

# Motivational anomalies in ADHD: Results from a clinical study in children and adolescents

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**OBJECTIVE:** We assessed motivational anomalies in patients with ADHD regarding the dimensions of achievement motivation.

**METHODS:** 145 students participated in the study (10 to 19 years). ADHD symptoms were assessed by parental and self-ratings using an ADHD Symptom Checklist. Achievement motivation was measured by school class-adapted versions of a standardized self-rating scale.

**RESULTS:** For the motivational dimension tenacity and diligence in the group of younger children significant deviation from mean norm values

were detected but lower deviations of achievement motivation from the mean norm value in adolescent students. Moreover, negative correlations between the extent of the core symptoms of ADHD and achievement motivation were found.

**CONCLUSION:** We observed a nearly moderate negative correlation between the extent of the core symptoms of ADHD and specific motivational anomalies in ADHD patients with an improvement of performance impairing motivational dimensions in adolescents.

**Key Words:** ADHD; Achievement motivation; Tenacity; Striving for achievement; Psychostimulants

## ABBREVIATIONS

ADHD: Attention Deficit Hyperactivity Disorder; DSM IV TR: Diagnostic and Statistical Manual of Mental Disorders (Textrevision); ICD: International Statistical Classification of Diseases and Related Health Problems; FBB-ADHS: Third Party Assessment Form for Attention Deficit/hyperactivity disorders; SBB-ADHS: Self-assessment sheet for attention deficit/hyperactivity disorders; FLM: Questionnaire for achievement motivation; QAM: Questionnaire of achievement motivation; ADHD-SR: Attention Deficit Hyperactive Disorder symptoms self-report; ADHD-PR: Attention Deficit Hyperactive Disorder symptoms parental-rating; DAT: Dopamine transporters

## INTRODUCTION

Prospective studies show that the core symptoms of Attention Deficit Hyperactivity Disorder (ADHD) change in the course of development from childhood to adolescence and adulthood with considerable remission rates of hyperactivity and impulsivity, whereas issues with attention tend to be more recalcitrant and persistent [1,2]. Difficulties in organizational skills, namely initiating, persisting and completing tasks become more pronounced, along with severe procrastination [3]. The latter is one of the principal causes of academic failure and scholastic underachievement in this disorder as well as a major reason for significant problems at work often leading to job resignation [4-6].

Behavioral studies demonstrated that children with ADHD show a dysregulation of motivational states towards incentives. They respond reliably to rewards being delivered immediately and regularly, but show a diminished sensitivity to delayed and intermittently delivered rewards [7]. Moreover, more frequent incentives are required for children with ADHD to modify their behavior [8].

The central neurologic structure associated with motivational processes is the mesolimbic dopaminergic reward pathway, projecting from the ventral tegmental area in the midbrain to the nucleus accumbens in the ventral striatum [9]. The relevant network includes the thalamus, the orbitofrontal cortex, the anterior cingulate cortex and the amygdala. The key neurotransmitter here is dopamine. In normal humans, a rewarding experience increases the dopamine firing rate in the ventral striatum and in

the nucleus accumbens and dopamine is reliably released due to anticipation of a reward provided that the reward is delivered regularly [10,11]. By contrast, in adolescents and adults with ADHD, a decreased activity of the ventral striatum in reward anticipation was observed compared to controls [10,12]. Volkow et al. [13,14] demonstrated that compared to healthy controls, adults with ADHD showed a reduction in dopamine receptors (D2/D3) and transporters. A correlation between psychological measures of motivation assessed in a multidimensional personality questionnaire and dopamine receptor/transporter availability existed.

The effects of methylphenidate and other psychostimulants are mediated via an increase in extracellular concentrations of dopamine in the prefrontal cortex and in the corpus striatum which leads to a significant reduction of the core symptoms in ADHD individuals [15,16]. Chelonis et al. demonstrated additional effects of methylphenidate on task motivation in children with ADHD. However, to date it remains unclear whether an increase in task motivation results from the effects of a reduction of the core symptoms, which facilitates the quality of work, or if it constitutes an independent effect [17].

In summary, there are considerable gaps in our understanding of the principal issue of whether an altered motivational status in ADHD is a consequence of the core symptoms of the disorder leading to an impaired academic and social development, or whether it represents an independent neural construct, which in turn promotes the ADHD core symptoms [8,14,18]. Results from behavioral and neurobiological studies support the hypothesis that ADHD may be considered a primary motivational disorder [13]. Actually, there are very few published neurobiological and clinical studies on this extremely important issue despite the need for more efficacious cognitive behavioral therapeutic tools, whose effects are often limited due to poor treatment motivation of the patients and the lack of specific treatment strategies addressing explicitly and specifically this central deficit in ADHD [19].

In our study, we addressed several basic questions in the intention that the results will contribute to a better comprehension of motivational anomalies in ADHD as well as provide clues for the creation of more efficacious behavioral treatment modalities.

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## Hypotheses

This project was set up with the following hypotheses: We hypothesized

1. Motivational anomalies in children and adolescents with ADHD regarding the dimensions of achievement motivation and expected significant differences between the motivational profile of children and juveniles with ADHD compared with a normal peer group of the reference population.
2. A (significant) negative correlation between the ADHD total symptom score as well as for singular ADHD core symptoms and the dimensions of achievement motivation.

## MATERIALS AND METHODS

### Study sample

The study population was recruited from an outpatient clinical service of Child and Adolescent Psychiatry. The inclusion criteria were (1) a diagnosis of attention deficit hyperactivity disorder or a hyperkinetic disorder (DSM IV TR 314.00 or 314.01; ICD 10 F90.0 or F90.1), (2) age 10-19 years, and (3) IQ>85. We excluded children with any other comorbid psychiatric and somatic disorder to avoid potential confounding factors that could affect the motivational status. 145 students participated in the study, of which 21% (or 30 students) were female. The students attended either primary schools or comprehensive schools and secondary schools (e.g., grammar school, grades 4-13). The social status of the parents was characterized by an average or even elevated occupational qualification.

All pupils received psychostimulant medication for more than 3 months after undergoing a careful titration of methylphenidate i.R. or e.R. under participation of clinical, parent and teacher ratings [20]. The dosage ranged between 20 and 50 mg/day, the mean daily dosage of the entire sample being 28.5 mg. At the time of the assessment for the purpose of this study, parents reported satisfaction with the medical treatment of the ADHD core symptoms. None of the participants took part in any psychosocial treatment or psychotherapy at the time of the assessment. Medical appointments with the child's and adolescent's treating psychiatrist were held every 3 months, combined with a 45-minute group session consisting of psychoeducation about ADHD for the treated children and adolescents.

Our study was a non-interventional study. No ethics or institutional review board approvals were required. Informed parental consent as well as the consent of the child were obtained from all participants, and the study was performed according to the Ethical Principles for Medical Research Involving Human Subjects [21].

### Measuring instruments

ADHD symptoms were assessed by parental ratings using the German ADHD Symptom Checklist (FBB-ADHS), which assesses the diagnostic criteria for ADHD according to DSM-IV-TR and ICD 10 for hyperkinetic disorders. It consists of 20 items, each with a four-point rating scale (ranging from 0=not at all to 3=very much) that was proven to be internally consistent [22]. The questionnaire assesses inattention (9 items), hyperactivity (7 items) and impulsivity (4 items) on separate scales. These scales were proven to be internally consistent with alpha scores between 0.78 and 0.93. A construct validity of 0.69 has been demonstrated for the checklist [22,23].

ADHD symptoms of the children and adolescents were also assessed by self-ratings using the German ADHD Symptom Checklist (SBB-ADHS) [22]. The rating scale contains 20 items each with a four-point rating scale (ranging from 0=not at all to 3=very much) with all symptom criteria for the diagnosis of ADHD/hyperkinetic disorder according to ICD (and DSM-IV TR). Internal consistency for the symptom subscales is 0.69-0.75, and 0.87 for the total symptom scale.

Achievement motivation was measured by two different school class-adapted versions, the FLM 4-6 and FLM 7-13 [24,25], a self-rating scale with 30 items. For the purpose of this publication, we use the English designation "questionnaire of achievement motivation -QAM". On a 5-point rating scale ("absolutely not true" through "absolutely true"), the principal aspects of achievement motivation are revealed: "striving for success", "tenacity and diligence", "fear of success" and "inhibitory test anxiety". In FLM 7-13, "activating test fear" is an additional subscale. Internal consistency of the FLM 4-6 for the 5 scales is between  $r=0.62$  and  $r=0.80$  ( $n=596$ ). Re-test reliability is between  $r=0.71$  and  $r=0.85$  ( $n=57$ ). Internal consistency for the five scales in the FLM 7-13 is between  $r=0.62$  and  $r=0.74$  ( $n=817$ ). Re-test reliability is  $r=0.67$  and  $r=0.76$ . Specific norm value tables (percent rank, t-value) for the two test versions exist for every single class and scale ( $n=602$ , FLM 4-6;  $n=823$ , FLM 7-13).

For the statistical analysis that we performed we compared mean values obtained in the study sample with the corresponding values given by the reference population of the measure instruments we used (FBB-ADHS; SBB-ADHS, FLM 4-6 and 7-13).

In the present study, two different t-tests were performed: Firstly, one sample t-test in order to prove the null hypothesis that a mean sample value is equal to 50 (mean reference value), and, secondly, the t-test for two independent samples.

Pearson correlation coefficients of t-values and scale values were computed in order to quantify the strength of relationship between the ADHD symptoms and different dimensions of achievement motivation.

The cut-off level for statistical significance was usually taken at 0.05. In correlation analysis, a second cut-off was set at 0.01. In case of multiple testing, the cut-off level for statistical significance was adjusted.

## RESULTS

### Achievement motivation in grades 4-6

Deviation from mean norm value: Table 1 shows deviation from mean norm value concerning four different dimensions of performance motivation. Mean and standard deviation are presented, as well as quartiles and percentiles. Looking at mean deviation from the norm T-value, striving for achievement is about one third standard deviation lower than that of reference population. Tenacity and diligence is two third standard deviations lower than that of reference population. The meaning of this statement is explained in the acknowledgment.

On the other hand, the fear of success was more expressed with twenty percent of reference population's standard deviation, and inhibitory test fear was equivalent to the reference population. Only the deviation of tenacity and diligence is statistically significant at an adjusted cut-off level for statistical significance of  $p=0.0127$ .

### Achievement motivation in grades 7-13

Deviation from mean norm value: Table 1 also gives the deviations from mean norm value of the QAM dimensions for grades 7-13, which are close to the reference population with no statistically significant differences. Fear of success shows the highest deviations. The analysis reveals positive deviation of the same magnitude for activating test fear.

**Table 1: Deviation from mean norm value for different dimensions of achievement motivation, grades 4 to 6 and grades 7 to 13 (QAM).**

	Deviation of					
	Striving for achievement	Tenacity and diligence	Fear of success	Activating test fear	Inhibitory test fear	
	From mean norm value in self-report					
	<b>Grade 4 to 6 (n=38)</b>					
<b>Mean</b>	-3.13	-6.97*	2.16	-	0.03	
<b>Std. Deviation</b>	12.24	9.38	8.91	-	11.48	
	5	-17.2	-24	-12	-	-19
	25	-12.5	-14.25	-5	-	-10
<b>Percentiles</b>	50	-6.5	-7.5	1	-	-3
	75	8.25	-1.5	8.25	-	7.25
	95	23	9.35	19.2	-	23
	<b>Grade 7 to 13 (n=103)</b>					
<b>Valid cases</b>	107	106	106	103	105	
<b>Mean</b>	-1.29	1.15	-2.87	2.36	0.98	
<b>Std. Deviation</b>	10.51	9.967	11.278	8.723	9.147	
	5	-16.8	-16	-22	-12	-16.1
	25	-9	-7	-11	-2	-5
<b>Percentiles</b>	50	-4	2	-5	2	2
	75	7	8.25	6.25	8	8
	95	19	17	17.3	19	15.4

The cut-off level for statistical significance is normally taken at  $\alpha=0.05$ . Since QAM consists of four (of five) dimensions, we must bear in mind multiplicity when performing statistical tests. Then the cut-off level for every single t-test is  $\alpha=1-(1-0,05)^m$  in which m=the number of single t-tests. Since we performed one t-test for each dimension of QAM, the cut-off level for every single test in younger students is set at 0.0127.

### Acknowledgment 2 (grades 7 - 13)

103 students grade 7-13 were examined. They had complete information on all five QAM sub-scales: striving for achievement, tenacity and diligence, fear of success, activating test fear and inhibitory test fear. 4 students with lack of information in at least one of the five sub-scales were analysed. Activating test fear was the only measure in students in grades 7 and above.

In summary, no significant deviations from the norm value were obtained in either group of the study population on different dimensions of achievement motivation, except for the dimension tenacity and diligence in the group of younger children (\*). Moreover, we detected lower deviations of achievement motivation from the mean norm value in older students in grades 7-13 compared to pupils in grades 4-6.

### Developmental profile of achievement motivation between grades 4 and 13

Figure 1 illustrates the distribution of mean t-values of QAM dimensions by grade, and offers further information on the differences of achievement motivation between younger and older pupils, grade by grade. The profile of achievement motivation for the entire study population is shown. We detected the following characteristics for the different dimensions of achievement motivation.

- Activating test fear (which was only measured in grade 7 and higher) shows more or less constant positive deviations across all grades except for grades 8 and 13 (the latter one represents only one student).

- For tenacity and diligence between grades 4 and 8, negative deviations or deviations close to zero from the mean were observed, whereas beginning with grade 10 this dimension increased in the positive direction.

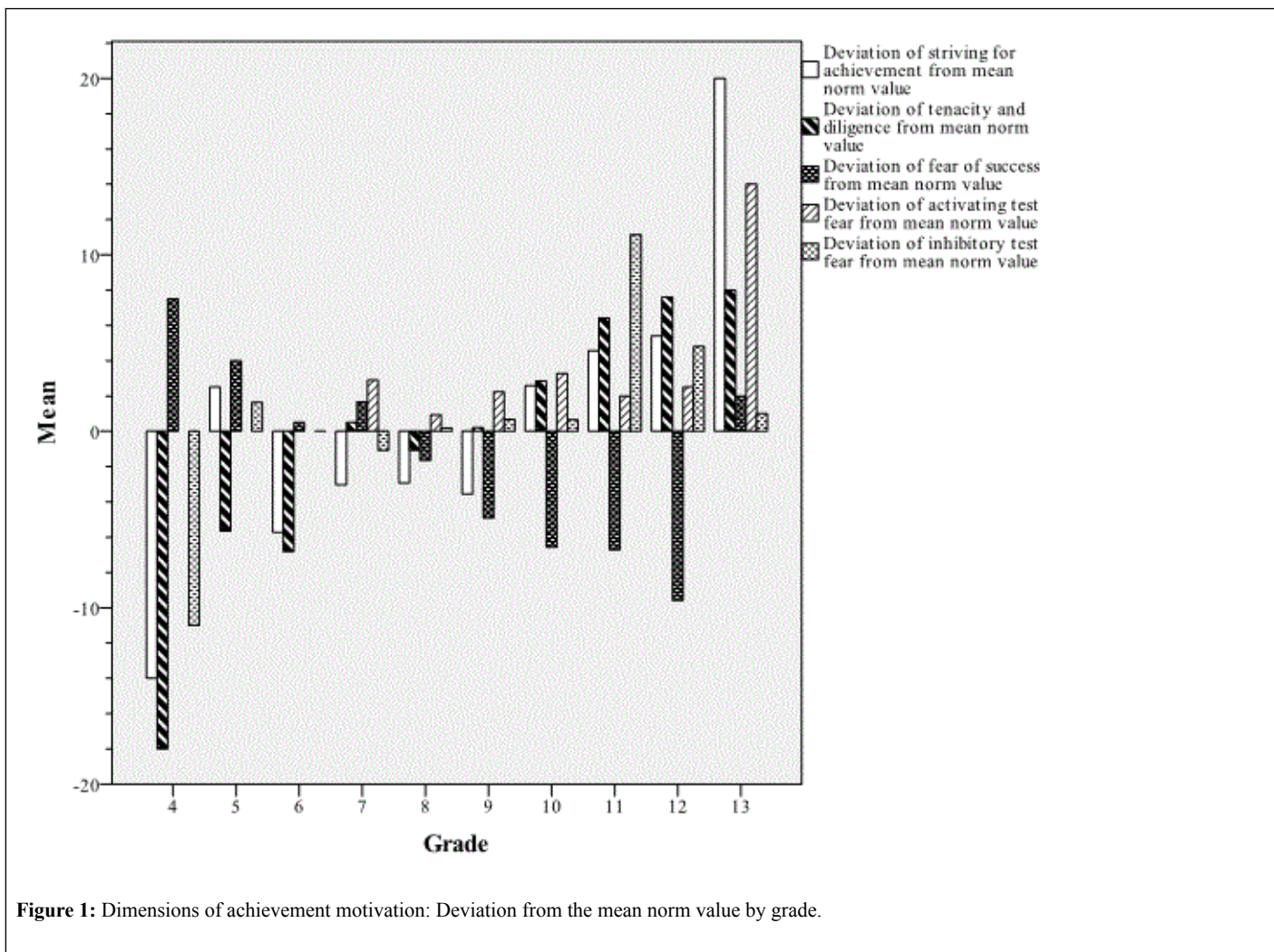
- The performance of striving for achievement is very similar to the dimension of tenacity and diligence, whereby positive expressions of this dimension are located from grades 9 and 10 onward, with its highest expression in grade 13.

- If we look at the deviation of fear of success, it stands nearly mirror-inverted in relation to both last mentioned variables when the line of zero deviation is the axis of symmetry. Whereas fear of success is expressed above the mean until grade 7, it becomes negative below the mean beginning with grade 8 and it continuously diminishes until grade 12.

- A remarkable positive deviation of inhibitory test fear is restricted to grades 11 and 12 since all other grades show negligible deviations close to zero.

### Acknowledgment 1 (grades 4 - 6)

The mean norm t-value for every single scale of QAM 4-6, i.e., the mean value of reference sample, is equal to 50 and its standard deviation is equal to 10. We computed the mean deviation of QAM-4-6 participants from the mean reference sample using statistical parameters and graphical instruments. We also performed a statistical test of the global null hypothesis that the mean difference between the individual t-value and the reference is 0. Analogously, we performed a one sample tests of the global null hypothesis that the mean of residuals to the mean reference t-value is zero (Since the above-mentioned residuals are approximately normally distributed, we were able to perform a one sample t-test).



**Acknowledgment**

Because grades 4 and 13 together only account for 3 students, the respective mean deviations are not as representative as that one's of the other grades. The absence of the purple-coloured bar chart in grades 5 and 6 reflects the fact that activating test fear is not part of the achievement motivation index in lower grades.

**Comparison of t-values for overall achievement motivation by grade**

We integrated all four dimensions of achievement motivation by calculating an overall mean t-value. Then we compared the overall mean value of groups of grades. We could not detect a statistically significant mean difference between both grade groups under consideration ( $p=0.18$ ). The overall mean t-values were not far from the norm value of 50.

**Comparison of t-values for different dimensions of achievement motivation by grade**

Table 2 shows the mean values and the standard deviations for each of the four dimensions of achievement motivation by group of grades which were directly comparable. In the dimension striving for achievement, we could not detect significant differences between lower and higher grades ( $p=0.37$ , independent sample t-test), whereas younger pupils reported lower values in tenacity and diligence being statistically significant at the adjusted cut-off level of 0.0127. On the other hand, the older age group (7-13) scored significantly lower on fear of success ( $p=0.007$ ). The

dimension inhibitory test fear did not discriminate between the two groups ( $p=0.61$ ).

**Table 2: Dimensions of achievement motivation: Mean t-values and standard deviation by group of grades.**

Dimension of achievement motivation	4th to 6th grade			7th to 13th grade		
	Mean	Std. Deviation	Cases	Mean	Std. Deviation	Cases
Striving for achievement	46.87	12.24		48.71	10.51	107
Tenacity and diligence	43.03	9.38	38	51.15	9.97	106
Fear of success	52.16	8.92		47.13	11.28	
Inhibitory test fear	50.03	11.48		50.98	9.15	105

**Summary of a grade specific profile of achievement motivation**

In younger students attending grades 4 to 7, we found an achievement motivation profile characterized by positive deviation from the mean norm value concerning fear of success and a negative deviation regarding striving for achievement and tenacity and diligence. The lower the grade, the more expressed is the deviation. In older students attending grades 10 to 13, we established a continuous change in signs of deviation since we noticed an achievement motivation profile that is characterized by a negative deviation in fear of success and a positive one in striving for achievement plus tenacity and diligence. The higher the grade, the more

expressed is the deviation of these two dimensions. Students attending grades 8 and 9 are characterized by a transition state.

The strength of the mean deviation across all grades is U-shaped in two respects: We have a U-shaped dispersion of positive deviations and an inverse one concerning the negative ones.

### ADHD symptom expression of the study population

We measured ADHD core symptoms by self-reports (SR) and parental rating (PR) in two different age groups, one with students aged 11-13, and the second one with students aged between 14 and 17. We transformed the measurements as deviations from the mean norm value for ease of comparability.

We performed a one sample t-test for ADHD total score as well as for every single core symptom with a statistical significance of  $p < 0.0005$  for every dimension.

#### Study population: Age 10-13

**ADHD symptoms self-report (ADHD-SR):** The results of the self-evaluation report are presented as deviation from the mean norm value in Table 3a. Together with the 5 and 95 percentiles, the three quartiles give an impression of the distribution of deviation.

As Table 3a shows, the mean ADHD total score of our study population as a global measure for ADHD symptom expression is nearly a half standard deviation (4.27) higher than the mean of the reference population. Among the three dimensions, the deviation is more pronounced for inattention (5.27) than for hyperactivity and impulsivity (4.27 and 3.83, respectively). Only 25 percent of the study population shows an ADHD symptom expression which falls below the mean reference value, and 50 percent show a symptom expression which is less than a half standard deviation (5.1) higher than the mean reference population.

**ADHD symptoms parental report (ADHD-PR):** Table 3a also shows that ADHD symptom expression was much more pronounced in parental ratings compared with students' own ratings in this age group.

#### Study population: Age 14-9

**ADHD symptoms self-report (ADHD-SR):** Table 3b shows the respective deviations from the mean norm values in the study population, aged between 14 and 19. The symptom scores were moderately higher compared to the reference population. 25% of the study population show ADHD symptoms which fall below the mean reference value except for hyperactivity, with a symptom expression less than a half standard deviation (5.1) lower than mean reference population.

**ADHD symptoms parental report (ADHD-PR):** Mean parental scores in the older age group, aged between 14 and 19, were remarkably higher than the self-reported values of their children. This held true for all dimension of the ADHD scale as well as the total score. Compared to the mean parental scores of the younger age group, parental ratings for the core symptom inattention were about 3 units higher in the older age group, and 2 units higher for the total symptom score.

In students' self and parental reports of both age groups, we performed a one sample t-test for ADHD total score as well as for every single core symptom. The adjusted cut-off level for the statistical significance for each single test was set at  $p = 1 - (1 - 0.05)^{1/8} = 0.0064$  in younger as well as in older students. The test procedure revealed  $p < 0.0005$  for every dimension, what means, that the expression of ADHD core symptoms was significantly higher compared with the reference population. Total symptom expression according to parental ratings was higher in the group with older students; for inattention the highest difference could be detected.

**Table 3a: Deviation from mean norm values, ADHD-SR and ADHD-PR, age 10-13.**

	Deviation of			
	Inattention	Hyperactivity	Impulsivity	ADHD total score
	<b>From mean norm value in self-report</b>			
<b>Mean</b>	5.27	4.27	3.83	4.27
<b>Std.Deviation</b>	8.17	8.5	6.68	7.23
	5	-5.1	-10.2	-5.1
	25	0	0	0
<b>Percentiles</b>	50	5.1	5.1	5.1
	75	12.76	10.2	10.2
	95	20.41	15.31	15.31
	<b>From mean norm value in parent's report</b>			
<b>Mean</b>	8.7	9.03	8.95	9.45
<b>Std.Deviation</b>	4.78	4.6	7.55	5
	5	0.51	0	-5.1
	25	5.1	5.1	5.1
<b>Percentiles</b>	50	10.2	10.2	10.2
	75	10.2	10.2	15.31
	95	19.9	15.31	20.41

**Table 3b: Deviation from mean norm values, ADHD-SR and ADHD-PR, age 14-19.**

	Deviation of			
	Inattention	Hyperactivity	Impulsivity	ADHD total score
	<b>From mean norm value in self-report</b>			
<b>Mean</b>	6.98	4.68	5.04	5.16
<b>Std Deviation</b>	9.6	9.14	7.45	9.32
	5	-10.2	-10.2	-5.1
	25	0	-5.1	0
<b>Percentiles</b>	50	5.1	5.1	0
	75	15.31	10.2	10.2
	95	20.41	20.41	15.31
	<b>From mean norm value in parent's report</b>			
<b>Mean</b>	11.78	9.11	9.6	11.24
<b>Std Deviation</b>	6.99	5.38	6.31	7.25
	5	-3.83	0	0
	25	10.2	5.1	5.1
<b>Percentiles</b>	50	10.2	10.2	10.2
	75	15.31	10.2	15.31
	95	20.41	20.41	20.41

### Correlations between achievement motivation and ADHD symptoms

Correlation analysis of QAM 4-6 and 7-13 with the ADHD values is performed on the basis of 38 and 103-107 students, respectively.

**Grades 4-6:** As demonstrated in Table 4, only low or very low, mostly negative, correlations for children between grades 4 and 6 were revealed between achievement motivation and ADHD total symptom score according to self-reports and parental reports.

Considering single core symptoms in this subgroup for the symptom inattention, weak negative correlations were observed for striving for achievement (-0.29) as well as for tenacity and diligence (-0.36) according to parents' ratings. According to self-reports, a low negative correlation existed only for tenacity and diligence (-0.34). For the core symptom hyperactivity, only a weak negative correlation with fear of success (-0.27) existed according to parents' reports. For the core symptom impulsivity, a low correlation with striving for achievement according to parental (0.34) and self-reports (0.33) was demonstrated; furthermore, according to self-reports for fear of success (0.32) and according to parental reports for inhibitory test fear (0.27).

**Grades 7-13:** Overall, as demonstrated in Table 4, for adolescents in grades 7-13, stronger and mostly negative correlations between ADHD symptoms and achievement motivation were revealed based on parental and self-reports. On the basis of scale values in older students, even a moderate negative correlation was revealed.

For ADHD total symptom score according to parental reports, nearly moderate negative correlations existed for the variables tenacity and diligence (-0.43) as well as for inhibitory test fear (-0.32). According to self-reports, a nearly moderate negative correlation existed only for tenacity and diligence (-0.47).

For inattention, a weak and nearly moderate correlation with tenacity and diligence was observed according to parental (-0.39) and self-reports (-0.46), respectively. Similar but slightly weaker correlations also existed for the core symptoms hyperactivity (-0.29 each).

For the core symptom impulsivity, weak negative correlations existed with the dimension of tenacity and diligence according to parental reports (-0.34) and according to self-reports (-0.22). In parental but not in self-reports, a low negative correlation was seen for inhibitory test fear for core symptoms hyperactivity (-0.30) and impulsivity (-0.26).

For the core symptom hyperactivity, a weak negative correlation with inhibitory test fear was detected according to parental ratings (-0.30).

**Table 4: Correlation between dimensions of Achievement Motivation (QAM) and core symptoms of ADHD (both measured by t-values).**

Achievement motivation and ADHD total score				
ADHD: Total score				
Achievement Motivation	(QAM 4-6)		(QAM 7-13)	
	Self-report	Parents report	Self-report	Parents report
Striving for achievement	0.03	-0.01	-0.03	-0.18**
Tenacity and diligence	-0.21	-0.24	-0.47**	-0.43**
Fear of success	0.04	-0.19	0.15	0.03
Activating test fear			-0.02	-0.08

Inhibitory test fear	0.13	0.22	0.07	-0.32**
	<b>Achievement motivation and inattention</b>			
<b>ADHD: inattention</b>				
Achievement Motivation	(QAM 4-6)		(QAM 7-13)	
Dimension	Self-report	Parents report	Self-report	Parents report
Striving for achievement	-0.14	-0.29 nearly*	-0.04	-0.03
Tenacity and diligence	-0.34*	-0.36*	-0.46**	-0.39**
Fear of success	-0.05	-0.26	0.09	-0.11
Activating test fear			-0.09	-0.1
Inhibitory test fear	0.04	0.07	0.14	-0.16
<b>Achievement motivation and hyperactivity</b>				
<b>ADHD: Hyperactivity</b>				
Achievement Motivation	(QAM 4-6)		(QAM 7-13)	
Dimension	Self-report	Parents report	Self-report	Parents report
Striving for achievement	0.09	0.09	-0.02	-0.12
Tenacity and diligence	-0.19	-0.11	-0.29**	-0.29**
Fear of success	0.09	-0.27 nearly	0.15	0.08
Activating test fear			0.07	-0.11
Inhibitory test fear	0.26	0.04	-0.03	-0.30**
<b>Achievement motivation and impulsivity</b>				
<b>ADHD: Impulsivity</b>				
Achievement Motivation	(QAM 4-6)		(QAM 7-13)	
Dimension	Self-report	Parents report	Self-report	Parents report
Striving for achievement	0.33 <sup>†</sup>	0.34 <sup>†</sup>	0.08	-0.11
Tenacity and diligence	0.03	0.08	-0.22 *	-0.34**
Fear of success	0.32 <sup>†</sup>	0.09	0.13	0.1
Activating test fear			0.04	-0.02
Inhibitory test fear	0.16	0.27 nearly	0.08	-0.26**

### Acknowledgment

Pearson correlation coefficients indicated with an asterisk (\*) are significantly different from zero (p<0.05). Coefficients indicated with a double asterisk (\*\*) are highly significantly different from zero (p<0.01).

Pearson correlation coefficients of T-values and scale values will be computed. Regularly, correlation coefficients whose absolute values are greater or equal 0.2 but fall below 0.5 are called "weak (or low) correlations". Correlations whose absolute values are greater or equal 0.5 but fall below 0.7 are called "moderate" correlations.

### DISCUSSION

In summary, there were no significant deviations from the norm value in either group of the study population on different dimensions of achievement motivation, except for the dimension tenacity and diligence in the group of younger children. Moreover, we detected lower deviations of achievement motivation from the mean norm value in older students in grades 7-13 compared to pupils in grades 4-6. The developmental profile of achievement motivation shows a more differentiated and highly interesting results if we consider younger and older students: In younger students in grades 4 to 7, we found an achievement motivation profile characterized by deficits regarding striving for achievement and tenacity and diligence and by a positive deviation from the mean norm value concerning the fear of success. The lower the grade, the more expressed the deviation.

In older students attending grades 10 to 13, a continuous change in signs of deviation is observed since the achievement motivation profile is characterized by negative deviation related to the fear of success, and a positive one concerning striving for achievement and tenacity and diligence. The higher the grade, the more expressed is the deviation of these two dimensions. Additionally, older students display positive deviations concerning activating test fear and - restricted to ages 11 and 12 -inhibitory test fear.

Students attending grades 8 and 9 are characterized by a transition state.

As regards our first hypothesis, we can state that on the one hand no significant motivational anomalies consisted between students with ADHD and their peers without this condition (except for the dimension tenacity and diligence in younger students), possibly due to the fact that we assessed stimulant-medicated students with at least a clinically effective ADHD core symptom reduction though statistical analysis still revealed significantly elevated ADHD-symptom expression. On the other hand, the analysis of an age and/or grade-specific motivational profile reveals a much more differentiated pattern with remarkable deviations especially for the clinically most important motivational dimensions of tenacity/diligence and striving for achievement.

Considering the relationship between the ADHD symptoms and achievement motivation, notable results can be presented; namely, in younger students no significant correlation between ADHD total symptom score and different dimensions of achievement motivation were established, whereas there was a significant negative correlation between the core symptom inattention and tenacity/diligence as well as striving for achievement according to parental and student ratings. No such correlation could be demonstrated for the core symptom hyperactivity. Very interestingly, the negative correlation between ADHD symptoms and different dimensions of achievement motivation was stronger in the study group with older students. This finding was most revealed for the correlation between the ADHD total symptom score, including all core symptoms, and the dimension tenacity and diligence according to parental and student ratings. This stronger correlation is possibility related to the higher ADHD symptom expression in the group with older students. Finally, in this subgroup of the study sample, a weak but significant negative correlation between ADHD symptoms and inhibitory test fear existed according to parental ratings.

Nora Volkow et al. observed similar correlations. In their study, scores on the achievement scale as a measuring instrument of motivation were significantly lower in ADHD participants than in controls [15]. Moreover, in the same study, a significant correlation between the score on the achievement scale and dopamine in the nucleus accumbens in terms of D2/D3 receptors and the dopamine transporters (DAT) was obtained, but not in the control group. Our results are also at least partially consistent with Volkow's study results as regards the correlation of specific ADHD

core symptoms with achievement motivation. We observed the same negative correlation between inattention and motivational measures and also for impulsivity, but not as stringently for hyperactivity.

In so far as our second hypothesis, we found a significant correlation between ADHD core symptoms and achievement motivation, dependent on specific core symptoms as well as on the age of the participants.

How can we interpret these striking results? To our knowledge, there are no similar research results assessing achievement motivation in children and adolescents with ADHD.

As Volkow et al. demonstrated repeatedly, our study results equally strongly suggest that there is at least a nearly moderate negative correlation between the extent of the core symptoms of ADHD and specific motivational anomalies in ADHD patients treated with psychostimulants [13,15].

A very helpful result for the interpretation of our study was the detection of a developmental profile of achievement motivation with an improvement of performance impairing motivational dimensions (tenacity and diligence as well as striving for achievement) in older students. As an explication, we refer to the already cited studies that demonstrated a dysfunction in the reward system in ADHD [26]. With the identification of personally relevant and strong rewards that are individually salient enough, motivational and behavioral changes can be induced [27]. In our study, students in grade 9 and older were confronted with graduation from school, suggesting that this important goal may have been individually meaningful enough to booster their achievement motivation.

### Clinical implications

Our study results are in high accordance with the recommendations formulated by Modesto-Lowe et al. for clinicians working with ADHD patients in their noteworthy literature review from 2013 [28]. In summary, these authors highlight the importance of intensive motivational work with ADHD children and adolescents in a differentiated way. Whereas for younger children the consequent application of reward and mild punishment procedures play an important role, a different strategy should be adopted in adolescents using a shared decision -making approach. Treatment principles that increase the intrinsic motivation become more important, for example by implementing motivational interviewing [29]. Another helpful technique may be patient coaching with the main task to jointly identify patient-tailored goals, helping the patients initiate and follow-through with taking the necessary steps in this regard [30,31]. Our results emphasize these suggestions as we identified significantly more motivational deficits in younger children than in adolescents.

### Limitations

This study investigated patients with ADHD treated with psychostimulant medications. It is conceivable that the correlations between ADHD core symptoms and motivational deficits, which are identified here at least partially, are more pronounced in untreated children. For this purpose, further studies should be carried out in untreated children and adolescents with ADHD, as well as investigating motivational anomalies in the course of time before and during treatment.

In this way, the question of the extent to which the manifestation of the core symptoms influences the motivational deficits could be explored in more detail. The hypothesis here is that the motivational deficits are more pronounced before therapy and tend to improve along with the reduction of ADHD core symptoms in the course of therapy.

In addition to studying drug-treated children and adolescents, it would be of great utility to carry out the same investigation under conditions of a behavioral intervention, since this would additionally reveal a possible influence of different treatment modalities on motivational variables.

Above all, if one postulates that in the course of becoming older, changes occur both with regard to motivational deficits, a significantly larger study sample should be investigated with a sufficient and identical number of subjects in the individual age groups.

Furthermore, the demonstrated correlations do not allow us to answer the question of which of the assessed dimensions is primary; either that the motivational deficit is the source of the core symptoms or, alternatively, that the presence of the core symptoms is leading to many personal disappointments during their school career with secondary motivational deficits. This issue should be addressed in longitudinal studies investigating a study group over the course of time.

There is, of course, no evidence of a correlation of motivational deficits, which have been demonstrated here by behavioural measuring instruments, as compared with neurobiological imaging. A combination of both methods would be optimal.

In addition to increasing the number of subjects, the methodology of symptom compilation should be complemented by obtaining teacher's ratings as well. This is of great importance because the overall motivational deficits are highly related to performance situations, and the measuring instruments used here focus considerably on the learning performance situation.

## Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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