of one or two basic dimensions in one measure - each of which could be additive - could increase the nonadditive component. This would indicate a greater complexity of the underlying mechanisms involved or the confounding of several simple factors. Then, for example, the nonadditive genetic component of extraversion would be the result of confounding positive affect and activation/arousal in one scale, each of which is related to extraversion according to the literature. Another example is the affiliation motive. The scale comprises two different types of affiliation, i.e., security seeking and intimacy. It is an open question in what way such a multidimensionality of scales affects the estimation of the impact of additive vs. nonadditive gene effects. These and other questions will be addressed when the Munich twin study will be completed.

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