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Findings from the Munich Longitudinal Study of Giftedness and Their Impact on Identification, Gifted Education and Counseling

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Abstract: The Munich Longitudinal Giftedness Study (MLGS), originally carried out from 1985 to 1989 and completed by two follow-ups in the nineties, focused on three aims in the first project phase and on five aims in the second phase. From the mid-nineties to the end of 2010, many consecutive studies based on the theoretical and empirical results of the MLGS have been implemented at the Center for the Study of Giftedness at Ludwig Maximilians University (LMU) of Munich. First of all, the "Munich Model of Giftedness" (MMG) and the extended version "Munich Dynamic Ability Achievement Model" (MDAAM) will be explained as the theoretical frame of the MLGS and the following investigations. After methodological remarks, selected findings of the MLGS are presented in greater detail. Practical applications to identifying gifted individuals and talent search for gifted programs are in the center of the following section. Of special interest should be MMG- and MDAAM-based scientifically evaluated intervention strategies and measures for enhancing individual potentials versus measures for reducing ineffective or dysfunctional motivation variables and self-concept patterns, e.g. with regard to STEM- and at-risk-groups. Finally, some conclusions will be discussed.

Keywords:

giftedness-related gender differences, multidimensional conceptions of giftedness, Munich Dynamic Ability Achievement Model (MDAAM), Munich High Ability Test Battery (MHBT), Munich Model of Giftedness (MMG), personal characteristics of giftedness, types of giftedness

The Munich Longitudinal Giftedness Study (MLGS) is based on a multidimensional concept of giftedness. Hence giftedness, academic and non-academic achievement as well as non-cognitive personality and environmental characteristics are considered to be multidimensional. The intellectual, creative, social, musical and psychomotor domains have been under investigation in this study.

After the first and second phase of the MLGS (1985 to 1997), many consecutive studies related to the MLGS-results were implemented at the Center for the Study of Giftedness (CSG) at LMU until 2010, for example, on the development of metacognition and metamemory in childhood, the relationship between leisure time activities and creative performance, the construction and validation of the Munich High Ability Test Battery (MHBT) by Heller and Perleth (2001, 2007), and several longitudinal program evaluation studies. Furthermore, MLGS-related replications and cross-cultural investigations in co-operation with the USSR/Russian Academy of (Educational) Sciences in Moscow, the Chinese Academy of Sciences in Beijing or the Korean Educational Development Institute in Seoul have been carried out in the last two decades (for greater detail see Heller, 2010a).

Theoretical Background

Giftedness models developed in the last three decades are mostly characterized by multidimensional or typological ability constructs, for example, by Renzulli (1978), Gardner (1983), Sternberg (1985), Mönks et al. (1986), Gagné (1985, 1993, 2000, 2008; for

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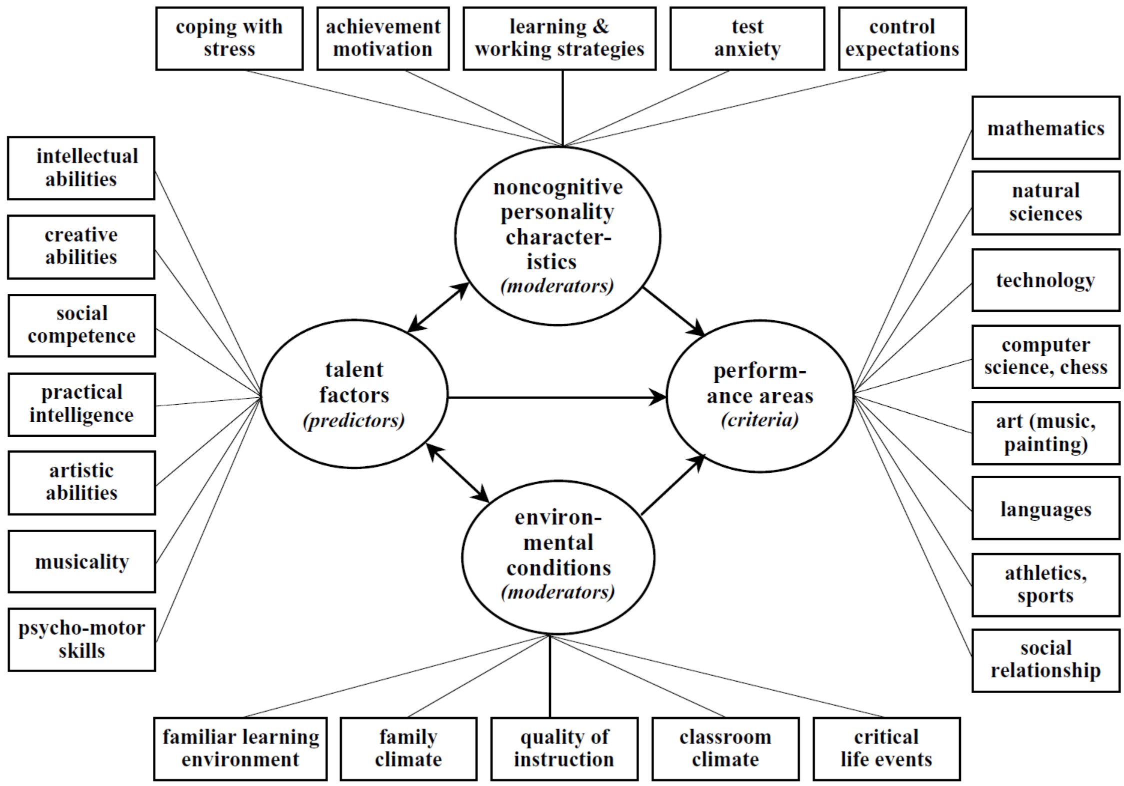
an overview see Sternberg & Davidson, 2005). According to this trend, Heller and Hany (1986) and Heller and Perleth (1992/2001) conceptualized "giftedness" or "talent" as a multi-factorized ability construct within a network of non-cognitive (motivations, control expectations, self-concepts, etc.) and social moderators as well as performance-related (criterion) variables. For diagnostic and intervention purposes, the difference between predictor, criterion, and moderator variables is of particular interest. The Munich Model of Giftedness (MMG) served as a reference model for the first two MLGS-phases (1985–1997; see figure 1).



Legend:

Talent factors (predictors)
- intelligence (language, mathematical, technical abilities, etc.)
- creativity (language, mathematical, technical, artistic, etc.)
- social competence
- musicality
- artistic abilities
- psycho-motor skills
- practical intelligence

(Noncognitive) Personality characteristics (moderators)
- achievement motivation
- hope for success vs. fear of failure
- control expectations
- thirst for knowledge
- ability to deal well with stress (coping with stress)
- self-concept (general, scholastic, of talent, etc.)

Environmental conditions (moderators)
- home environmental stimulation („creative" environment)
- educational style
- parental educational level
- demands on performance made at home
- social reactions to success and failure
- number of siblings and sibling position
- family climate
- quality of instruction
- school climate
- critical life events
- differentiated learning and instruction

Performance areas (criteria)
- mathematics, computer science, etc.
- natural sciences
- technology, handicraft, trade, etc.
- languages
- music, arts (musical-artistic area)
- social activities, leadership, etc.
- athletics/sports

Figure 1. The Munich Model of Giftedness (MMG) by Heller and Hany (1986), Heller (1991, 1992/2001), Heller, Perleth and Lim (2005).

According to this model, giftedness arises in the areas of intellect, creativity, social competence, artistic (musical) ability, and psychomotor ability. The individual potentials of giftedness correspond to particular academic or nonacademic achievement areas. In addition to cognitive abilities, various (non-cognitive) personality characteristics such as motives, interests, self-concepts, and so on, are involved. Family and school socialization factors are important learning environmental conditions for developing expertise and domain-specific performances.

For several MLGS-based investigations, especially with developmental and/or intervention purposes, Ziegler and Perleth (1997) and Perleth (2001) – also see Heller, Perleth and Lim (2005) – extended the MMG to the Munich Process Model and the Munich Dynamic Ability-Achievement Model (MDAAM) respectively.

The MDAAM (see figure 2) attempts to bridge the gap between the prospective (status-psychometric) approach and the dynamic or process-oriented research including the retrospective expertise-novice paradigm with regard to developing excellence. Such an integrative model must fulfill the following requirements (according to Perleth, 2001, pp. 367–372):

- conceptualizing abilities and gifts in a differentiated manner;
- combining the findings of genetic psychology and cognitive information processing research;
- considering the domain-specific character of performances;
- explaining how cognitive abilities are transformed into achievement, e.g. by learning processes, amount of learning time, quality of experiences, etc.;
- knowledge acquisition processes and the role of foreknowledge as prerequisites of achievement in and outside school;
- the function of intervening variables (individual moderators like interests, motives, working behavior etc., and social conditions like family and school climate, fostering feasibilities etc.) with regard to excellence performance;
- fulfilling of one of Sternberg's criteria for a "good definition of giftedness" by presenting an appropriate level of complexity so that it is convincing to gifted children and youth as well as to relevant persons, e.g. parents and teachers.

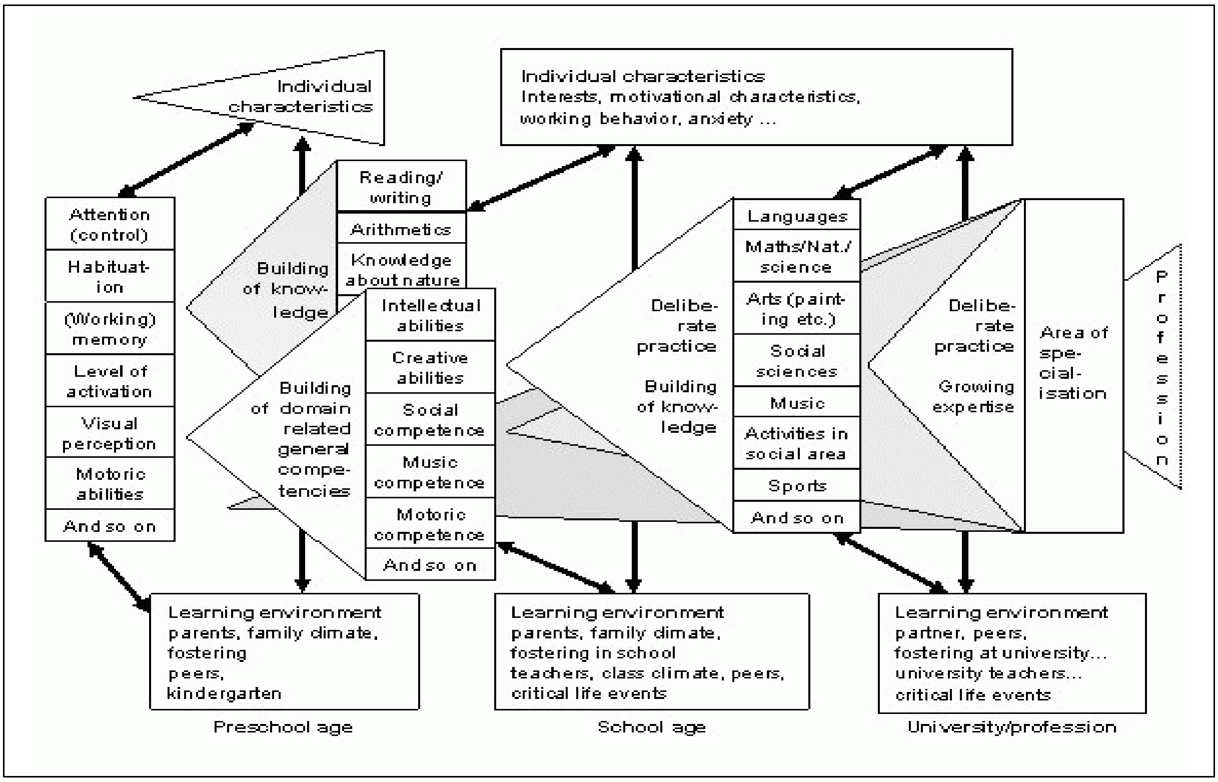


Figure 2. The Munich Dynamic Ability-Achievement Model (MDAAM) by Perleth (2001, p. 367).

The MDAAM distinguishes between three stages of achievement or expertise development. These are related to the main phases of school and vocational training, which can be roughly compared with Plomin's (1994) classification into "passive" (pre-school age), "reactive" (primary school age), and "active" (adolescence/adulthood) genotype-environment relations. Certain learning processes belong to each of these stages. They serve the building up of competencies and are symbolized by the grey triangles. These triangles open to the right are indicating growth in abilities, knowledge, or competencies. The left corner of the triangles indicates when the respective learning process begins (the different tones of grey are just to make the figure clearer).

The profession phase is related to Ackerman's model in which an integration of psychometric and information processing perspectives is attempted (Ackerman, 1988). This claims that, as the level of expertise increases, the accumulation of knowledge and the acquisition of field-specific competencies are influenced by active learning processes, that is, non-cognitive personality traits such as interests or motivation tend to prevail over giftedness potentials. Nevertheless, it is still uncertain whether active learning time is solely responsible for the development of excellent achievement in a certain domain, as assumed in Ericsson's "deliberate practice" hypothesis. There is no convincing proof for the claims in Ericsson et al. (e.g. Ericsson, Krampe, & Tesch-Römer, 1993) that all adolescents or young adults in randomly chosen domains – independent of the individual talents – are capable of achieving the same level of expertise as the very able. Hence, the formulation of threshold hypotheses (e.g. Schneider, 1993, 2000) may be regarded as an attempt to "salvage" the research findings in the expertise paradigm without having to forsake the importance of cognitive learning and achievement potentials for the development of expertise at a high or very high level (excellence), as demonstrated in the psychometric paradigm of giftedness research.

Research on the expert-novice paradigm from a lifespan perspective has suggested that the development of expertise and excellence is a function of an individual's developmental stage. While motivation and interest in a subject or domain seem to be the determining factors at early stages, instructional methods and quality of teaching become more and more important as the difficulty level increases (Subotnik & Arnold, 2000; Subotnik & Steiner, 1993). For greater detail, see Heller, Perleth, and Lim (2005) or Heller (2010a).

Objectives

Identification Phase (I)

The project phase one was dedicated to questions of identification and the validity of the MMG:

(1) Construction and evaluation of tests and questionnaires for the identification of gifted students (grades 1 to 12).
(2) Testing relevant aspects of the MMG underlying the MMG, particularly the independence of the giftedness domains under investigation.
(3) Analysis of the typological structure of the sample, especially identifying possible types of gifted students in different age groups.

Longitudinal Phase (II)

In project phase two, developmental, academic and nonacademic achievement analyses were computed. Essential aims of this phase were:

(1) The evaluation of the predictive validity of instruments employed during three measurement periods (1986, 1987, 1988) for identifying gifted students in the 1st to 12th grade.
(2) Longitudinal evaluation of the validity of the typological giftedness concept of the

MMG and relationships between various types of giftedness or talent and performance.
(3) Evaluation of the effects of personality and social environmental factors on the performance of gifted students over time.
(4) Description and analysis of the developmental course of gifted children and adolescents in relation to changes in cognitive and non-cognitive characteristics.
(5) Analysis of the interaction between giftedness, achievement, personality, and achievement.

Sample, Method, and Design of the Study

The goal of identification in our study is not a special educational program but rather solely scientific interest in the target group of gifted and their individual characteristics and development. Hence the (quasi)experimental planning has to be based on the main hypotheses: that there are various types of giftedness (see MMG in figure 1 and 2) within the empirically determined giftedness patterns, those persons with the highest values are to be considered highly gifted. This means that our instruments should measure several factors of giftedness as independently from each other as possible. Thus they must differentiate well in the upper ranges. We meet these requirements by employing a two-step identification process and using multidimensional measurements in both steps.

Starting from a large randomized multi-regional sample ($n = 26{,}000$), a two-step identification process was used. First, in the screening phase, teachers were asked to nominate the top 30% from their school class compared with all of the age-related students, that is, to judge them on the basis of five giftedness dimensions of the MMG: intelligence, creativity, social competence, musicality, psycho-motor skills. This rough selection process – which does not have to be extremely valid – is satisfactory, in order to eliminate a large number of those who are not qualified from the limited number of gifted students. In the second step, standardized aptitude tests (measuring the predictors) and questionnaires (measuring the moderators) were employed with the aim of further reducing the pre-selected 30 percent to the top 2 to 5 percent in each of the mentioned five MMG-talent domains. The identification methods here can then measure more exactly and avoid the "bandwidth-fidelity-dilemma" (according to Cronbach & Gleser, 1965).

At the same time, the following instruments are supposed to include enough variance to determine types of giftedness using cluster analysis: KFT-V, KFT-Q, KFT-N, KFT-GL (German version of CogAT by Heller & Perleth, 2000); Verbal Creativity Test by Schoppe, 1975; Unusual Uses Test in accordance to Guilford, 1967; and so on. For the grouping of subjects in gifted and highly gifted or extraordinarily (extremely) gifted (target groups) versus gifted (comparison group) we used – among others – the computer program NORMIX. Our work on the construction of tests and questionnaires which met the requirements mentioned above resulted in the Munich High Ability Test Battery (MHBT) by Heller and Perleth (2001/2007, 2008).

For detailed information about the sample design, the data computing and practical problems in the execution of the longitudinal study see Perleth and Heller (1994, pp. 80–92) and/or Hany (2011, pp. 44–163), Perleth and Sierwald (2001, pp. 174–228), Perleth (2001a, pp. 381–388, 206–410; 2001b, pp. 447–477). Included here is only a few remarks. The predictor variables of MMG were treated as independent variables and the criteria variables as dependent variables in a quasi-experimental design. The so-called moderator variables served as "intervening" variables. In order to compare the gifted cohorts at a particular point in time either univariate (one dependent variable) or multivariate (with several dependent variables) analyses of variance were employed. When longitudinal data were present, the differences between the different gifted groups were calculated using Analysis of Variances with repeated measurements, or nonparametric methods were used.

The design, which combined cross-sectional and longitudinal sequences with six Cohorts, facilitated control of age/grade and cohort effects. Time of measurement effects, however, could not be controlled (see Schaie & Baltes, 1975). The main focus was on the analyses of age/grade effects. Within each cohort, the design and the methods selected enabled analysis of the following developmental rationales (cf. Schneider, 1989): a) interindividual differences (at each time of measurement), b) intraindividual changes (developmental functions), c) interindividual differences in intraindividual changes, and, d) interindividual differences in interindividual changes (changes of relative position of individuals). Apart from those ANOVA-based approaches, the design allowed for the use of structural equation analysis for each cohort. Special attention was given to models that included latent variables; for greater detail see Perleth and Heller (1994, pp. 80–92).

Results

Due to the limited space, numerous individual findings cannot be reported here. For greater detail see Heller (1990, 1991/1996), Perleth and Heller (1994), Heller, Hany, Perleth and Sierwald (2010), among others. The following major results emerged from the ***first*** MLGS-phase:

(1) The instruments used to measure cognitive and non-cognitive (motivational etc.) dimensions of the gifted and talented, together with relevant social conditions, were sufficiently reliable. The (five) ability factors of the MMG were relatively independent dimensions as indicated by the results of factor analysis. Thus, the hypothesis of domain-specific forms of giftedness or talent was confirmed.

(2) Significant differences could be found between the highly gifted (top 3–5%), the gifted (top 6–10%) and average students in each giftedness domain as well as among the various types of giftedness. A few examples demonstrate this. The academically or intellectually talented students had better school marks than the rest of the sample. The creative students were in some aspects more active and more successful in artistic and literary areas, the socially talented in social areas, and so on. Multiple or many-sided talented students were found relatively infrequently in the selected sample (n = 1,888). However, if one views those students (from age 6 to 18 years), who were both highly intellectually and creatively talented, then the "schoolhouse gifted" according to Renzulli (1986) were superior to all of the other students in important performance areas. Furthermore, particularly capable students differed from others in important personality characteristics (e.g. motivational variables). These results were even more marked when the group of best students was again divided into extremely or extraordinarily gifted (top 1–2%) and highly gifted (top 3–5%); see figure 3 below. The underachiever versus achiever profiles in figure 4 below illustrate the major causes of underachievement, that is, unfavorable noncognitive moderator variables of the underachievers.

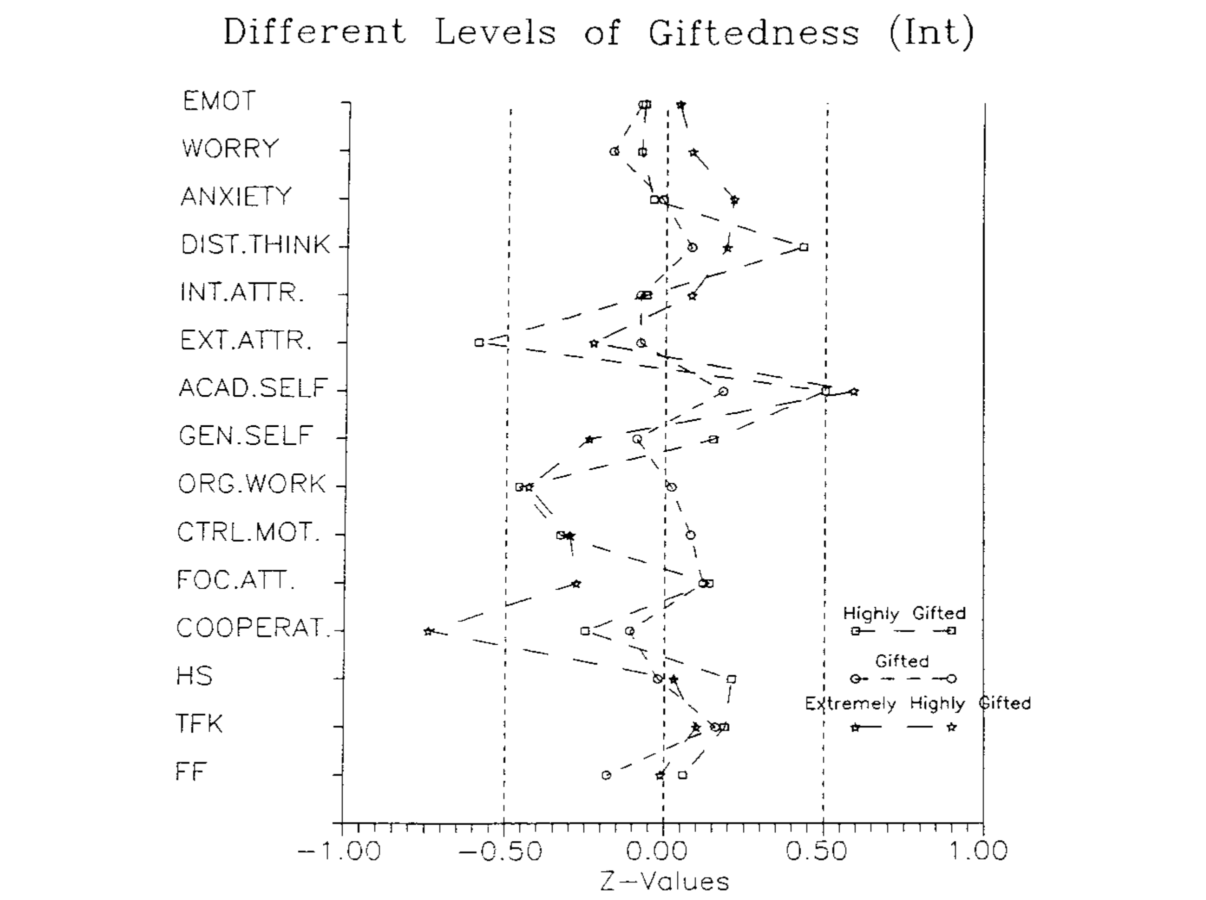
(3) Research conducted to evaluate different strategies for the identification using various statistical approaches (e.g. factor analysis, cluster analysis or regression analysis) and diverse information sources showed that both for practical purposes and with regard to our research, a multidimensional cutoff best optimized the different constraints (simplicity, practicability, effectiveness, etc.). Cluster analyses seem to be more appropriate for the description than the identification of gifted students (for greater detail see Hany, 2001, 2010).

The results of the ***second*** phase of the MLGS can be summarized as follows:

(1) Most of the test-retest coefficients for the variables of giftedness and motivation are in the central range (between .50 and .70). In order to determine the stability of the scales used in both forms (the students were given the parallel form during the second measurement point) of the German version of the CogAT, the correlations between the first and the third measurement point were calculated separately. The corresponding coefficients were almost all higher than those between the first and second measurements; for greater detail see Perleth, Sierwald and Heller (1993, pp.

152). Overall, the analyses confirmed our model of giftedness. Domain-specific giftedness tests were best able to predict domain-specific achievement, while personality characteristics (e.g. motivational variables) played a mediating role according to Gagné's catalysts (Gagné, 2000, 2008). Therefore, identification or talent search for gifted programs should not simply rely on intelligence tests (especially measuring only the g-factor).

(2) In the following, more detailed results about the relationship between giftedness and non-cognitive personality characteristics as well as various achievement variables will be presented. The best 6–10 percent of an age cohort will be referred to as "gifted", the best 3–5 percent as "highly gifted" and the top 1–2 percent as "extremely gifted" or "extraordinary". In the ***intellectually*** gifted group (figure 3),



Legend:	EMOT	=	Test anxiety
	WORRY	=	Worry regarding school marks
	ANXIETY	=	General anxiety
	DIST.THINK	=	Stability of quality of thinking
	INT.ATTR.	=	Intrinsic causal attribution
	EXT.ATTR.	=	Extrinsic causal attribution
	ACAD.SELF	=	Academic self concept
	GEN.SELF	=	General, non-academic self concept
	ORG.WORK	=	Planning and organizing of work
	CTRL.MOT.	=	Control of motivation
	FOC.ATT.	=	Focusing control of attention
	COOPERAT.	=	Cooperation with peers
	HS	=	Hope for success
	TFK/QFK	=	Thirst/Quest for knowledge
	FF	=	Fear of failure

Figure 3. Personal characteristics of intellectually extremely, highly gifted, and gifted students in grade 10 (according to Heller et al., 2010, p. 26).

the significantly higher academic self-concept in the highly gifted (German Gymnasium) students is obvious. These results correspond well to those of a Dutch study (Mönks et al., 1986). In agreement with them again, we found no differences between the three gifted groups regarding general, nonacademic self-concept. Furthermore, the extremely or extraordinarily and highly gifted had higher scores in "external causal attribution" than did their gifted counterparts. It is particularly obvious that the highly and extremely gifted students had lower scores in "organizing and planning of work" as well as in "control of motivation" (in accordance to Kuhl, 1983). But in "cooperation" only the extremely (not the highly) gifted had remarkably lower scores than the gifted. Apparently intellectually very gifted achievers do not have any difficulties with homework so that they do not need the usual basic techniques to cope with schoolwork. Hence, they prefer to work alone and do not cooperate well with normally gifted classmates in heterogeneous learning groups. This is quite understandable when one considers the well-known developmental acceleration of highly gifted youth. In the ***creativity*** group, the differences of the profiles were not as great, perhaps due to measurement (method artifacts) and/or conceptual problems of the creativity research. The older adolescents could be differentiated by their academic self-concept as well as by motor control and the motivation variables "hope for success" and "thirst for knowledge". These differences were not, however, significant; for greater detail see Heller (2010a/b).

In contrast, the gifted ***underachievers*** were clearly quite different from the gifted achievers. The term "underachiever" is used here to characterize students who achieve far less than could be expected on the basis of their giftedness potential. In comparison to the "achievers" (gifted students with balanced potential/performance), they do not live up to their potential. The underachiever profile in figure 4 corresponds to what can be found in the literature on the subject. Underachievers generally tend to be more anxious, and

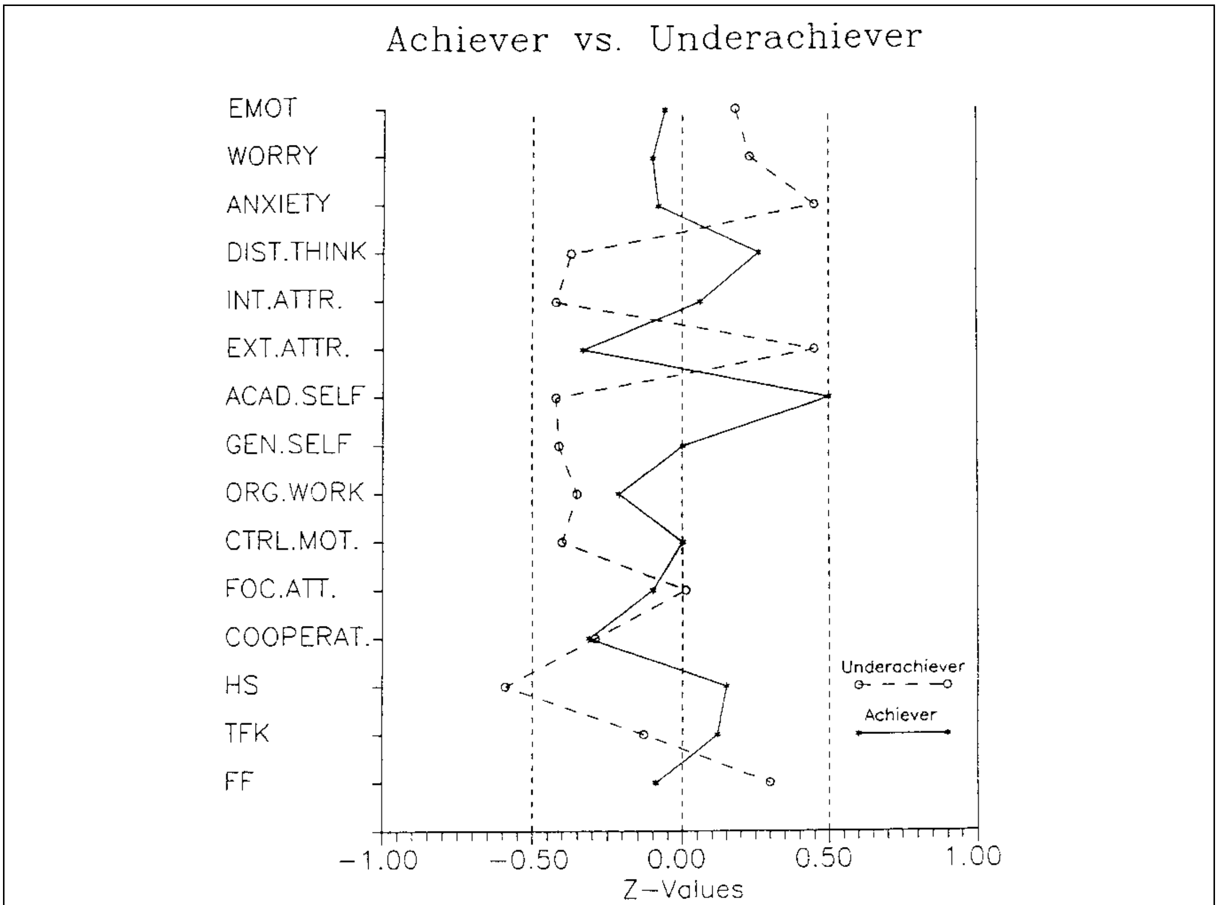


Figure 4. Personal characteristics of gifted achievers versus underachievers in grade 10 (according to Heller et al., 2010, p. 28).

their thought processes are more easily disturbed in stressful situations. They seem to attribute success more externally and failure more internally stable, i.e. they attribute the latter to what they see as their lack of ability. The academic self-concept of the underachievers – that is, the subjective conviction of one's personal ability to perform academically – is clearly poorer than that of the achievers. This is also true of their general self-concept and their motivational control. They obtained low scores on the achievement motivation scales with regard to the variables "hope for success", but a high score on "fear of failure". Their motivational structure is, therefore, dysfunctional.

(3) Environmental factors measured by questionnaires (e.g. critical life events) did not show a great deal of influence on the performance of gifted as well as of average students, especially in the older cohorts. This is also true with regard to the family and school climate scales in the MHBT. Against that, the results of a supplementary interview study showed the important role of environmental factors on the development of individual highly gifted students. The need for nurturing the gifted was more obvious in this case study, especially with regard to the development of extraordinary interests. A controlling, achievement-oriented family climate seems to favor especially the development of technical interests, while students with interests in arts and music came mostly from families with ongoing, culturally-oriented leisure time activities, high independence, and an average level of parental control. If one considers the whole sample, however, influences from socialization as well as critical life events, and so on, seem to be of minor importance – compared with social-emotional, motivational and other personal moderator variables – for the actual genesis of achievement in and outside of school (Perleth & Heller, 1994, p. 96).

(4) Differentiated analyses for the sub-sample of gifted primary school children showed that intelligence seems to be a relatively stable trait ($r = .75$ between the CogAT/KFT-results of wave 2 and 3 in the cohort of third graders). But this does not give a developmental function of intelligence, because the stability of inter-individual differences in our findings does not mean that there is no increase in the cognitive competencies during the primary school age. The structural model applied on the CogAT/KFT-data of the cohort of third graders have correlations between the latent variable "general intelligence" at the three measurement points of .71 to .87. And with secondary school students, we were able to study developmental functions of the speed of information processing. The findings indicate that performance on this task increased between grade 5 and grade 11 and remained stable for the older students in grade 12 to 13. This is in accordance with the Number Connection Test results by Oswald and Roth (1978). Contrary to these findings, the measured creativity variables were quite unstable, at primary as well as at secondary school level. When similar findings from other longitudinal studies are taken into account, there is some considerable reason to doubt the common theories of creativity as well as the quality of creativity tests used in the MGLS (Perleth & Heller, 1994, pp. 97–98).

(5) Multiple analyses of variance confirmed that in the 7th graders the differences between the groups for academic and nonacademic achievements and activities were significant for wave 1 and 3 (5%-level for all comparisons in this section), while univariate tests turned out to be significant for the school "main" subjects as English, German, and mathematics and for non-school science. Students-Newman-Keuls a posteriori tests for univariate analysis of variance showed that the significant superiority on German and mathematics of the intelligent students at wave 1 vanished at wave 3. The situation in the older cohort is quite similar in academic achievement. The significant overall difference is caused by differences in German, English, and mathematics at wave 1 and in mathematics and arts at wave 3. The significant difference between the intelligent and creative at wave 1 could not be found at wave 3 where the creative students are superior to the talented students in arts. In nonacademic achievements, the creative students scored significantly higher

in literature, arts (significantly only at wave 1), and social activities. The better scores of the intelligent students in comparison to the creative students in science are not significant; the significant effects in this variable result to some extent from the lower scores of the average students (Perleth, Sierwald, & Heller, 1993, pp. 194–195).

Finally, certain ***gender-related results*** are of particular interest. They are summarized as follows:

- Girls were less frequently judged by their teachers to be the best in cognitive or intellectual abilities and more frequently in musical abilities, and arts.
- The results of the giftedness or high ability tests were partly sex-dependent. Girls had – on average – poorer scores in the area of intellectual abilities, especially with regard to quantitative (mathematical) and practical-technical competencies. If the total score of CogAT/KFT is used as selection criterion, for example, in talent searches for gifted programs, a sex-specific selection effect will be apparent in the area of intelligence. The girls were, however, superior to their male counterparts in information processing speed (e.g. in ZVT by Oswald & Roth, 1987) and in creativity, especially verbal creativity (e.g. in VKT by Schoppe, 1975).
- It is striking that, according to our results, girls' giftedness potentials declined steadily with increasing age or continued schooling as compared with boys'. But this statement is based solely on cross-sectional evidence. Hence, possible cohort effects cannot be excluded.
- Girls were somewhat superior to boys in their academic achievement – except for mathematics and physics accomplishments, where the boys showed better performance. With regard to extracurricular (leisure time) activities and accomplishments, a sex-role distribution is apparent. Girls were more frequently represented in musical and artistic domains, whereas they were relatively seldom found in scientific-technical activities.
- Several sex-related effects were found with regard to the prediction of academic excellence (see table 1). In some aspects, different predictors are necessary for the prediction of excellent academic performances for girls than for boys. Above and beyond this, test items that were primarily developed for boys, were too "difficult" for girls, whereas many girl-specific items were too "easy" for the boys. Independently of clarifying whether girls employ other problem solving strategies to obtain excellent performances (which could not be measured here), the problem of test fairness thus arises.

Table 1. Prediction of Academic Achievement (School Marks in German): Cross Validation of Gender-Specific Discriminant Analyses (DA)

A. Predictors out of DA of Females					
		Female		Male	
Mark in German predicted		≤ 2[a]	> 2	≤ 2	>2
Actually achieved	≤ 2	**66.0**[b]	34.0	**28.8**	71.2
	> 2	26.1	73.9	14.6	85.4
Proportion of correct predictions		**70.6**		**52.0**	
B. Predictors out of DA of Males					
		Female		Male	
Mark in German predicted		≤ 2	> 2	≤ 2	> 2
Actually achieved	≤ 2	77.1	22.9	**78.3**	21.7
	> 2	25.6	**74.4**	54.9	45.1
Proportion of correct predictions		**75.9**		**60.3**	

[a] School marks ≤ 2 denote high achievement, > 2 denote low achievement; [b] Proportions of correct predictions are marked by boldness.

- Highly gifted, especially STEM-talented, girls often tend to demonstrate "fear of failure" rather than "confidence of success". They often underestimate their own talents in mathematics and the "hard" sciences and technology. Hence, in a series of experiments and studies in the field in the last two decades we developed and validated motivational and attributional retraining techniques for reducing such unfavorable cognitions and motivations, especially in STEM-talented girls and women. For an overview see Heller and Ziegler (1996), Ziegler and Heller (1997) or in greater detail Heller (2010a, pp. 219–342). The mentioned topic implies important tasks not only of gifted education in the area of STEM (cf. Heller, 2009) but also of gifted counseling and intervention in individual cases (Heller, 2010a, pp. 345–402).
- Our evaluation data on sex-related differences in environmental variables, here family climate questionnaire, indicate that no notable differences between girls and boys were found regarding self-perceived family climate. However, in a recent program evaluation study (Heller, von Bistram, & Collier, 2010), we observed several gender differences in an extremely selected (top 1%) STEM-talented group from the German Gymnasium. Here the female talents perceived higher scores in the family climate scales (part of the MHBT) for "cultural orientation" and "independence" versus lower scores for "control" compared with their male counterparts. With regard to school climate, the STEM-talented girls received (in the concerned MHBT-scales) higher scores for "cooperation with classmates" and "engagement of classmates" versus lower scores for "competition" and "disturbances in the classroom". Hence, the perception of social environmental climate variables depends on the level and shape of giftedness and talent as well as on gender.
- Extracurricular (leisure time) activities and performances take place in both sexes when similar conditions exist. The more active girls tend to be closer in level of activity to other girls than to active boys. Obviously, girls do not succeed in turning achievements in scientific-technical areas into social recognition as easily as boys.

Discussion

The most important implications of the MLGS can be summarized in six hypotheses, as interpreted below.

(1) Giftedness is a very complex phenomenon. This fact needs to be taken into consideration in its conceptualization. Thus multidimensional constructs and so-called synthetic or systematic models like MDAAM are to be promoted.

(2) In an analogous manner, satisfactory results are only to be expected when all available information sources are used, that is, by using formal tests and informal instruments (e.g. teacher checklists, questionnaires, portfolios).

(3) Many hypotheses about cognitive, motivational and social-emotional development of gifted children and adolescents offer interesting questions both for fundamental research and also for gifted education and upbringing practices. Scientifically founded knowledge about the positive and negative socialization conditions form an essential basis for the preventive vs. interventive developmental aids or psychological counseling measures and so on.

(4) Reliable and valid predictions about academic and non-academic achievement behavior in gifted youth not only make available appropriate prognostic models and appropriate decision strategies, but also provide empirically founded indicators of giftedness and usable criterion variables for achievement. The MLGS has located numerous important sources of information and many diagnostic techniques have been tested. The instruments of the Munich High Ability Test Battery (MHBT) by Heller and Perleth (2001/2007, 2008) have been developed within the framework of the MLGS. Two MHBT-forms are available (in German): the MHBT-P for primary school level (grade 1–4) and the MHBT-S for secondary school level (grades 5–12).

(5) One must count gifted girls or physically handicapped gifted among the so-called high-risk groups, that is, among those youth whose gifts and talents may be

overlooked or not recognized early. Such clients can only be recognized in an appropriate diagnosis-prognosis approach (Heller, 2010a, pp. 139–216).

(6) Further studies directed towards the early identification and nurturance of highly gifted children are of great importance with regard to the design of appropriate learning environments. For greater detail see Perleth, Schatz and Mönks (2000/2002), Heller, Perleth and Lim (2005).

Conclusion

All in all, the usefulness of a multidimensional conception of giftedness or talent could be demonstrated. The achievement behavior of the intelligent and creative gifted showed the distinctions of both groups, the intelligent showing advantages inside, the creative outside school (see also Renzulli, 2005). With respect to the creative gifted, it seems to be of major importance for guidance counseling and curricula as well as for fostering that creativity is a giftedness trait that seems to unfold full power in self-controlled learning and achievement situations, especially in older youth or maybe university students. For education in the schools this means that schools should provide creative youth with (extracurricular) possibilities to work and learn in a more free, self-controlled atmosphere in order to support the development of their creative potential. Otherwise individuals and society will be losing precious gifted potentials.

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