Intellectual and non-intellectual determinants of high academic achievement – the contribution of personality traits to the assessment of high performance potential

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Abstract:

In this paper a study is presented which tries to explain and predict high academic achievement in children or adolescents on the basis of intellectual and non-intellectual determinants – in this case, performance relevant personality traits as well as the social environment of stimulation. The prognosis of high academic achievement is based on a new diagnostic model, the *Viennese Diagnostic Model of High Achievement Potential*, which undergoes its first empirical validation here. The results show impressive evidence that performance-relevant personality traits and categories of social environment of stimulation contribute to high academic achievement in children and adolescents of above-average intelligence.

Keywords: academic achievement, high ability, IQ, caregiving, achievement motivation, Adaptive Intelligence Diagnosticum (AID)

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There is no doubt that intelligence is one of the best predictors of academic achievement, as shown by numerous results from research (see the most current papers: Busato et al., 2000; Furnham & Chamorro-Premuzic, 2004; Laidra, Pullmann & Allik, 2007; Rohde & Thompson, 2007; Spinath, Freudenthaler, and Neubauer, 2010). There is, however, also evidence in the specific field of high academic achievement that a certain "plus" or "minus" of giftedness - in other words: individual differences given at a certain high level – hardly predict in the same way differences in educational achievement and subsequental professional success (cf. Winner, 1996; Subotnik, Kassan, Summers & Wasser, 1993). As a matter of empirical fact, at higher educational levels the predictive power of intellectual, cognitive abilities is rather modest or often actually not significant (Ackerman, 1994; Seth & Pratap, 1971; Singh & Varma, 1995; Wolf, 1972). Furthermore, research on the psycho-educational topic of underachievers emphatically shows that there are also other traits than cognitive abilities that are of high importance for high academic achievement (see for a review Butler-Por, 1993). Herskovits and Gefferth (1995; see Subotnik & Arnold, 2002) as well as Bloom (1985), and Spinath, Freudenthaler, and Neubauer (2010) identified serveral personality traits and conditions of social environment being important determinants of high achievement in children. To get to the point: Although there is no doubt that a certain minimum of intelligence (particularly as traditional intelligence tests measure) is absolutely necessary for extraordinary academic achievements, it is most unlikely that every additional point in the IQ-score automatically entails a corresponding increase in high academic achievement.

At the *Center for Testing and Consulting*, situated in the Faculty of Psychology at the University of Vienna, we assess potential high academic achievement with particular reference to performance-relevant personality traits as well as to the social environment of stimulation. The *Viennese Diagnostic Model of High Achievement Potential* (Holocher-Ertl, Kubinger, & Hohensinn, 2008a) constitutes the basis of such assessments. It is an explanatory model which has grown "dialectically" from the interaction of theory and practice, and has already proven its worth in the course of practical application: the resulting diagnoses and suggestions for interventions are highly estimated by parents as being very helpful. According to this model, there is no need for a child to score highly on every basic and complex cognitive ability scale in order to be diagnosed as having high cognitive achievement potential. In case of an established specific deficiency in ability or for instance a certain deficiency in personality it is instead necessary that this deficiency is most likely compensable by some other assessed strengths or can easily be counteracted by special interventions.

The *Viennese Diagnostic Model of High Achievement Potential* also assumes that a child's cognitive abilities, as well as his or her performance-relevant personality traits, can only unfold in an optimal learning and developmental environment (a situation of "caregiving"). Performance-relevant personality traits refer to any disposition which helps a child to transform its abilities into performance. That is, a process of development of caregiving, development of cognitive abilities, and development of personality, which all influence one another reciprocally, is assumed. Consequently, all these three components must be analyzed before a prognosis of exceptional academic performance can be stated (see for details Fig. 1).
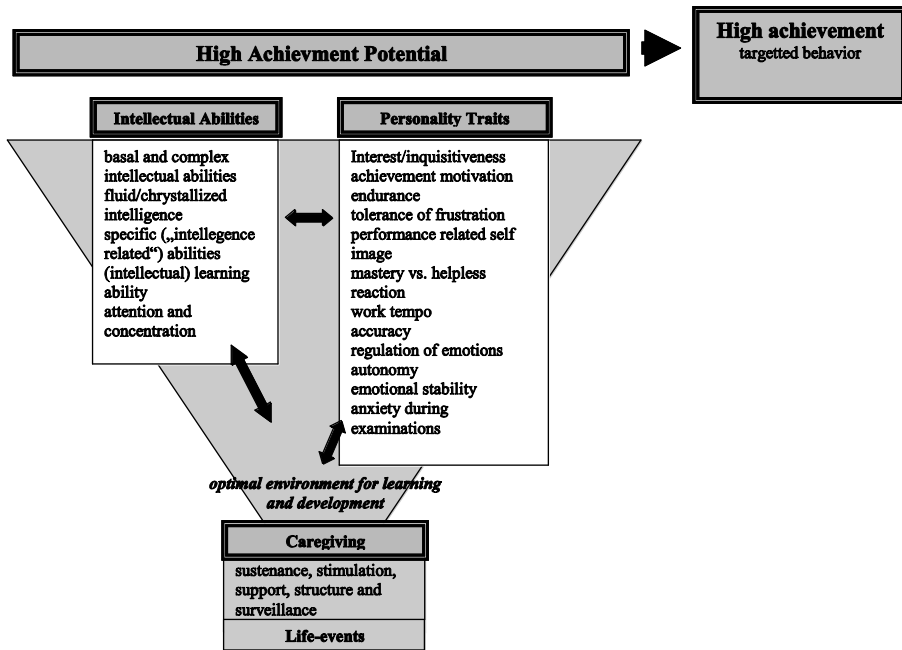
Figure 1:
The Viennese Diagnostic Model of High Achievement Potential

Of course there is already evidence that non-intellectual variables in children and adolescents, above all personality traits, contribute to the manifestation of performance (scf. Barberanelli, Caprara, Rabasca, & Pastorelli, 2003; Hair & Graziano, 2003; Heaven, Mak, Barry & Ciarrochi, 2002; Spinath et al., 2006). But these results show great disparity, which personality traits to what extent do actually relate to academic achievements. Mainly this disparity is a result of the used research method, as there are always children's self-reports: as is well-known, children are generally unlikely to reflect on their own behavioral dispositions and they are most likely incapable of evaluating their academic, cognitive, and motivational state in an appropriate manner and express it in a self-report instrument (cf. Lachar & Gruber, 2003). Furthermore, they may even not respond honestly but faking good (cf. Seiwald, 2002, who shows that faking of children is very likely). And, of course, there are further methodical problems in research, such as there are varying time lapses between the collection of predictor and criterion data; finally, different personality measures as well as different criteria as concerns their academic success were applied.

As the *Diagnostic Model of High Achievement Potential* has been applied over a few years at the *Center of Testing and Consulting*, it is now possible to test whether there is actually an interdependency of intellectual and non-intellectual determinants of the manifestation of high academic achievement. All testees with prognosis of high giftedness followed by the diagnosis of high achievement potential as well as those testees without

high achievement potential have be catamnestically evaluated with respect to the prognostic correctness of diagnosis. That is the matter of this paper. The quality of the prognoses based on the *Viennese Diagnostic Model of High Achievement Potential* will be compared with those which would have resulted in a diagnosis of giftedness according to the traditional, but arbitrary criteria of an IQ of at least 130 (which means that high achievement potential would automatically be assumed).

Method

The aim of this study is to estimate the interdependency effects of intellectual and nonintellecutal determinants of high academic achievement, as given in the *Viennese Diagnostic Model of High Achievement Potential*. First, the best prediction of academic achievement has to be established separately with regard to cognitive abilities, personality traits, and caregiving variables, as well as with regard to the combination of all these components. Second, the prognosis of academic achievement according to this prediction has to be established.

Participants

In the present study we refer to 62 children of an age range from 7-16 years, who were tested in the *Center of Testing and Consulting* in the years 2004-2006. They all became clients of the centre because cognitive high giftedness was in question. From the original group of 62 children, 46 actually participated in the follow-up study (10 girls and 36 boys). Their mean of age was 10.9 (SD.= 2.4). One third of them belonged to primary school, two-thirds to secondary school.

Measures

Cognitive Abilities. – Cognitive abilities were measured with the intelligence test-battery AID, *Adaptive Intelligence Diagnosticum* (*Version 2.1* – AID 2; Kubinger & Wurst, 2000), which fulfills high psychometric standards and is – due to its design as an adaptive test – especially convenient when it comes to assessing highly gifted children (for details see Holocher-Ertl, Kubinger & Hohensinn, 2008a). The test consists of 11 subtests, which primarily measure verbal, numeric, and spatial intelligence, information processing speed, memory, and social comprehension (see Kubinger, 2008, for a detailed description of AID). In order to separate a child's intellectual potential, traditionally described as "fluid intelligence", and the same child's "crystallized intelligence" based on socialization and academic training, some of Raven's tests were additionally applied (CFT 1, Weiß & Osterland, 1997; and CFT 20-R, Weiß, 2006).

Personality Traits. – For establishing performance-relevant personality traits we used different methical approaches. The German personality questionnaire PFK 9-14 for children

of the age of 9 to 14 (*Personality Questionnaire for Children;* Seitz & Rausche, 2004) was used to appraise self-image, motives, and mode of behavior. Additionally self-descriptions of the children were obtained using a semi-structured child interview. The parents assessed the personality traits in a self-administered parents' questionnaire. Furthermore, the intelligence test-battery AID offers a "multi-functional" testing approach, which allows additionally to the measurement of cognitive ability traits also to rate behavioral dispositions, that is particularly achievement motivation, tolerance of frustration, endurance, concentration, mastery vs. helpless reaction, self-image, and autonomy.

Caregiving Variables. – Several questions for the assessment of the emotional and cognitive stimulation and structure in children's homes and schools (caregiving variables) were included in the self-administered parents' questionnaire, and were additionally included in the child-interview.

Academic Measures. – Data of the current academic achievement, that is *Grade Point Average* (GPAs) in the primary school and high school, were collected from the participants' school reports. In addition, we considered the attendance at science, maths, language, and philosophy contests.

Procedures

Phone contact with the parents resulted in permission for their children to participate in the study and an appointment was then scheduled. Each participant was tested individually, taking an average time of 4 hours; in the meantime, the parents completed the parents' questionnaire. At the end, parents and participants received feedback of the test results and further recommendations.

Analysis

In general a type-I-risk of $\alpha = .05$ was committed.

A step-wise logistic regression analysis was applied in order to predict the academic achievement; the independent variables were entered in four steps. The contribution of the independent variables in each step was assessed step-wise using the procedure "forwards". First, only the scores of performance-relevant personality traits were considered. Second, only the caregiving variables were taken into account, and third, the scores of cognitive abilities according to AID and the Raven´s tests were used. Finally, all those scores from the first three analyses which had resulted in significance were considered as a pool in order to predict the academic achievement.

For the evaluation of the prognostic validity of the diagnoses according to the *Viennese Diagnostic Model of High Achievement Potential*, in particular for a competitive evaluation with respect to the traditional IQ-diagnosis (minimum IQ of 130) as described above, a McNemar's test was calculated.

Results

Means and standard deviations of all cognitive ability scores used in the current study and of the GPAs are given in Table 1. Relative frequencies of the scores of the personality traits und caregiving variables are given in Table 2. The scores of the individual personality and caregiving variables result as a summarized rating from 1) the questionnaires, 2) parents' and 3) children's interviews, and also from 4) the behavioural observations by the psychologists who conducted the assessment. 24 of the 46 participats were categorized as academically "high-performing" according to their GPAs.

Table 1:
Descriptive statistics of the scores of the cognitive ability tests and the GPAs

	Descriptive statistics			
	M	*SD*	min	max
IQ-AID 2	120.45	10.9	89.88	146.33
IQ- Raven´s test	118.48	13.9	92.02	149.98
verbal intelligence				
AID 2 subtest Producing Synonyms	61.00	7.05	46	81
AD 2 subtest Verbal Abstraction	60.27	7.05	43	75
numeric intelligence				
AID 2 subtest Applied Computing	64.07	8.70	45	81
spatial intelligence				
AID 2 subtest Analyzing and Synthesizing	60.27	7.50	43	75
social competence				
AID 2 subtest Social and Material Sequencing	59.47	11.93	32	77
AID 2 subtest Social Understanding and Material Reflection	60.69	9.62	30	81
information processing speed				
AID 2 subtest Coding	58.04	6.70	42	77
Memory				
AID 2 subtest Learning and Remembering	61.13	10.92	34	81
AID 2 subtest Immediately Reproducing (of figural stimuli)	58.04	6.70	42	77
Achievement				
GPAs	1.71	0.88	1	4.17

Note. All AID 2 sub-test scores are *T*-scores, GPA = *Grade Point Average*, *M* = mean, *SD* = standard deviation.

Table 2:

Descriptive statistics of the personality traits and caregiving variables

	relative frequencies of trait categories of personality		
	0	**1**	**2**
Interest	10.9	50.0	39.1
Attention and concentration	28.3	50.0	21.7
Achievement motivation	28.3	43.5	28.3
Endurance	30.4	37.0	32.6
Tolerance of frustration	23.9	56.5	19.6
Performance related self image	17.4	41.3	41.3
Mastery vs. helpless reaction	8.7	78.3	13.0
Work tempo	8.7	39.1	52.2
Accuracy	17.4	60.9	21.7
Ability to control emotions	28.3	54.3	17.4
Autonomy	19.6	50.0	30.4
Emotional stability	39.1	34.8	26.1
Anxiety during examinations	71.7	17.4	10.9
Cognitive stimulation at home	21.7	39.1	39.1
Emotional support at home	17.4	41.3	41.3
Cognitive stimulation at school	15.2	54.3	30.4
Emotional support at school	21.7	21.7	21.7
Non-cognitive stimulation at home (sport, music,...)	10.9	39.1	50.0

Note. 0 = below-average, 1 = average, 2 = above-average.

Table 3 presents the means of all cognitive ability scores as opposed to the sub-samples "high academic achievement" vs. "no-high academic achievement". Only one of them differs significantly according to Student's *t*-test between both these sub-samples. Table 4 shows the performance-relevant personality traits' and caregiving variables' relative frequencies for both these sub-samples. According to Wilcoxon-*U*-test 7 personality traits and one caregiving variable disclosed significant differences.

The results for the four applications of logistic regression analyses are given in Table 5. As concerns the prediction of high or no-high academic achievement by performance-relevant personality traits, four of the twelve traits contribute significantly to the correct prediction: achievement motivation, endurance, tolerance of frustration and ability to control emotions. If only these variables were taken into consideration then 84.4 % of the children could be allocated correctly to either the group of high academic achievers

Table 3:
Cognitive ability scores opposed for the subsamples

	no-high academic achievement	high academic achievement	significance *p*
IQ – AID 2	118	122	.191
IQ – Raven´s	121	115	.191
verbal intelligence			
AID 2 subtest Producing Synonyms	59.65	62.41	.193
AID 2 subtest Verbal Abstraction	60.00	60.55	.811
AID 2 subtest Everday Knowledge	60.48	63.38	.195
numerical intelligence			
AID 2 subtest Applied Computing	63.91	64.23	.905
spatial intelligence			
AID 2 subtest Analyzing and Synthesizing	62.35	63.68	.650
social competence			
AID 2 subtest Social and Material Sequencing	57.35	61.68	.227
AID 2 subtest Social Understanding and Material Reflection	58.91	62.55	.209
information processing speed			
AID 2 subtest Coding	56.26	61.05	.054
Memory			
AID 2 subtest Learning and Remembering	59.65	62.68	.358
AID 2 subtest Immediately Reproducing (of figural stimuli)	57.74	58.36	.759

Note. All AID 2 sub-test scores are *T*-scores

or the group of no-high academic achievers. From the cognitive ability scores only one, the ability of concentration and attention proved to contribute significantly to the prediction of high academic achievement. However, even this single ability allocates 73.3 % of the children correctly. As concerns the caregiving variables again just a single variable contributes significantly to prediction: non-cognitive stimulation at home. The percentage of correct allocations amounts to 65.2. Finally, when predicting high academic achievement with the combination of all personality traits, caregiving variables, and cognitive abilities, which proved to contribute significantly before, then the variables achievement motivation, concentration and attention, endurance, tolerance of frustration, and non-cognitive stimulation at home establish a significant contribution to prediction. These variables together result in 91.3 % of the partcipants being allocated correctly to both groups.

Table 4:

Relative frequencies of categories of personality traits and caregiving variables in the sub-samples

| | *Relative frequencies of categories of personality traits and caregiving variables* | | | | | | significance |
| | high academic achievement | | | no-high academic achievement | | | |
	0	*1*	*2*	*0*	*1*	*2*	*p*
Interest	4.0	40.0	56.0	19.0	61.9	19.0	**.007**
Attention and concentration	8.0	56.0	36.0	52.4	42.9	4.8	**.000**
Achievement motivation	8.0	44.0	48.0	52.4	42.9	4.8	**.000**
Endurance	20.0	36.0	44.0	42.9	38.1	19.0	**.044**
Tolerance of frustration	16.0	40.0	44.0	42.9	47.6	9.5	**.006**
Performance related self image	12.0	36.0	52.0	23.8	47.6	28.6	.100
Mastery vs. helpless reaction	12.0	68.0	20.0	4.8	90.5	4.8	.540
Work tempo	12.0	36.0	52.0	4.8	42.9	52.4	.805
Accuracy	8.0	56.0	36.0	28.6	66.7	4.8	**.005**
Ability to control emotions	12.0	68.0	20.0	47.6	38.1	4.8	**.031**
Autonomy	12.0	48.0	40.0	28.6	52.4	19.0	.073
Emotional stability	24.0	32.0	44.0	57.1	38.1	4.8	**.003**
Anxiety during examinations	80.0	16.0	4.0	61.9	19.0	19.0	.135
Cognitive stimulation at home	24.0	32.0	44.0	19.0	47.6	33.3	.741
Emotional support at home	8.0	56.0	36.0	19.0	52.4	28.6	.185
Cognitive stimulation at school	12.0	56.0	32.0	19.0	52.4	28.6	.615
Emotional support at school	12.0	56.0	32.0	33.3	42.9	23.8	.171
Non-cognitive stimulation at home (sport, music,...)	0.0	36.0	64.0	23.8	42.9	33.3	**.012**

Note. 0 = below-average, 1 = average, 2 = above-average.

To test the consistency of these results, the analyses were repeated but this time the step-wise procedure was used "backwards". As a matter of fact the same independent variables were of relevance.

As indicated, the second aim of the present study was to test the prognostic validity of the *Viennese Diagnostic Model of High Achievement Potential*. In particular, it was of interest whether and to what extent the prognostic validity of our model exceeds the approach of using only the traditional way of assessment, that is applying the criterion IQ ≥ 130. For this purpose, the binary diagnoses ("high achievement potential *vs.* no-high achievement potential" on the one hand, and "giftedness on the basis of a minimum IQ

Table 5:
Step-wise logistic regression of high academic achievement

	R^2	p
logistic regression including personality traits		
Achievement motivation	.296	.001
Endurance	.432	.012
Tolerance of frustration	.530	.023
Ability to control emotions	.611	.030
logistic regression including cognitive ability scores		
Attention and concentration	.296	.001
logistic regression including caregiving variables		
Non-cognitive stimulation at home (music, sport, games, ...)	.277	.003
logistic regression including personality traits, cognitive ability scores and caregiving variables		
Achievement motivation	.302	.001
Concentration and attention	.530	.001
Endurance	.640	.010
Tolerance of frustration	.750	.005
Non-cognitive stimulation at home (music, sport, games, ...)	.801	.040

of 130 *vs.* no giftedness") – which both were established in the first consultation of the participants in the years 2004 to 2006 – were compared with their current academic achievement ("high performing *vs.* non-high performing") in the year 2008.

"High achievement potential" was assessed to those participants, who showed high potential in ability, personality, and caregiving at their first consultation at the center. Additionally, even those participants, who were diagnosed at the time with certain deficits (in one or even more of these domains), were now, some years later, qualified as having high achievement potential as long as they took care of the initially recommended intervention programs. This is due to the psychological development concept that certain deficits can be compensated by appropriate intervention measurements and programms respectively. Be aware, using the traditional criterion of giftedness which only takes the extent of the IQ into account, high achievement potential would only be assessed to children having an IQ greater than 130, but those participants who show any deficits would simply be assessed as having no chance, for instance by compensation, to produce high academic achievements.

To carry out the aimed-for evaluation, the proportion of correctly classified participants with and without high academic achievements were calculated using both approaches, the *Viennese Diagnostic Model of High Achievement Potential* approach and the IQ-based approach.

Table 6:
The percentage of correctly predicted children (with and without academic achievement), according to the Viennese Diagnostic Model of High Achievment Potential approach, and according to the traditional IQ-based approach.

	high academic achievement potential according to the *Viennese Diagnostic Model of High Achievement Potential*	IQ ≥ 130	significance *p*
High academic achievement	69.4 %	55.1 %	.230

Table 7:
Sensitivity of correctly predicted children as a high academic achiever, according to the Viennese Diagnostic Model of High Achievement Potential approach, and according to the traditional IQ-based approach (IQ ≥ 130).

	high academic achievement potential according to the *Viennese Diagnostic Model of High Achievement Potential*	IQ ≥ 130	significance *p*
High academic achievement	80.08 %	26.90 %	.001

As a result, the *Viennese Diagnostic Model of High Achievement Potential* approach leads to a higher rate of correct prognoses of academic achievement than the IQ-based approach – though the difference in the rates is not significant according to McNemar's test (see Table 6). On the other hand, it is very disappointing that the IQ-based approach was only able to predict academic achievement correctly in hardly more than half of the cases.

Furthermore, an analysis of sensitivity was done. The sensitivity rate refers to the proportion of high academic achievers who have been correctly predicted as such. In comparison to the traditional IQ-based approach, the *Viennese Diagnostic Model of High Achievement Potential* reveals now a significant higher sensitivity (Table 7). Participants who show high academic achievements could be predicted by that model with a very high percentage (almost 81 %), whereas the IQ-based predictions make up for hardly more than a fourth of the cases.

Discussion

The results show impressive evidence that performance-relevant personality traits contribute to the manifestation of high academic achievement. If children and adolescents possess an above-average IQ then high academic achievement can actually be predicted primarily on the basis of performance-relevant personality traits – and also, to some extent, on the basis of their social environment of stimulation. Our study discloses the personality traits performance motivation, endurance, frustration tolerance, and the ability to control emotions as significant prediction components. These are, in actual fact traits, which enable children to confront problems and challenges in their day-to-day school life with enthusiasm and interest; and also not to give up when faced with obstacles and failure, but rather to put more effort into confronting these and be willing to solve problems.

An exceptionally high intelligence that has been established by the IQ greater than 130 cannot, however, warrant the person's willingness to learn and perform. The other way round, children who have all these particular personality traits do not necessarily have to have an IQ greater than 130 in order to produce high academic achievement. The group of high academic achievers did not surpass the group of no-high achievers either in specific cognitive abilities, with the exception of the ability of attention and concentration, or in IQ, which can be seen from the logistic regression result. On the other hand, the social environment of stimulation, assessed according to the *Viennese Diagnostic Model of High Achievement Potential*, contributes significantly to performance. Non-cognitive stimulation in the domestic environment turns out to be of particular importance in this regard. If one includes all mentioned determinants then 91.3% of the investigated participants of the study can be allocated correctly with regard to their actual performance at a later stage. These results prove that - given a certain high level of intelligence – individual differences hardly correlate with the hit rate of prediction of educational high achievement. In our sample mainly very well abled children (mean of IQ was 120) were investigated (so there was actually only a small variance in the cognitive ability scores) as a consequence personality traits and care giving variables become quite much more important.

 The present findings share as well the results of a few other studies which have been carried out in the area of high achievement. Herskovits and Gefferth (1995; see Subotnik & Arnold, 2002) identify the variables achievement motivation, self concept of abilities and family support as important determinants of high achievement in 9 to 11 year old children. Bloom (1985) observed that parents of high achiever children focus on the components achievement, success, and perseverance at work, they support their children in their interests and provide the relevant resources; the children themselves show a high degree of self confidence and great motivation to learn.

Our findings support the *Viennese Diagnostic Model of High Achievement Potential,* and validate it, respectively. If the model would not correctly predict late high academic achievers with such a high percentage – as does likewise orientation just on an IQ $\geq$ 130 – it were completely useless. It is particularly the sensitivity of the model that is remark-

able: 81% of the high achieving children were actually identified and predicted as such by the model. In contrast, the IQ-based approach with its sensitivity of hardly more than a quarter, results in nearly three quarters of cases of the high academic achievers as not to be able to identify accordingly at an early stage. Therefore with the *Viennese Diagnostic Model of High Achievement Potential* the risk of not identifying potential high achievers and as a consequence of which not strengthening their resources early, is kept low.

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