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The effect of exercise

on social behavior and academic achievement in

teenagers in a school-setting

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22.05.2014, Ursula Simone Spitzer

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Index

1. Introduction	p. 7
2. Methods	p. 10
2.1. Student description	p.10
2.2. Procedure	p. 11
2.3. Variables	p. 13
2.3.1. PANAS	p. 13
2.3.2. Rosenberg Scale	p. 14
2.3.3. d2 Test of Attention	p. 15
2.3.4. DRT: Diagnostic spelling test	p. 16
2.3.5. Contact with a social worker	p. 16
2.3.6. LSL	p. 16
2.3.7. Body-Mass-Index	p. 17
2.3.8. Academic performance	p. 17
2.3.9. Cooper-Test	p. 17
2.4. Discussion of equipment	p. 18
2.5. Data analysis	p. 18
3. Results	p. 19
3.1. Part 1: Qualitative data	p. 19
3.2. Part 2: Quantitative data	p. 22
3.2.1: Effects of the intervention	p. 22
3.2.1.1. PANAS	p. 22
3.2.1.2. Rosenberg Scale	p. 28
3.2.1.3. LSL: teachers list for social and studying behavior	p. 29
3.2.1.4. d2 Test of Attention	p. 35
3.2.1.5. Body-mass-index	p. 38
3.2.1.6. Cooper-Test	p. 38
3.2.1.7. DRT: Diagnostic spelling test	p. 39
3.2.1.8. Academic performance	p. 39
3.2.2: Correlations at the first time point of measurement,	
September 2010	p. 42

	3.2.2.1. Correlation between the d2 Test of Attention	
	and academic and social performance	p. 42
	3.2.2.1.1. Total number of processed items	p. 42
	3.2.2.1.2. Number of errors	p. 43
	3.2.2.1.3. Percentage of errors	p. 44
	3.2.2.1.4. Concentration performance	p. 44
	3.2.2.2. Correlation between the teachers list for social	
	and studying behavior and academic and social performance	p. 45
	3.2.2.2.1. First item: Cooperation	p. 45
	3.2.2.2.2. Second item: Self-perception	p. 46
	3.2.2.3. Third item: Self-control	p. 47
	3.2.2.2.4. Fourth item: Readiness to help others and empathy	p. 47
	3.2.2.5. Fifth item: Adequate assertiveness	p. 48
	3.2.2.2.6. Sixth item: Social contact	p. 48
	3.2.2.2.7. Seventh item: Willingness to make an effort	p. 49
	3.2.2.2.8. Eighth item: Concentration	p. 49
	3.2.2.9. Ninth item: Independence while studying	p. 50
	3.2.2.2.10. Tenth item: Accurateness while studying	p. 51
4. Discussion		p. 53
5. Summary		p. 63
6. Zusammenfas	ssung	p. 66
7. Literature		p. 68
8. Appendix		p. 74
9. Curriculum v	vitae	p. 79

1. Introduction

German schooling authorities do not place great emphasis on physical education (PE) and regular exercise. A shift of focus, from PE lessons to other school subjects, has been commented on by German researchers (Kubesch et al. 2009). Others argue that the focus is regularly set on academic achievement, and that consequently attention to exercise is reduced (Chaddock et al. 2012; Juster et al. 2004; Mahar et al. 2006). In spite of this emphasis on cognitive function, the Program for International Student Assessment (PISA study) revealed that German 9th grade students range only within the middle of the academic scale when compared with peers from other countries that are part of the Organization for Economic Cooperation and Development (OECD). Due to a sedentary lifestyle in industrialized countries, mainly caused by time spent in front of screen-media and the consumption of junk food, an increasing number of children are overweight or even diagnosed as obese (Morrow & Ede 2009). These relationships are discussed in a recent policy statement by the American Academy of Pediatrics. The authors conclude: "Media clearly play an important role in the current epidemic of childhood and adolescent obesity. The sheer number of advertisements that children and adolescents see for junk food and fast food have an effect" (Council on Communications and Media 2011)¹.

In the light of recent evidence from various scientific disciplines (Alexander & Brown 2011; Churchwell et al. 2011; Hillmann et al. 2009; Jurado & Rosselli 2007; Miller & Cohen 2001; Squire 2004), this state of affairs needs to be reconsidered. We know from basic and applied neuroscience, that PE not only has beneficial effects on body functioning but also on the mind, ranging from increased attention and cognitive control to enhanced emotional and social responsivity, short-term and long-term memory and even neuronal growth (Ardila et al. 2006; Chaddock et al. 2011; Diamond 2011; Hillmann et al. 2008; Jurado et al. 2007; Moffitt et al. 2011; Scudder et al. 2012). Last but not least, a protein of the neurotrophin family called brain derived neurotrophic factor (BDNF) has been shown to have an overall positive effect on neurons: recent studies have revealed links between exercise and higher levels of BDNF and links between BDNF and improved performance on cognitive tasks (Berchtold et al. 2010; Bramham et al. 2005; Robinet et al. 2011; Rojas Vega et al. 2006; Suzuki et al. 2011; Winter et al. 2007; Yoshii & Constantine-Paton 2009).

¹ <u>http://pediatrics.aappublications.org/content/128/1/201</u>, last visit: January 8th, 2012.

In his monograph *SPARK!* John Ratey explains and summarizes scientific literature and evidence about the importance of regular exercise and how it benefits the brain (Ratey & Hagerman 2008). The author highlights that learning and studying highly depend on a well-functioning brain and that sources that enhance the performance of the brain should be introduced into school environments. Exercise is being discussed to be a very powerful tool in the book to improve the academic performance and social behavior of teenagers and many examples are given in which the introduction of exercise to a school environment has benefitted the community in many different ways.

How can this new knowledge about PE and positive effects on school related behaviors be applied? Since schools have to be attended by every child, they therefore provide an excellent opportunity for universal physical activity. Additionally, if students attend an all-day school and do not get home before 4 pm, it is especially important to find a way to incorporate exercise into the school program because throughout the day it becomes increasingly difficult for students to sit still and focus on their tasks.

The present study was conceived to investigate the effect of extra weekly exercise classes on student social and academic performance in an all-day school setting. Two sixth grade classes took part in the study; an intervention class receiving extra exercise lessons and a control class not receiving extra exercise lessons. We hypothesized that extra exercise classes would change the students' social behavior, self-perception and academic performance. Therefore, academic grades in mathematics, German and English language, music, and art were compared at baseline (after fifth grade) and at posttest (after the first half-term of sixth grade). Students of both classes filled out the Rosenberg self-esteem scale and the positive affect, negative affect scale in order to assess any influences that exercise may have on the way students felt emotionally. The teacher who taught both classes in German filled out a form before and after the study period, interviews were regularly carried out with those teachers who taught in both classes to determine whether the teachers noticed any behavioral or academic changes in the students. The study was approved by the Ethics Committee of the German Sport University Cologne.

The main questions were:

8

- Do three weekly exercise classes over a study period of four months increase academic performance in teenagers?
- To which extend does this training have a positive impact on social behavior in teenagers?
- Do teachers who teach the same lessons in exercise and control classes notice any differences between them?
- Is self-esteem influenced by this training?
- Is physical fitness enhanced in the intervention group after the study period?

2. Methods

2.1. Student description

The study involved students of two 6^{th} grade classes with one class of 24 students receiving extra exercise lessons, whereas the other class of 20 students did not receive exercise lessons.

Group	Gender	Age	BMI Sep.	BMI Dec.
Intervention	F= 9	Mean:	Mean: 22.07; SD: 5.71;	Mean: 23.10; SD: 5.52;
N=24		148.22;	N=9	$N=8^{(2)}$
		SD: 4.15		
	$M = 15^{(1)}$	Mean:	Mean: 22.26; SD: 4.77;	Mean: 21.81; SD: 4.68;
		152.86;	$N=11^{(3)}$	$N=12^{(4)}$
		SD: 8.37		
Control	F=7	Mean:	Mean: 22.45; SD: 3.80;	Mean: 23.35; SD: 4.11;
N=20		156.86;	N= 7	N= 7
		SD: 18.33		
	M=13	Mean:	Mean: 19.71; SD: 2.81,	Mean: 20.00; SD: 3.44;
		153.85;	N=12 ⁽⁵⁾	$N=9^{(6)}$
		SD: 11.00		

Table² 1: Description of students

⁽¹⁾ Data from one male student of the intervention class were excluded from further analysis because the students had missed more than 500 hours of schooling during the study period and participated only in four exercise lessons.

⁽²⁾ One female student in the intervention class did not finish the intervention; she left the school due to hospitalization at the beginning of December.

⁽³⁾ Three male students joined the intervention class after the autumn break.

⁽⁴⁾ Two male students in the intervention class were ill when the second BMI measurement was taken.

⁽⁵⁾ One male student in the control class did not want his weight to be taken.

⁽⁶⁾ Three more male students in this group were ill when the second BMI measurement was taken.

In general, the result section provides information about the number of students participating in the various testing procedures.

² In the following text, the word *table* will be abbreviated with *tab*..

2.2. Procedure

The intervention took place at a German primary school (German: *Hauptschule*) in the city of Bochum located in the federal state of North Rhine-Westphalia. This school is an all-day school starting at 7.55 am and ending at 15.45 pm. The intervention and the control class had 3 hours of so called *individual instruction time* weekly. During this time each students could work in her or his pace on a specific task in German, English and mathematics. On two days (Monday and Wednesday) the first lesson in both classes consisted of *individual instruction time*, during which each students could work in her or his pace on a specific task. For the rest of the day, students usually did not have any homework to do besides studying vocabulary in English. Due to the intervention, two of these *individual instruction time* lessons were cancelled in the timetable of the intervention class. Instead of intensifying their knowledge in German, English and mathematics, all the students in the intervention class had exercise lessons. Put differently, the students in the instruction class only had 15 minutes each to work on these three students whereas the control class had 45 minutes to work on German, English and mathematics.

Both sixth grade classes have two conflict resolution lessons weekly during which problems in the class are being discussed with the class teacher. The third exercise lesson took place during one conflict resolution lessons.

The study period started with the beginning of the school year 2010/11 on August 31st and ended on the last day before Christmas break, December 23rd. Starting with week 3 of the school year, with a one week school trip at the end of September and two weeks of autumn break at the end of October without exercise lessons, the overall number of exercise lessons held in the intervention class was 36. Three exercise lessons per week were accomplished in the intervention class. The exercise lessons were always held during the first hour of school during which time the control class had English lessons.

Two of the weekly exercise lessons were carried out in the Gymnastics hall of the school; the hall was divided into three equally large fields. The class teacher, who had to be present during all the exercise lessons for insurance reasons, directed a soccer-game on the first field. On the second field, a university student (who was hired for this reason) directed hockey,

soccer, badminton, relay or another ball game (German: *Zehnerball*). The third field was supervised by the conductor of the study. Here, basketball was performed.

The third weekly exercise lesson was held in the assembly hall of the school. A dancing master was hired to teach the students in hip-hop and street dance. However, this teacher was five times late during the study period. In these situations, the class-teacher decided spontaneously to go for a walk of 20 minutes with the intervention class at a park nearby. Thus it was insured that the intervention class was in motion three times per week. After four dance-lessons, some of the male students in the intervention class did not want to dance any longer; they were given the chance by the conductor of the study to go jogging in the schoolyard instead which is what they did.

Several tests were carried out before the exercise lessons started and after the 36th lesson was accomplished. At the beginning of September, the study and the utilized tests were explained by the conductor of the study to each student in a dedicated study room. First, each student was asked personally for her or his agreement to the study. None of the students disagreed to participate in the study. Secondly, the height and weight of all students, except for one male student in the control class, were taken and the body-mass-index (BMI) was calculated. Thirdly, the conductor of the study explained the *Rosenberg Scale* and the *Positive Affect, Negative Affect Scale* (PANAS) to the students.

To ensure that the students understood these tests, they were asked to give synonyms of the adjectives used in the PANAS. Then, they were asked to explain the sentences used in the Rosenberg-scale in their own words. Eventually, the students were given an information letter for their parents, in whom the purpose of the study was explained and the parents were asked for their written consent to the study. At a parent-teacher-conference, the conductor of the study was present in order to give the parents a chance to ask questions about the study.

The PANAS was administered at four time points during the study (Sept. 9th, Nov. 15th, Dec. 1st and Dec. 20th), three times per day (before and after the first lesson, i.e. at 7.55 and 8.40 am, respectively, and at 12.30 pm). Assessment was performed in parallel in both classes, with the class-room teacher handing out the forms to the control class, and the conductor of the study handing out the forms to the intervention class.

The Rosenberg Scale was carried out on three different days during the study period (Sept.6th, Nov. 26th and Dec. 20th). The scale was handed out to the students at the same time in both classes. Again, the class-room teacher handed out the forms in the control class and the conductor of the study handed out the forms in the intervention class.

As it happened, in both classes the very same teacher was responsible for giving the German lesson. Fortunately for the study, he had already taught German in fifth grade in both the control and intervention class and therefore knew the students very well. Thus, he took over the function of a *research assistant*: The d2 Test of Attention and a German spelling test (DRT) were both administered by this German teacher. He was also asked by the conductor of the study to fill out a third-party assessment form (LSL), a so called *teachers list for social and studying behavior*: The form consists of 50 statements referring to the social behavior of students, e.g. cooperation, self-control and readiness to help others. This form was filled out twice by the German teacher: The first time in September before the exercise lessons started and the second time in December after the last exercise lesson had taken place.

School grades were collected by the conductor of the study after the study period had ended. We were interested in those subjects that were taught in both classes by the same teacher which happened to be in art, music and German. We were furthermore interested in the grades in English and Math. As it happened, the same exams were written in German and Math. Therefore, these results will also be examined. Teachers who had taught the same subject (art, music, German) in both classes were interviewed regularly during the study period. Their observations will be presented in the section on qualitative data in the results section.

2.3. Variables

In the following sections, the tests and questionnaires that were used in the study will be explained.

2.3.1. PANAS

Students' emotional state was assessed 12 times using the PANAS, an established instrument for this purpose in the field of psychology and education. It is a 20-item self-report measure of

positive and negative affect that was developed by Watson, Clark, and Tellegen. Negative affect and positive affect reflect opposite dimensions: subjective distress and displeasing engagement is reflected in a high NA-score, whereas a low NA-score is observed if these feelings are absent. PA shows the extent to which a subject has pleasurable experiences with his environment. "[...] Thus, emotions such as enthusiasm and alertness are indicative of high PA, whilst lethargy and sadness characterize low PA [...]" (Watson & Clark, 1984). The subject is asked to estimate to which degree each of the 20 items is experienced by him at the given moment. Then, he can choose between the options 1 'very slightly or not at all', 2 'a little', 3 'moderately', 4 'quite a bit' and 5 'very much'. The PANAS can be used with different time-frames. The time-frame used in this study was 'at the moment'.

The PANAS was used in a repeated measures design at about equally spaced time-points during the study. On each day of measurement, the PANAS was administered before the school day started (either an exercise lesson in the intervention-class, or any other subject except for physical education in the control class), after the first lesson had ended, and a third time before the afternoon break. Before the students were asked to fill out the form, each word was explained again by the conductor of the study in the intervention class and by the class teacher in the control class to ensure that the students understood the words.

2.3.2. Rosenberg Scale

The self-esteem of the students was assessed with the Rosenberg Scale, developed by Morris Rosenberg, a professor of sociology, in the 1960s.³ The original scale was developed with over 5000 high school junior and senior children, which is why this scale was chosen to assess whether exercise had an effect on self-esteem. It consists of ten items, each being a sentence that the subject must rate. The original scale consisted of four possible answering options 1 'strongly agree', 2 'agree', 3 'disagree' and 4 'strongly disagree'. In this study, a fifth answering option was included, namely 'neither nor'.

The subject is asked to rate to which degree he agrees with the ten stated sentences. E.g. the first sentence is "I feel that I'm a person of worth, at least on an equal plane with others".

³ <u>http://www.bsos.umd.edu/socy/research/rosenberg.htm</u>, last visit: March 15th, 2011.

The Rosenberg Scale was used in a repeated measures design three times during the study. Every time, it was administered at the same time of the day in both classes. To ensure that the students understood the meaning of the sentences, each sentence was explained either by the conductor of the study in the intervention class or by the class teacher in the control class before the students were allowed to give an answer to a specific item.

2.3.3. d2 Test of Attention

The d2 Test of Attention was developed in 1962 by psychology professor Rolf Brickenkamp. As it says in the product description: the test measures "[...] 1.) processing speed and quantity of that is to say the amount of finished material in a specific timeframe, 2.) quality, meaning the accuracy with which the test was filled out (...) and 3.) time dependent development of achievement, that tells something about the behavior at work, such as (...) continuance, instability and early satiation [...]⁴⁴ (Brickenkamp, 2002). The test itself consists of 14 lines with 47 characters each. Each character is either the letter *d* or *p* with one to four dashes 'attached' to each letter. The dashes are either above or below the characters. The subject has 20 seconds for each of the 14 lines to cross only those *d*'s that have two dashes (either one dash above and below the letter or two dashes below or above the letter). A *d* with more or less than two dashes and a *p* must not be crossed. The following variables were of relevance to us and will be discussed in the result section:

1.) TN (*total number of items processed*): this score measures the total number of correct and incorrect items processed by the subject.

2.) E: the number of errors made in the test is the number of d's with two dashes that were omitted by the subject plus the number of incorrect crossed characters.

3.) E%: the percentage of errors measures the proportion of errors that were made within each part of the test. The less the percentage of errors made in the test, the more accurate did the subject work.

⁴ German: "[...] (das) Zustandekommen (der Konzentrationsleitsung) lässt sich auf die individuelle Koordination von Antriebs- und Kontrollfunktionen zurückführen, die sich im Test d2 in drei Verhaltenskomponenten manifestieren: (1) im Tempo bzw. in der Quantität, d.h. in der Menge des in einer bestimmten Zeiteinheit bearbeiteten Materials (Antrieb), (2) in der Qualität, d.h. der Güte, Sorgfalt und Genauigkeit der Bearbeitung, die sich invers aus dem Fehleranteil erschließen lässt (Kontrolle), (3) im zeitlichen Verlauf der Leistung, der Rückschlüsse auf Besonderheiten des Arbeitsverhaltens, wie Anfangserregung, Konstanz oder Instabilität, frühzeitige Sättigung, Ermüdung und dgl., ermöglichen soll (Kontrolle) [...]".

4.) CL: Concentration performance represents the number of correctly crossed out characters minus the number of incorrect crossed out characters (e.g. a *p* or a *d* with 3 dashes).

The d2 Test of Attention was performed twice in both classes, before the first and after the last exercise lesson. The German teacher, i.e. always the same person, handed out the forms and administered the test during a German lesson in both classes. The d2 Test provides the user with a separate instruction sheet for children, which was used both times.

2.3.4. DRT: Diagnostic spelling test

The diagnostic spelling test, DRT, has two versions, A and B. It is often used to assess the progress in German of pupils during a specific time frame. The test was administered in both classes by the German teacher in September and December.

2.3.5. Contact with a social worker

It is common practice at this school, to reprove a student when he or she misbehaves. If the warning does not show an effect, e.g. in that the student does not stop to disturb the lesson, he is dismissed by the present teacher from class. The student then has to show up at the social worker's office and explain and discuss the reason for which he was dismissed. The number of contacts between the social worker and the students participating at the study was used as a reference about the students' behavior.

2.3.6. LSL

The LSL, *teachers list for social and studying behavior* (German: *Lehrereinschätzliste für Sozial- und Lernverhalten*), is a common form in Germany that teachers use in order to assess a student's behavior. It consists of six topics concerning the social behavior of the student (cooperation, self-perception, self-control, readiness to help others, adequate assertiveness, social contact). Four topics deal with the study behavior of the student (willingness to make an effort, concentration, independence and accurateness while studying). There are five statements to be rated under each topic. The answering options are 0 'behavior never occurs', 1 'behavior rarely occurs', 2 'behavior occurs sometimes' and 3 'behavior occurs often'. In the handbook of this test, it is stated that the teacher should know the student at least for half a year during which he could observe the student both inside the class room and outside in the schoolyard. The teacher then rates a student's behavior during the past 4 weeks when he fills out the form.

In this study, the German teacher filled out the LSL before the first exercise lesson took place, and after the last exercise lesson was performed.

2.3.7. Body-Mass-Index

The body-mass-index (BMI) was calculated twice: before the first exercise lesson took place, each student's height and weight was taken by the conductor of the study. The same procedure took place after the last exercise lesson was accomplished. Since the students were between 11 and 14 years old, a BMI higher than 22 was considered as overweighed in this study and a BMI higher than 26 was considered as obese (cf. Kromeyer-Hauschild et al. 2001).

2.3.8. Academic performance

In this study, school marks were taken into account in order to assess the students' academic performance. The conductor of the study collected school marks after the study period ended in the following subjects: Mathematics, English, German, arts and music.

Furthermore, the school marks in these subjects from the end of the fifth school year were collected and compared to the school marks at the half-term of the sixth grade.

2.3.9. Cooper-Test

The Cooper-Test assesses how far a person can run within 12 minutes. It was chosen to measure changes in the fitness level over the study period. During PE class, students ran the Cooper-Test before and after the study period.

2.4. Discussion of equipment

A calibrated digital personal scale was used to measure the students' weight in September and December.

The room, in which the conductor of the study informed each subject about the design of the study, was normally used by the students during school breaks. It was a large room with a friendly atmosphere.

The Gymnastic hall in which two exercise lessons took place was located next to the school building. The hall itself was approximately 25 meters long and 13 meters wide.

2.5. Data analysis

Data were analyzed using standard descriptive and inferential statistical procedures. The variables (school grades, d2 Test of Attention, DRT) were characterized using means and standard deviation (SD). The PANAS and Rosenberg Scale data were analyzed using separate repeated measures ANOVAs for changes during the days and changes during the entire study period.

3. Results

3.1. Part 1: Qualitative data

The conductor of the study arranged several interviews with those teachers who taught in both classes. We were interested to find out whether these teachers noted any differences behavioral or concentration wise. The content of the interviews is given in English. The German quotation is to be found in the footnotes.

1.) Have you noted any differences between the classes?

The teachers reported that the sense of togetherness in the class (German: *Klassenzusammenhalt*) had become better in the intervention class than in the control class. They had not noted any differences between both classes during the fifth grade. As the German teacher was asked this question he spontaneously described the previous afternoon break during which the girls and the boys of the intervention class had played basketball in the schoolyard together. The students of the control class would never play together during a school break, he said.

The students in the intervention class were described as more concentrated and less aggressive in general. The art teacher, e.g. who used to teach both classes on different days (Wednesday and Thursday) at the same time (14.15 pm to 15.45 pm) reported that some students in the control class were often already physically involved in fights when she arrived at the class room. It frequently happened that students started a fight during this afternoon lesson and ran around in the class room. About 40 percent of the students in the control class would work on a given task regularly, she said.

In the intervention class, students had started to put their chairs and tables together to form one big table on which they work together on a given task. They would talk to each other and in her opinion, about 90 percent of the students would work concentrated. As a matter of fact, both classes worked on paper stars before Christmas. In the control class 8 paper stars were put on the windows, whereas in the intervention class 28 stars were completed during the same amount of time and stuck onto the windows.⁵

⁵ German translation of the art teachers report: "[...] Wenn ich nach der großen Pause zur Klasse komme, sind einige Kinder schon in einen Streit verwickelt. Es kommt häufiger vor, dass Kinder während des Unterrichts sich plötzlich in einer Schlägerei befinden, bzw. durch's Klassenzimmer toben. Ungefähr 40% der Kinder in dieser

2.) Have you noticed a behavioral change in the intervention class?

The German teacher reported that girls and boys in the intervention class sometimes sit and talk together during school breaks. This behavior, he said, had become usual in the intervention class, whereas at this age, it was actually very unusual; typically, boys and girls would not communicate, as was the case in the control class, until grade 8 or 9, when they would become more interested in the other gender.

3.) Is one class friendlier, nicer than the other? Is thus the atmosphere in that class better? All the interviewed teachers reported that they had noted amelioration in the way the students of the intervention class treated each other. Problems, especially amongst the girls would be solved more quickly than in the previous school year, the German teacher reported. They would also excuse themselves and treat each other more directly, this teacher said.⁶ All the interviewed teachers had observed that the students of the control class used more swear words towards each other.

4.) Have you noticed any influence of the exercise on the intervention class?

Generally, the teachers described that the intervention class had become more disciplined. The German teacher even went as far as to say that the exercise caused the discipline. They saw the extra exercise as a way for the students to get rid of their urge to move (German: *Bewegungsdrang*).⁷

5.) Have you noticed that you (German teacher) treat the intervention class or that you perceive this class differently?

The German teacher who was present during the exercise classes stated that his perception of this class has become broader: One female student would engage in her team more than he would have expected and another male student would be much more confident. Again, two

Klasse arbeiten regelmäßig und konzentriert an einer Aufgabe. In der Interventionsklasse haben die Kinder von sich aus begonnen, ihre Tische und Stühle vor dem Unterricht zu einem großen Tisch zusammenzuschieben um gemeinsam an einem Projekt zu arbeiten. Sie unterhalten sich und ich würde sagen, dass 90 % der Schüler konzentriert arbeiten. In der Tat haben die Schüler beider Klassen vor Weihnachten an Papiersternen gearbeitet. In der Kontrollklasse wurden 8 Sterne fertiggestellt um ans Fenster zu hängen, wohingegen 28 Sterne in der Interventionsklasse fertig gestellt wurden [...]".

⁶ German translation: "[...] Probleme unter den Mädchen lassen sich zügiger lösen. Sie entschuldigen sich und gehen direkter miteinander um [...]".

⁷ German translation: "[...] Ich denke dass die Disziplin durch die Bewegung gefördert wurde. Die Kinder konnten ihren Bewegungsdrang ausleben [...]".

more male students would show responsibility in the game. These character traits were new to the teacher.⁸

6.) What is your impression of the study?

The German teacher explained that in his opinion the intervention had made the whole class more sportive: even the more corpulent and weaker kids would engage in playing basketball during school breaks now. They would even go as far as to ask for the ball and expect to be involved in the game.⁹

In tab. 1, an overview of the investigated parameters is to be found.

Tab. 1	: In	vestigated	parameters
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Behavioral differences	 The sense of togetherness changed positively in the intervention class Students in the intervention class were described as more concentrated and less aggressive Girls and boys in the intervention class started to talk to each other Students in the intervention class treat each other friendlier than before Students in the control class use more swear words
Influence of exercise	The intervention class was described as more disciplined
Impression of the study	 Intervention made the intervention class more sportive The present class teacher became a better understanding of his students

⁸ German translation: "[...] Ich habe insgesamt ein umfassenderes Bild bekommen: Ein Mädchen strengt sich richtig an und ein anderer Junge zeigt wesentlich mehr Selbstvertrauen als ich gedacht hätte. Zwei andere Jungen übernehmen Verantwortung. Diese Eigenschaften der Kinder sind mir vorher nicht aufgefallen [...]".

⁹ German translation: "[...] Die Intervention hat die ganze Klasse sportlicher gemacht, selbst unsportliche und schwache Kinder wollen mittags beim Basketball mitspielen. Sie fordern beim Spiel mit einbezoegen zu werden und wollen auch im Ballbesitz sein. [...]".

3.2. Part 2: Quantitative data

3.2.1: Effects of the intervention

3.2.1.1. PANAS

On each day of measurement, students filled out the PANAS three times. Some forms had to be excluded from further analysis because they had not been filled out properly: Either two crosses instead of only one cross had been placed in a row, or a row had been skipped, making it impossible to come up with either a PA- or a NA-score.

The lowest score for either the NA or the PA scale was 10, the highest score was 50. At none of the 4 time points, the repeated measures ANOVAs revealed significant change of positive or negative affect during the day (cf. tab. 2).

Tab. 2: Positive affect (PA) and negative affect (NA) during the day at three different time points.

	Sept.9th	Nov. 15th	Dec. 1st	Dec. 20th
PA	F(2, 54)=.56;	F(2, 32)=1.94;	F(2, 28)=.18;	F(2, 40)=.37;
	p=.58	p=.20	p=.84	p=.70
NA	F(2, 58)=.30;	F(2, 28)=.18;	F(2, 36)=,52;	F(2, 42)=.50 p=.61
	p=.75	p=.84	p=,60	

In order to assess change in affect over the entire study period, three additional ANOVAs were performed for the PANAS data at each time point of the day (cf. tab. 3).

Tab. 3: Change in positive and negative affect over time.

	PANAS at 7.55 am	PANAS at 8.40 am	PANAS at 12.30 pm
PA	F(3, 27)=,08; p=,97	F(3, 27)=.74; p=.54	F(3, 30)=.44; p=.72
NA	F(3, 42)=2,58; p=.07	F(3, 42)=1,59; p=.21	F(3, 30)=.29; p=.83



Fig. 1: Change of the negative affect during the study period at 7:55 am: whereas the negative affect in the intervention class declined, the negative affect in the control class increased at the four time points of measurement.

A numerical difference in the first NA-score could be observed and is shown in figure¹⁰ 1. However, none of the other repeated measures ANOVAs were significant.

We were interested in finding out whether the exercise lessons did have an effect on the alertness of the students. Therefore, the scores for the words (1) *awake* (German: *wach*), (2) *attentive* (German: *aufmerksam*) and (3) *active* (German: *aktiv*) were analyzed. For each word, the highest score was 5, the lowest score was 1.

(1) *Awake*: There was a numerical difference in the first time point in that the intervention class stated to be more awake than the control class:

 $^{^{\}rm 10}$ In the following text, the word figure will be abbreviated with fig..



Fig. 2: Numerical difference in the scores for the word *awake* on the first time point, Sept. 9th.

However, there were no significant differences between the intervention and the control class at the other days of measurement to be found (cf. tab. 4).

Tab. 4: Results of ANOVAs for *awake* at 7:55 am, 8:40 am and 12:30 pm on 2nd, 3rd and 4th time point.

Time point 2, Nov. 15th	Time point 3; Dec. 1st	Time point 4, Dec. 20th
F(2, 40)=2.18; p=.13	F(2, 38)=.32; p=.73	F(2, 54)=.32; p=.73

Again, we were interested to see whether a change over time could be observed and three additional ANOVAs were performed for the PANAS data on the word *awake* at each time point of the day. From tab. 5 it can be seen, that there were no significant changes.

Tab. 5: Change over time for *awake* at the same time point.

Score for awake at 7.55 am	Score for awake at 8.40 am	Score for awake at 12.30 pm
F(3, 48)=.52; p=.67	F(3, 42)=.59; p=.63	F(3, 39)=.83; p=.49

(2) *Attentive*: The repeated measures ANOVAs did not reveal any significant change for the word *attentive*: neither did the scores change significantly on the three time points on each day of measurement (cf. tab. 6), nor did the scores at the same time point on the four different days of measurement change (tab. 7).

Tab. 6: Results of ANOVAs for *attentive* on the 1st, 2nd, 3rd and 4th day of measurement.

1 st time point,	2 nd time point,	3 rd time point,	4 th time point 4,
Sep.9th	Nov.15th	Dec. 1st	Dec. 20th
F(2, 74)=.82; p=.45	F(2, 38)=.40; p=.67	F(2, 36)=.85; p=.43	F(2, 54)=.71; p=.50

Tab. 7: Results of ANOVAs for attentive on different time points.

Score for alert at 7.55 am	Score for alert at 8.40 am	Score for alert at 12.30 pm
F(3, 36)=.59; p=.62	F(3, 42)=.56; p=.64	F(3, 39)=.87; p=.47

(3) *Active*: The measures ANOVA revealed a trend in the scores for the word *active* on the first day of measurement:



Fig. 3: Scores for the word *active* during the first day of measurement. The overall score for this word increased in the intervention class over the time of the first lesson and decreased in the control class. At the third time of measurement, 12:30 pm, the score for *active* was still higher in the intervention class than in the control class.

There was also a numerical difference on the second day of measurement for the word *active* (cf. fig. 4).



Fig. 4: Scores for the word active during the second day of measurement.

Repeated measures ANOVAs did not reveal any trends on the third and fourth days of measurement, with F (2, 38) = .03; p=.97 on the third day of measurement and F (2, 54)=.08; p=.92 on the fourth day of measurement.

Three more ANOVAs revealed no significant changes for the same time points on the four days of measurement (cf. tab. 8).

Tab.8: ANOVAs for the word active at the same time	points on the four days of measurement.
--	---

Score for active at 7.55 am	Score for active at 8.40 am	Score for active at noon
F(3, 48)=.15; p=.93	F(3, 42)=.88; p=.46	F(3, 42)=.70; p=.56

3.2.1.2. Rosenberg Scale

The Rosenberg Scale was administered in both classes at the same time of the day on Sep. 6th, Nov. 26th and Dec. 20th. Before the scale was to be filled out, the present teacher or the conductor of the study explained each sentence again to the students. The highest score on the Rosenberg Scale was 50 and the lowest 10.

The repeated measures ANOVAs did not reveal any significant changes between the three measurement points (F (2.40)=.42; p=.66). For each of the ten items a repeated measures ANOVAs was calculated in order to find out whether the scores on a specific item had changed significantly between the intervention and the control group. The lowest score was 1 and the highest 5. It turned out that the sentence *I certainly feel useless at times* decreased significantly in the intervention class over time, whereas the score on this item in the control class increased with time.



Fig. 5: Score on the Rosenberg Scale for the sixth sentence *I certainly feel useless at times*. As it can be conferred by this figure, the feeling that is expressed in this sentence is less expressed in the intervention class over time whereas it increases in the control class.

None of the other sentences showed significant change between the control and intervention class over the time of the study period.

3.2.1.3. LSL: teachers list for social and studying behavior

This assessment form was filled out for each student in both the control and intervention class by the German teacher at two different time points: Before the first exercise lesson took place and after the last exercise lesson was performed.

The LSL consists of ten topics. Under each topic five statements have to be rated (e.g. under the topic *concentration*, the statement *works together with others in a group* is found along with four other statements). Each statement can be given a score between 0 = behavior never occurs and 3 = behavior occurs often. Therefore, the overall sum for each topic varies between 0 and 15 points.

Each topic score at pre-test was compared with the specific topic score at post-test, e.g. the overall score for the topic *readiness to help others* in the control and intervention class was compared to the overall score for this item in December in both classes. The repeated measures ANOVAs revealed the following results:

A numerical difference was found for the topic readiness to help others and empathy:



Fig. 6: LSL-scores in September and December for *readiness to help others and empathy*. The score for this topic increases more in the intervention class.

Furthermore, a numerical difference could be observed for the topic *social contact*; here, the control class attained a higher result than the intervention class (cf. fig. 7).



Fig. 7: LSL-scores in September and December for social contact.

Whereas the score for *willingness to make an effort* in the control group almost remained the same during September and December, a numerical difference towards more *willingness to make an effort* was found in the intervention class (cf. fig. 8).



Fig. 8: LSL-scores in September and December for willingness to make an effort.

Another numerical difference was found for the topic *concentration*:



Fig. 9: LSL-scores in September and December for concentration.

Eventually, a significant difference between the control and the intervention class was found for the topic *accurateness while studying*. It was the only topic on which one group, namely the control group scored worse in December than in September. The score in the intervention class was slightly better in December than in September.



Fig. 10: LSL-scores in September and December for accurateness while studying.

None of the other topics revealed significant differences in their scores between September and December (cf. tab. 9).

Торіс	Measured ANOVAs
Cooperation	F(1, 36)=.00021; p=.99
Self-perception	F(1, 36)=.04; p=.84
Self-control	F(1, 36)=.99; p=.33
Adequate assertiveness	F(1, 36)=1.44; p=.24
Independence while studying	F(1, 36)=1.53; p=.22

Tab. 9: Not significant results in the LSL.

3.2.1.4. d2 Test of Attention

Each student in both classes filled out the form before and after the study period. The forms that were filled out incorrectly (e.g. some students crossed out only p's probably because they filled out the form upside-down) were not evaluated further.

As it is often the case with this test, students in both classes did better on the second test. However, the intervention class performed better on each variable than the control class, a development that is shown below.

The total number of processed items (TN) did not vary significantly between the control and intervention class between September and December. Nevertheless, there was a numerical difference that is shown in Fig. 11:



Fig. 11: TN scores in September and December.

We admit that the confidence intervals in the next graph are very high. Although not at all significant, we found it interesting that there was a numerical difference between the groups. Whereas the intervention class committed fewer errors, the control group committed more, as is shown in fig. 12:



Fig. 12: Number of errors committed in the d2 Test of Attention in September and December.

The percentage of errors in the d2 test was also not significant. Again, it was of interest, that there was a numerical difference between both classes (cf. fig. 13).
Fig. 13: Percentage of errors made in the d2 Test of Attention in September and December. The score decreases in the intervention class and increases in the control class.

The concentration performance again revealed a numerical difference between both classes (cf. fig. 14).



Fig. 14: Concentration performance in September and December in both classes.

3.2.1.5. Body-mass-index

The BMI showed no significant result (F (1, 33) = 1.24, p=.27) between the measurements carried out at pre- and post-test. Yet, it is worth noticing that of the 40 BMI measurements that were collected, six students were overweighed (BMI > 22) and seven students were obese (BMI > 26).

3.2.1.6. Cooper-Test

The Cooper-test was carried out in September with all the subjects involved. Yet, when the test was supposed to take place a second time in December, it was snowing so much, that the Gymnastic hall was closed: The school principle feared that the ceiling may brake because of the heavy snow masses. Only very few students had completed the Cooper test at that point. Based on the limited results, comparison between the two classes was not possible.

3.2.1.7. DRT: Diagnostic spelling test

The diagnostic spelling test showed significant difference between the control and the intervention class (cf. fig.16).



Fig. 16: Results in the DRT.

3.2.1.8. Academic performance

There was a significant difference in the German grade between the end of the fifth school year and the German grade at the half-term of the sixth school year, in that the intervention class outperformed the control class (cf. fig. 17).



Fig. 17: Change in the mean of the German grades at the end of school year 5 and the half-term of school year 6.

There was only a numerical difference in the three German exams that were administered during the study period (cf. fig. 18). The exams were the same in both the intervention and the control class.



Fig. 18: The means of the German exams in the intervention class became numerically better in the intervention class than in the control class during the time of the study period.

There were no significant differences between both classes in the mathematic grades after school year five and half-term six to be found (F(1, 33)=.27; p=.60). The results of each of the three mathematic exams that were administered during the study period did not significantly show any difference (F(2, 66) = .12; p=.89).

There were no significant differences between both classes in the English grades after school year five and half-term six to be found (F(1,31)=1.23; p=.28). The English exams were not analyzed further because different exams were administered by different teachers in the control and the intervention class which made comparison between the classes impossible.

The music grades between the end of school year five and the half-term of year six did not differ significantly (F(1, 31)=.60; p=.44). Also, the art grades between the end of school year five and the half-term of year six were not significant (F(1, 31)=.54; p=.47).

3.2.2: Correlations at the first time point of measurement, September 2010

We were interested in the correlations at the first time point of measurement. Therefore, in the following section, correlations between the first d2 Test of Attention and the first LSL, *teachers list for social and studying behavior,* on the one hand and academic performance and social behavior on the other hand will be discussed. Correlations that have only little significance, p<0.1, are marked with a '+', more significant correlations, with p<.05, are marked with '*', very significant correlations, with p<0.01, are marked with '**' and finally, highly significant correlations, with p<0.001, are marked with '**' in tab. 10-23.

3.2.2.1. Correlation between the d2 Test of Attention and academic and social performance

3.2.2.1.1. Total number of processed items

In the first d2 Test of Attention the total number of processed items (TN) correlated with the first exam performed by both the control and intervention class in mathematics and in German in September (cf. tab. 10).

aam	annihistered in September and deddenne and soerar performance and the ESE.						
d2	Class 5: German grade	.0837	N=32	p=.649			
TN	Class 5: Math	1955	N=32	p=.284			
	Class 5: English	0403	N=32	p=.826			
	Class 5: Music	0026	N=32	p=.989			
	Class 6: exam in mathematics, September	3345	N=34	p=.053 +			
	DRT: Spelling exam	1190	N=34	p=.503			
	Class 6: exam in German, September	3364	N=33	p=.056 +			
	Class 6: exam in English, September	0471	N=33	p=.795			
	Contact with social worker until Dec. of 5 th grade	.0840	N=34	p=.637			
	Contact with social worker during 5 th grade	0148	N=34	p=.934			
	LSL 1: Cooperation	.0356	N=34	p=.842			
	LSL 1: Self-perception	.0480	N=34	p=.788			
	LSL 1: Self-control	0357	N=34	p=.841			
	LSL 1: Readiness to help others and empathy	.0140	N=34	p=.937			
	LSL 1: Adequate assertiveness	1758	N=34	p=.320			
	LSL 1: Social contact	1059	N=34	p=.551			
	LSL 1: Willingness to make an effort	.0106	N=34	p=.953			
	LSL 1: Concentration	.0035	N=34	p=.984			
	LSL 1: Independence while studying	.1407	N=34	p=.427			

Tab. 10: Correlations between the total number of processed items in the d2 Test of Attention administered in September and academic and social performance and the LSL.

LSL 1: Accurateness while studying	.0262	N=34	p=.883

3.2.2.1.2. Number of errors

The number of errors (E) committed in the d2 Test of Attention correlated significantly with the German grade at the end of year five. It furthermore correlated significantly with the frequency in which misbehaving subjects were sent to the social worker of the school by teachers.

When correlated with the *teachers list for social and studying behavior*, the item *willingness to make an effort* correlated significantly with the number of errors committed in this test and less significantly with the item *concentration*.

LOL .				
d2 E	Class 5: German grade	.3841	N=32	p=.030*
	Class 5: Math	.2566	N=32	p=.156
	Class 5: English	.1163	N=32	p=.526
	Class 5: Music	.0755	N=32	p=.681
	Class 6: exam in mathematics, September	.1226	N=34	p=.490
	DRT: Spelling exam	0978	N=34	p=.582
	Class 6: exam in German, September	.0621	N=33	p=.732
	Class 6: exam in English, September	.2610	N=33	p=.142
	Contact with social worker until Dec. of 5 th grade	.3713	N=34	p=.031*
	Contact with social worker during 5 th grade	.2598	N=34	p=.138
	LSL 1: Cooperation	0060	N=34	p=.973
	LSL 1: Self-perception	1258	N=34	p=.478
	LSL 1: Self-control	2085	N=34	p=.237
	LSL 1: Readiness to help others and empathy	.0306	N=34	p=.864
	LSL 1: Adequate assertiveness	2540	N=34	p=.147
	LSL 1: Social contact	0316	N=34	p=.859
	LSL 1: Willingness to make an effort	3565	N=34	p=.039*
	LSL 1: Concentration	3334	N=34	p=.054 +
	LSL 1: Independence while studying	2629	N=34	p=.133
	LSL 1: Accurateness while studying	2570	N=34	p=.142

Tab. 11: Correlations between the no. of errors and academic and social performance and the LSL.

3.2.2.1.3. Percentage of errors

The percentage of errors (E%) in the d2 correlated little significantly with the mean mathematics grade of the subjects at the end of their fifth school year and the frequency by which subject had been sent to the social worker during the first 4 months of the fifth school year. The percentage of errors correlated highly with the mean German grade at the end of the fifth school year.

Two items, *concentration* and *independence while studying*, of the *teachers list for social and studying behavior*, correlated little significantly. The item *willingness to make an effort* correlated more significantly.

d2 E%	Class 5: German grade	.3833	N=32	p=.030*
	Class 5: Math	.3035	N=32	p=.091 +
	Class 5: English	.1003	N=32	p=.585
	Class 5: Music	.0983	N=32	p=.592
	Class 6: exam in mathematics, September	.1372	N=34	p=.439
	DRT: Spelling exam	0514	N=34	p=.773
	Class 6: exam in German, September	.1307	N=33	p=.468
	Class 6: exam in English, September	.2727	N=33	p=.125
	Contact with social worker until Dec. of 5 th grade	.3355	N=34	p=.052 +
	Contact with social worker during 5 th grade	.2717	N=34	p=.120
	LSL 1: Cooperation	.0182	N=34	p=.919
	LSL 1: Self-perception	1321	N=34	p=.456
	LSL 1: Self-control	2148	N=34	p=.222
	LSL 1: Readiness to help others and empathy	.0675	N=34	p=.704
	LSL 1: Adequate assertiveness	2456	N=34	p=.161
	LSL 1: Social contact	0083	N=34	p=.963
	LSL 1: Willingness to make an effort	3787	N=34	p=.027*
	LSL 1: Concentration	3312	N=34	p=.056 +
	LSL 1: Independence while studying	2900	N=34	p=.096 +
	LSL 1: Accurateness while studying	2454	N=34	p=.162

Tab. 12: Correlations between the percentage of errors and academic and social performance and the LSL.

3.2.2.1.4. Concentration performance

The concentration performance (CP) correlated significantly with the mean grade subject received in mathematics at the end of the fifth school year and the first mathematics exam of

the sixth school year. This item also correlated with the first German exam performed in September.

1				
d2 CP	Class 5: German grade	1573	N=32	p=.390
	Class 5: Math	3621	N=32	P=.042*
	Class 5: English	0423	N=32	p=.818
	Class 5: Music	0277	N=32	p=.881
	Class 6: exam in mathematics, September	4097	N=34	p=.016*
	DRT: Spelling exam	0854	N=34	p=.631
	Class 6: exam in German, September	3303	N=33	p=.060 +
	Class 6: exam in English, September	2714	N=33	p=.127
	Contact with social worker until Dec. of 5 th grade	2127	N=34	p=.227
	Contact with social worker during 5 th grade	2310	N=34	p=.189
	LSL 1: Cooperation	.0064	N=34	p=.971
	LSL 1: Self-perception	.1256	N=34	p=.479
	LSL 1: Self-control	.0895	N=34	p=.615
	LSL 1: Readiness to help others and empathy	1203	N=34	p=.498
	LSL 1: Adequate assertiveness	.0190	N=34	p=.915
	LSL 1: Social contact	1102	N=34	p=.535
	LSL 1: Willingness to make an effort	.2443	N=34	p=.164
	LSL 1: Concentration	.2235	N=34	p=.204
	LSL 1: Independence while studying	.2811	N=34	p=.107
	LSL 1: Accurateness while studying	.1815	N=34	p=.304

Tab. 13: Correlations between the concentration performance and academic and social performance.

3.2.2.2. Correlation between the teachers list for social and studying behavior and academic and social performance

3.2.2.2.1. First item: Cooperation

The item *cooperation* correlated with the subjects' performance in music in year five, the results in their first German exam of the sixth school year and the frequency of being sent to the social worker during the fifth school year.

The item correlated even more significantly with the frequency of being sent to the social worker during the first few months of the fifth school year.

1 do. 14. Contentions between the term <i>cooperation</i> and deddenne and social performance.					
LSL:	Class 5 German	.0683	N=35	p=.697	
Cooperation	Class 5: Math	.0768	N=35	p=.661	
	Class 5: English	.1515	N=33	p=.400	
	Class 5: Music	2996	N=33	p=.090	
				+	
	Class 6: exam in mathematics, September	.0489	N=38	p=.770	
	DRT: Spelling exam	1180	N=38	p=.480	
	Class 6: exam in German, September	.2815	N=37	p=.091	
				+	
	Class 6: exam in English, September	.2251	N=37	p=.180	
	Contact with social worker until Dec. of 5 th	3386	N=40	p=.033*	
	grade				
	Contact with social worker during 5 th grade	2784	N=40	p=.082	
				+	

Tab. 14: Correlations between the item cooperation and academic and social performance.

3.2.2.2. Second item: Self-perception

The item *self-perception* correlated highly significant with the frequency of the students being sent to the social worker during the first months of the fifth school year and the overall frequency of such visits during the fifth school year.

1 ab. 15. Conclutions between the term self-perception and academic and social performance.					
LSL:	Class 5 German	.0679	N=35	p=.699	
Self-perception	Class 5: Math	1483	N=35	p=.395	
	Class 5: English	0629	N=33	p=.728	
	Class 5: Music	2735	N=33	p=.124	
	Class 6: exam in mathematics, September	0577	N=38	p=.731	
	DRT: Spelling exam	.0414	N=38	p=.805	
	Class 6: exam in German, September	0862	N=37	p=.612	
	Class 6: exam in English, September	.1912	N=37	p=.257	
	Contact with social worker until Dec. of	5101	N=40	p=.001**	
	5 th grade				
	Contact with social worker during 5 th	4686	N=40	p=.002**	
	grade				

Tab. 15: Correlations between the item *self-perception* and academic and social performance.

3.2.2.3. Third item: Self-control

As the previous item *self-perception*, this item, *self-control*, correlated very high (p<.000) significant with the overall frequency of being sent to the social worker during school year five and the first few months of that same school year.

Self-control moreover correlated with the mean grade in English at the end of school year five. The item correlated significantly with the music grade at the end of the fifth school year.

Tuo. To. Confolutions occur den the hemisely control and academic and social performance.				
LSL:	Class 5 German	2212	N=35	p=.202
Self-control	Class 5: Math	2181	N=35	p=.208
	Class 5: English	2953	N=33	p=.095 +
	Class 5: Music	4197	N=33	p=.015*
	Class 6: exam in math, September	.1105	N=38	p=.509
	DRT	.0818	N=38	p=.625
	Class 6: exam in German, September	1300	N=37	p=.443
	Class 6: exam in English, September	0665	N=37	p=.696
	Contact with social worker until Dec. of	5855	N=40	p=.000***
	5 th grade			
	Contact with social worker during 5 th	5940	N=40	p=.000***
	grade			

Tab. 16: Correlations between the item self-control and academic and social performance.

3.2.2.2.4. Fourth item: Readiness to help others and empathy

The item *readiness to help others and empathy* correlated with the frequency in which students were sent to the social worker during the fifth school year and even more significantly with the frequency in which students were sent to the social worker during the first few months.

and social performance.					
LSL:	Class 5 German	0045	N=35	p=.980	
Readiness to	Class 5: Math	.1096	N=35	p=.531	
help others and	Class 5: English	1826	N=33	p=.309	
empathy	Class 5: Music	2391	N=33	p=.180	
	Class 6: exam in math, September	.0168	N=38	p=.920	
	DRT	.0531	N=38	p=.751	
	Class 6: exam in German, September	.0205	N=37	p=.904	
	Class 6: exam in English, September	.1792	N=37	p=.289	
	Contact with social worker until Dec.	3309	N=40	p=.037*	

Tab. 17: Correlations between the item *readiness to help others and empathy* and academic and social performance.

of 5 th grade			
Contact with social worker during 5 th	2713	N=40	p=.090 +
grade			

3.2.2.5. Fifth item: Adequate assertiveness

This item, *adequate assertiveness* (German: *Angemessene Selbstbehauptung*) again, correlated highly significant (p<.000) with both the frequency in which students were sent to the social worker during the first few months in year five and year five on the whole. *Adequate assertiveness* also correlated with the performance of the control and intervention class in the student music during the fifth school year.

Tab. 18: Correlations between the item adequate assertiveness and academic and social performance.

LSL:	Class 5: German	1353	N=35	p=.438
Adequate	Class 5: Math	0820	N=35	p=.640
assertiveness	Class 5 English	1305	N=33	p=.469
	Class 5: Music	3715	N=33	p=.033*
	Class 6: exam in math, September	.1845	N=38	p=.268
	DRT	.1247	N=38	p=.456
	Class 6: exam in German, September	1612	N=37	p=.340
	Class 6: exam in English, September	.1208	N=37	p=.476
	Contact with social worker until Dec.	6080	N=40	p=.000***
	of 5 th grade			
	Contact with social worker during 5 th	6132	N=40	p=.000***
	grade			

3.2.2.2.6. Sixth item: Social contact

This item, social contact, correlated with none of the items in question.

LSL:	Class 5 German	0000	N=35	p=1.00
Social contact	Class 5: Math	.1119	N=35	p=.522
	Class 5: English	.1578	N=33	p=.380
	Class 5: Music	1441	N=33	p=.424

Tab. 19: Correlations between the item social contact and academic and social performance.

Class 6: exam in mat	h, September	.1506	N=38	p=.367
DRT		.1842	N=38	p=.268
Class 6: exam in Ger	man, September	0599	N=37	p=.725
Class 6: exam in Eng	lish, September	.1779	N=37	p=.292
Contact with social w of 5 th grade	vorker until Dec.	1661	N=40	p=.306
Contact with social w	vorker during 5 th	1244	N=40	p=.445
grade				

3.2.2.7. Seventh item: Willingness to make an effort

Willingness to make an effort correlated significantly with the grade in math at the end of school year five. It furthermore correlated with the frequency in which the students were sent to the social worker during the fifth school year and during the first few months.

This item also correlated with the music grade of year five and the first exam in German that was administered in the sixth school year.

Tab. 20: Correlations between	the item willingnes.	s to make an effo	ort and academic an	nd social
performance.				

LSL:	Class 5 German	2757	N=35	p=.109
Willingness to	Class 5: Math	3410	N=35	p=.045*
make an effort	Class 5: English	2609	N=33	p=.143
	Class 5: Music	3373	N=33	p=.055 +
	Class 6: exam in math, September	2090	N=38	p=.208
	DRT	.0427	N=38	p=.799
	Class 6: exam in German, September	3112	N=37	p=.061 +
	Class 6: exam in English, September	1460	N=37	p=.389
	Contact with social worker until Dec.	3560	N=40	p=.024*
	of 5 th grade			
	Contact with social worker during 5 th	3423	N=40	p=.031*
	grade			

3.2.2.8. Eighth item: Concentration

Concentration correlated with several items: the mean grade in music during the fifth school year, the first exam in German during the sixth school year and the frequency in which students were sent to the social worker in fifth school year.

Moreover, *concentration* correlated significantly with the mean grades in the subjects German, math and English in the fifth school year. There was also a significant correlation between this item and the frequency in which students were sent to the social worker during the first months of the fifth school year.

LSL:	Class 5 German	3597	N=35	p=.034*
Concentration	Class 5: Math	4197	N=35	p=.012*
	Class 5: English	4390	N=33	p=.011*
	Class 5: Music	3294	N=33	p=.061 +
	Class 6: exam in math, September	1940	N=38	p=.243
	DRT	.2415	N=38	p=.144
	Class 6: exam in German, September	3240	N=37	p=.050 +
	Class 6: exam in English, September	1869	N=37	p=.268
	Contact with social worker until Dec.	3451	N=40	p=.029*
	of 5 th grade			
	Contact with social worker during 5 th	2996	N=40	p=.060 +
	grade			

Tab. 21: Correlations between the item *concentration* and academic and social performance.

3.2.2.9. Ninth item: Independence while studying

This item correlated with the frequency in which students were sent to the social worker during the fifth school year. Besides, *independence while studying* correlated significantly with the grades in math, English and music in the fifth school year and the first exam in German, administered in September, during the sixth school year. Eventually, this item correlated significantly with the frequency in which students were sent to the social worker during the first months of the fifth school year.

performance.				
LSL:	Class 5 German	2698	N=35	p=.117
Independence	Class 5 math	4005	N=35	p=.017*
while studying	Class 5 English	3747	N=33	p=.032*
	Class 5 music	4143	N=33	p=.017*
	Class 6: exam in math, September	2577	N=38	p=.118
	DRT	.1759	N=38	p=.291
	Class 6: exam in German, September	4110	N=37	p=.011*
	Class 6: exam in English, September	2322	N=37	p=.167

Tab. 22: Correlations between the item *independence while studying* and academic and social performance.

Contact with social worker until Dec.	3400	N=40	p=.032*
of 5 th grade			-
Contact with social worker during 5 th	3033	N=40	p=.057 +
grade			-

3.2.2.2.10. Tenth item: Accurateness while studying

This item correlated with the grade in English in the fifth school year. *Accurateness while studying* correlated significantly with the grades in German and music in the fifth in the fifth school year and the frequency in which students were sent to the social worker during that year. Most interestingly, the item correlated highly significantly with the frequency in which students were sent to the social worker during that year. Most interestingly, the item correlated highly significantly with the frequency in which students were sent to the social worker during that year.

Tab. 23: Correlations between the item accurateness while studying and academic and social performance.

LSL:	Class 5 German	3978	N=35	p=.018*
Accurateness	Class 5 math	1549	N=35	p=.374
while studying	Class 5 English	3169	N=33	p=.072 +
	Class 5 music	4150	N=33	p=.016*
	Class 6: exam in math, September	0161	N=38	p=.924
	DRT	.0295	N=38	p=.860
	Class 6: exam in German, September	0423	N=37	p=.804
	Class 6: exam in English, September	1758	N=37	p=.298
	Contact with social worker until Dec.	4550	N=40	p=.003**
	of 5 th grade			
	Contact with social worker during 5 th	3914	N=40	p=.013*
	grade			

All in all, five items (cooperation, willingness to make an effort, concentration, independence while studying and accurateness while studying) of the *teachers list for social and studying behavior* correlated positively with the German grade at the end of year 5 or the German exam in September. Three items (willingness to make an effort, concentration and independence while studying) correlated significantly with the math grade at the end of year 5 or the math exam in September. Four items (self-control, concentration, independence while studying) correlated positively with the English grade at the end of year 5 or the math exam in September. Four items (self-control, concentration, independence while studying) correlated positively with the English grade at the

end of year 5. Seven items (cooperation, self-control, adequate assertiveness, willingness to make an effort, concentration, independence while studying and accurateness while studying) correlated positively and some of them significantly with the music grade of year 5.

4. Discussion

The purpose of this study was to investigate whether exercise improves academic performance and social behavior of teenagers in a school environment (Spitzer & Hollmann, 2013). In a controlled study, 44 sixth graders (age 11 - 16 years) either received a total of 36 extra exercise lessons (intervention class; n = 24), three times per week, at the beginning of the school day (first lesson), or had normal lessons (control class; n = 20). In addition to qualitative observations, a range of dependent variables were assessed before, during and after the intervention period in order to determine the effects of regular exercise on physical, academic, cognitive, emotional and social performance.

Teachers' observation

The teachers who taught in both classes, and therefore had the opportunity for comparison, noted that the way students treated each other improved during the study period in the intervention class: boys and girls would talk to each other in a friendly manner during recess time and girls in the intervention class had fewer difficulties solving arguments. Students started to work together during art class and were reported to be more creative during music class.

In general, students in the intervention class were described as less aggressive and more concentrated: these features that had not been observed prior to the study period. The intervention class started to play together as a class either basketball or table tennis during recess time. This behavior was not noticed in any other class at the school.

Social and studying behavior

Social behavior and attitude towards studying was assessed with a dedicated scale that comprised of 10 sub-scales. The intervention class significantly outperformed the control class on the topic (sub-scale) *accurateness while studying*. Statistical trends (0.05) in favor of the intervention class were found for three sub-scales,*readiness to help others and empathy, willingness to make an effort*and*concentration*. These topics have*alertness*in common. It improved in the intervention class more than in the control class, possibly because students had to exercise in small teams of three, and had to adjust to these new teams, playing new games every ten minutes. In order to be more successful in the team, students had to work together even if they did not like the other persons on the team. The rules were altered

weekly: at one point on the basketball field, for example, students were only allowed to aim at the basketball basket when the basketball had been passed at least seven times within one team. Since there were only so few players on the field, the students had to pay more attention to the other members on the team and if one student in the team was weaker than the rest of the team, other players had to be more careful, i.e. more alert, to include them and thus be successful.

Additionally, under these conditions, less sportive students could not hide or stand around on the field; they had to move and be part of the team. Therefore every student had to pay attention to the game, had to focus and constantly concentrate on the other team members. In order to be successful, *every member* of the team needed to make an effort.

These improvements were qualitatively observed in the Gym after the first month by the supervisor of the study. From the data on social and study behavior rated by the teacher, it appears that positive behavioral features developed quickly in the Gym and were carried into the classroom, where they helped the students to stay on task, to work more accurately and overall try harder and help others.

According to a common misconception widely implemented in the scheduling of physical activities for school children, physical activities take place in the afternoon. Obviously, it is assumed that children are exhausted and tired after physical activity and therefore should not start the school day with it. Our results are in contradiction to this idea (scheduling sports in the afternoon), and in line with data provided by a study by Mahar and coworkers. The authors demonstrated by means of pedometers, that extra exercise in the classroom ("Energizers activities") not only improved on-task behavior, but students were also more active during recess time. So they must have been *less* tired and exhausted (Mahar et al. 2006).

In sum, even though on-task behavior was not explicitly assessed in this study, results of the *teachers list for social and studying behavior* showed that students who exercised more improved in their ability to concentrate, i.e., to pay attention. This is important, as exercise is often perceived as the cause for children becoming distracted. However, as the study by Mahar and coworkers demonstrated and in accordance with the study presented here, it is

worth noting again that the item *concentration* showed a bigger increase in the intervention class than in the control class, the students in the intervention class did not become less attentive over the course of the day. Quite the opposite was the case.

D2 test of Attention

This effect of physical exercise on attention is further demonstrated by data on the d2 Test of Attention. Exercise had a positive effect (statistical trend in favor of the intervention class) on the four variables of the d2 Test of Attention, denoting indices of processing capacity and proneness to errors; in contrast, the students in the control class worsened in two of these variables.¹¹

The d2 Test of Attention was also used by Budde and co-workers to investigate the effect of physical exercise on concentration and attention in high-school students at the age of 15. In a pre-post design, the test was used twice, before and after a single 10 minute intervention took place. The intervention consisted of either a non-specific physical exercise or coordinative exercise. Both interventions were of the same intensity as regards physical activity. The performance in the d2 Test of Attention of the students in the coordinative task group increased significantly compared to the physical activity group (Budde et al. 2008). This result can be taken as evidence that not physical activity alone, but physical activity that is cognitive functioning. Accordingly, going for a walk in a park leads to larger increases in cognitive performance than walking in a city (Taylor & Kuo, 2008). In our study, physical activity in the intervention class was associated with complex social interaction, and therefore, possibly increased subsequent cognitive performance for this very reason.

Academic performance

The art and music teacher reported that the behavior of the subjects in the intervention class improved and that subjects showed more interest, were more creative and worked together in groups. Yet, these observations were not reflected in the student' grades in the subjects of music and art. Why did the students in the intervention class not earn better grades, as their attention and attitude towards the tasks was reported by the teachers to have improved? Quite

¹¹ Cf. fig. 12: Number of errors committed in the d2 Test of Attention and fig. 13: Percentage of errors made in the d2 Test of Attention.

possibly, the study period was too short to have produced a bigger impact. This is supported by the fact that in the subject of German language, an improvement of spelling capability as well as in the grades was noticed. In a study on the effects of a video-game console (play station II) on academic performance with a duration of 4 months i.e., (slightly longer than this study), the tests in reading and writing, but not the test in mathematics, showed a significant decrease. As the authors (Weis & Cerankosky, 2010) argue, reading and writing abilities are very sensitive measures of academic performance in younger children. The developmental trajectory of other abilities often trails behind language development. Therefore the fact that the grades in German were most responsive to the intervention does not come as a surprise.

The finding of a significant improvement in German grades in the intervention class compared to the control class is particularly striking since the students in the intervention class spent less time on the subject of German than the control class (only 15 instead of 45 minutes). These results are in line with a recent review by Trudeau and Shephard on relationships between academic performance and school-based physical activities. The authors conclude that physical activity can safely be added to a school curriculum even if this entails that time allocated for other school subjects is curtailed: academic achievement of the students is not at risk. It appears that they complete their tasks, and use their time, more efficiently. Put differently: "[...] The literature strongly suggests that the academic achievement, physical fitness and health of our children will not be improved by limiting the time allocated to PE instruction, school PA and sports programs [...]" (Trudeau & Shephard, 2008).

To put it in a nutshell, concerning the findings on academic achievement in this study, the results are in accordance with a literature review that was done for the Centers for Disease Control and Prevention's (CDC) Division of Adolescent and School Health (DASH): All the examined studies that dealt with physical activities and academic achievement found either positive or no relationships between increased amounts of time spent in physical education class and academic achievement (CDC, 2010). No study found a negative relation.

Correlations between the d2 Test of Attention and academic and social performance

The fact that we found correlations between the d2 test of attention and measures academic and social performance confirms a general link between attention and achievement. That focusing and being alert make studying easier and that executive functioning is connected to narrative writing has already been explained above. That a student who is more willing to make an effort commits fewer errors and is also more likely to concentrate makes sense. If one was going to be very positive about these connections, one could state that anything that enhances attention will have a positive effect on school grades in return and since exercise has been shown to make students more alert and less agitated, everything possible should be done to make exercise interventions more applicable to school environments.

Correlation between the *social and studying behavior* and academic and social performance

Not surprisingly, the item *concentration* correlated positively with all the academic subjects (German, mathematics, English, music) that were taken into account. Another correlation between all four subjects and the item *independence while studying* was found. The less a student needs support with his or her work and the more he or she can work on a task without having to ask for help which may not be available quickly since there are up to 20 other students in a classroom, the faster will he or she be done with a task and can move on to the next one.

Physical fitness parameters

When baseline and posttest measures were compared in the here presented study, the BMI¹² did not significantly differ between the intervention and the control class. There were several children in both classes, however, that were overweight (n=6) or obese (n=7). Put differently, 32.5 % of the children included in the study had a BMI above the normal weight range. The Robert Koch Institut gathered data on children's' overall health status between 2003 and 2006. Their sample constituted of 14.474 children (7530 boys) between the age 3 and 17. Within this sample, about 15% of school children are overweight (Kurth & Schaffrath Rosario, 2007).

Both high energy consumption and decreasing physical activity could be the cause for these findings (Dollman et al. 2005). It would be interesting to find out in future studies whether teenagers who engage in the exercise program not only for four months but over a period of

¹² For an overview article on the BMI and its use in school settings, please confer the overview article provided by Hall and Cole (2006).

time of one or two years would benefit from it in that their BMI score and weight would be reduced. Furthermore, the waist-to-height ratio may be utilized in another study: This tool has recently been explored and discussed by Mokha and colleagues (2010) as another anthropometric index that may reveal even more information about cardiometabolic riscs in children than BMI measurements. Another reason for the absence of any significant findings may be that the sample size was too small again to find any differences.

In order to have an impact on the loss of weight, gathering knowledge about how physically active children are during the day is a first step (Pate et al. 2006); but a sedentary lifestyle and unhealthy nutrition also have to be addressed if obesity is to be reduced. Subjects, their parents and school staff would have to be educated about healthier diets and it would have to be assessed how much time subjects spend in front of screens (Baier et al. 2010; Bleckmann 2012; Feierabend et al. 2011; Mößle 2012; Rideout et al. 2010).

Similar to the BMI, the Cooper-Test did not reveal any differences in fitness levels between the students because bad weather prevented the researchers from completing data gathering at the second day of measurement.

Self-reported affect and self-esteem

Students were encouraged to ask either the teacher or the researchers for help in case they did not understand the meaning of a word in the questionnaires used. Yet, many students did not want to fill out the forms in the first place, because reading was difficult and exhausting for them. Since the PANAS had to be filled out three times on each day of measurement, it is likely that the students did not pay attention to the form after a while and crossed the blanks randomly. That is probably the main reason why over the course of the intervention no significant outcome was revealed.

In accordance with studies that show that exercise has positive effects on overweighed children (Petty et al., 2009), we thought that the extra weekly exercise lessons would have a positive effect on the students in the intervention class and to assess this, we used the Rosenberg scale. It was administered on three different days of measurement over the time of the study period. Yet, there were no significant outcomes except for on one item, namely the statement *I certainly feel useless at times*.

Limitations, general considerations and outlook

This study has several limitations, some of which are obvious (small sample size, relatively short duration, and "messy" setting of an ordinary school), while others appear to be particularly caused by the special affordances of empirical research in education.

As mentioned above, the reasons why there were no significant outcomes in any of the selfrating scales were teacher compliance with the study, as well as two student-related factors, problems with language and boredom with the questionnaires. It is shown in figure 5, that the standard deviation was smaller in the intervention class than in the control class. A possible reason for this outcome may be that the teachers who administered the Rosenberg scale in the control class did not explain the meaning of the statements as thoroughly to the students as it was the case in the intervention class, where the class was split into two groups in the gym hall so that the students were more concentrated and less excited when filling out the questionnaire.

Teachers' willingness to comply with a research study in a school is crucial (cf. Feiden 2011), as can be seen from the following example: A teacher who taught in the control class once stated that she did not think that the Rosenberg scale was going to reveal anything of interest because the students did not understand the sentences. A research assistant was not present when the students in the control class were asked to complete the Rosenberg scale. The low compliance of the teachers in this class, in that they did not pay attention to whether the students understood the sentences or not, not willing to make an effort to explain the sentences thoroughly but rather interested to complete the Rosenberg scale as quick as possible so that the normal lessons could take place may have also contributed to the few findings that were revealed with this scale.

Very generally speaking, it is one thing to demonstrate an effect of an intervention, and quite another thing to elucidate the possible underlying mechanism of action of the effect. This study, even though it was partly motivated by increasing neurobiological evidence for close ties between physical and mental activity, was about physical activity, and not about the mechanism of action of physical activity. Further research using (neuro-) biological markers and variables in a school setting needs to be done in order to demonstrate that findings in the lab and in laboratory animals (cf. Naylor et al. 2008), on growth factors, neuromodulators, and neurotransmitters, can be meaningfully translated into classroom settings. Such translational research is routinely performed in the medical domain, but almost unheard of in education. As regards this study, its limitations are the peculiarities of age and school settings that do not allow the generalization of the results. Hence, it has to be replicated in other school forms (*Realschule, Gymnasium*) and in students of various ages, and – of course, in larger samples. Factors that enhance the outcome of such projects should be isolated and school- teacher-, and student-variables be assessed such that we obtain a better understanding of how schools should include exercise in their curricula.

For how long should students exercise in school? Is exercise during recess enough? Or should it be 30 minutes during a lesson? Many studies have shown that even short bouts of exercise can have beneficial effects. Hill and co-workers analyzed the effect of a classroom-based exercise program on test performance in 1224 students. They showed that a 10 to 15 minute teacher-directed exercise intervention had a positive significant effect on cognitive tests administered one hour after the intervention took place (Hill et al. 2010).

On the other hand, Stroth and co-workers were able to show that students who were physically fit did better in a cognition test (Eriksen flanker task) than unfit students after an acute bout of exercise (Stroth et al. 2009). These findings are in line with a study that was performed in California: Roberts and co-workers studied 1989 students of grades 5, 7 and 9 and compared their BMI, their aerobic fitness level and test scores with each other. They controlled for SES, ethnicity, sex and age differences. In the authors' words: "[...] The most impressive findings were the consistency of positive associations between aerobic fitness and standardized test score performance and the consistency of inverse associations between BMI-for-age and standardized test score performance [...]" (Roberts et al. 2010).

In a longitudinal study, Aberg and co-workers found that cardiovascular improvement in men between age 15 and 18 predicted higher educational achievement and higher socioeconomic status later in life (Aberg et al. 2009).

Finally, Moser demonstrated that students who exercised during the fifth hour of the school day did successively better on three different concentration tests during the sixth hour of the school day (Moser 2010).

Notwithstanding many such studies reporting positive effects of short physical activity (cf. Hillmann et al. 2003; Schneider et al. 2009; O'Leary et al. 2011), there are arguments in favor of somewhat longer exercise durations (Kamijo 2011; Stranahan et al. 2007), i.e., do not favor a trend toward less PE classes and more Energizers during the school day. One reason for this is related to the actions of the neuromodulator serotonin on executive functions (cf. Meeusen et al. 2001; Meeusen & Fontenelle 2012). As Strüder and co-workers argued convincingly, the amount of free tryptophan - the precursor of serotonin - in the blood is increased by endurance exercise because albumin, a protein that usually binds tryptophan, more readily binds to free fatty acids that are released during exercise, thus releasing tryptophan (Strüder et al. 1998). The released tryptophan can then cross the blood brain barrier through active carriers. (Bound to the protein albumin, tryptophan cannot cross the blood-brain barrier).

This process is promoted by a second factor: Amino acids usually compete for the blood-brain barrier carriers. When the body is engaged in prolonged exercise, the muscles uptake more amino acids. This results in less competition for the blood-brain carriers for tryptophan. With a higher tryptophan concentration in the brain, the biosyntheses of serotonin and therefore the concentration of serotonin that can be released are increased. As Kubesch says, "[...] this acute exercise-induced serotonin biosynthesis may have an effect on executive functions that rely on 5-HT dependent structures [...]" (Kubesch et al. 2009). However, Kubesch points out that it takes 20 to 30 minutes to induce the release of fatty acids that than promote the increase of the concentration of tryptophan and thereby the concentration of serotonin. In a study that involved 81 seventh grade students, the effects of either a 30-minute physical education program or a short movement break were investigated. The researchers found that the students who received a 30-minute physical education program performed significantly better in a test that measured on-task attention in the face of distraction.

Again, these findings are in accordance with the results presented in this paper: Students in the exercise class improved in general in on-task behavior and specifically in the d2 Test of Attention.

Finally, our findings may be interpreted in the light of what is known about the effects of growth factors in the brain (Carro et al. 2001; Hollmann et al. 2012; Kobilo et al. 2011; van Praag 2009; Wang & van Praag 2012). Ardila and co-workers showed (2006) showed that

children who have problems with expressing their ideas in written form do less well in executive functioning tests. Students in the intervention class had less time to focus on German, instead they spent time playing together in teams and they had to communicate with each other while involved in the game. They were running and sweating during three mornings of the school week while subjects in the control class were in their seats, not involved in exercise at all. BDNF levels were not measured in the study, nor were any executive function tests administered. Yet, the fact that the intervention class outperformed the control class significantly supports the assumption that exercise did influence the brains of the more physically active students in a way that dealing with words and language became easier for them.

Conclusion

Extra weekly exercise lessons had an overall positive effect on students' behavior in the intervention class: they socialized more, worked together during classes and started playing together during recess time. No negative effects were observed or reported by teachers. Even though students in the intervention class did not have as much time as the control class to work on academic subjects, they did not receive lower grades: They achieved as well as the control class in most subjects and even outperformed the control class in German.

5. Summary

A study about the effect of early morning exercise three times per week for a time period of four months was conducted with sixth grade students at a German school (*Hauptschule*).

There were a total of 44 children (28 boys) involved in the study. Nine girls were in the intervention group, the mean age was $148.22 \text{ months} \pm 4.15$, the mean BMI in September was 22.07 ± 5.71 and the mean BMI in December was 23.10 ± 5.52 . There were 15 boys in the intervention group, the mean age was 152.86 ± 8.37 months, the mean BMI in September was 22.26 ± 4.77 and the mean BMI in December was 21.81 ± 4.68 . Seven girls were in the control group, the mean age was 156.86 ± 18.33 months, the mean BMI in September was 22.45 ± 3.80 and the mean BMI in December was 23.35 ± 4.11 . There were 13 boys in the control group, the mean age was 153.85 ± 11.00 months, the mean BMI in September was 19.71 ± 2.81 and the mean BMI in December was 20.00 ± 3.44 .

The intervention group received exercise lessons over a study period of four months (September-December), whereas the control group had normal lessons during the same time. In total, 36 extra exercise lessons took place during the study period. The effect of extra exercise was measured through school grades and the *teachers' list of social and studying behavior*.

Three exercise lessons were conducted every week with the intervention group during the study period. The exercise lessons were always scheduled during the first hour of the school day. Two of the exercise lessons took place in a gymnastic hall where the students were grouped together in very small teams of three to four players. On account of this, all the students were involved in the game: they had to move constantly for 30 minutes on average and no student could be excluded because the team depended on each member. The third exercise lesson took place in the aula where a dancing instructor conducted hip-hop lessons.

The main focus of this investigation was set on the question: Do extra exercise lessons influence academic performance and social behavior?

The main findings were:

1. The performance in the subject of German increased in the intervention class whereas it decreased in the control class. The difference between the performances was significant (p=.03).

2. This outcome is supported by the German spelling exam: here again, the control class was outperformed significantly (p=.0035) by the intervention class. In the subjects of Math and English, the academic performance of the students in the intervention was not different from the control class.

3. Quantitative data from the d2 test of Attention carried out before and after the study period, showed that the students in the intervention class did numerically better in all four variables than the students in the control class on the second day of measurement, even though none of the differences reached statistical significance.

4. Data from the *teachers' list of social and studying behavior* revealed that the students in the intervention class showed positive behavioral changes regarding *alertness*, i.e., their ability to concentrate on a specific task and their sustained attention during a lesson increased.

5. Teachers who taught in both classes were interviewed regularly and observed that the attitude amongst students in the intervention class changed for the better: they started to work together, to communicate among each other, and to solve problems more quickly. To summarize these observations, students in the intervention class became more respectful and cooperative towards each other and towards the teachers. These developments were not observed in the control class and had not been noted before in the intervention class.

6. Two physical fitness parameters, the Cooper-test and the BMI, were supposed to be assessed before and after the study period. The BMI was not significantly different between the control and intervention class. Bad weather conditions prevented the researchers from completing data gathering on the Cooper-test, and the few data gathered did not reveal any differences in fitness levels.

In conclusion, analysis of the data revealed either positive or no effects on the students of the intervention class in that their grades and attention enhanced or remained the same and their

social behavior was observed as improved. No negative effect was revealed by the fact that the intervention group had less normal lessons. Because of the results of this study, the school decided to change the curriculum of fifth and sixth grade students: in addition to three PE lessons, these classes receive two more extra exercise lessons weekly, starting from the school year of 2011/12 on.

6. Zusammenfassung

Es wurden Untersuchungen durchgeführt über den Einfluss eines frühmorgendlichen körperlichen Trainings auf Schülerinnen und Schüler einer sechsten Jahrgangsstufe. Die Fragestellung lautete, inwieweit diese Maßnahme in der Lage ist, körperliche und geistige Leistungsparameter zu beeinflussen.

Für die Untersuchungen stellten sich insgesamt 44 Kinder zur Verfügung (28 Jungen, 16 Mädchen). 9 Mädchen wurden in die Interventionsgruppe gelost. Ihr mittleres Alter betrug 148,22 Monate \pm 4,15, der mittlere Body Mass Index (BMI) vor Studienbeginn 22,07 \pm 5,71. 15 Jungen zählten zur Interventionsgruppe mit einem mittleren Alter von 152,86 Monate \pm 8,37. Ihr mittlerer BMI belief sich vor Studienbeginn auf 22,26 \pm 4,77. 7 Mädchen befanden sich in der Kontrollgruppe; ihr mittleres Alter belief sich auf 156,86 Monate \pm 18,33, der mittlere BMI auf 22,45 \pm 3,80. 13 Jungen zählten zur Kontrollgruppe; das mittlere Alter betrug 153,85 Monate \pm 11,00, der mittlere BMI betrug vor Studienbeginn 19,71 \pm 2,81.

Mit der Interventionsgruppe wurde über einen Zeitraum von vier Monaten drei Mal wöchentlich ein körperliches Training durchgeführt. An zwei Tagen fand das Training in der Turnhalle statt, wo die Kinder in sehr kleinen Teams von drei bis vier Spielern auf drei Spielfeldern gegeneinander spielten. Auf den Spielfeldern wurden unterschiedliche Sportarten (z.B. Fußball, Basketball, Handball) angeboten. Nach 10 Minuten rotierten die Teams auf das nächste Feld, wodurch die durchschnittliche Belastungsintensität 30 Minuten betrug. Am dritten Tag fand das Training in der Aula statt, wo ein Tanzlehrer Hip-Hop Unterricht durchführte.

Die wesentlichen Befunde lauten:

1. Die Leistung im Unterrichtsfach Deutsch nahm in der Interventionsklasse zu, wohingegen sie in der Kontrollklasse abnahm. Der Unterschied in der Leistung war signifikant (p=0,03).

2. Dieser Befund wird durch die Ergebnisse des Deutschen Rechtschreibtests gestützt: Die Interventionsklasse verbesserte sich in ihrer Leistung signifikant (p=0.0035) gegenüber der Kontrollklasse. In den Unterrichtsfächern Mathematik und Englisch waren die Leistungen zwischen den beiden Klassen nicht signifikant verschieden.

3. Die Ergebnisse des d2 Konzentrationstests ergaben, dass die Interventionsklasse sich in allen vier Parametern numerisch gegenüber der Kontrollklasse verbesserte zum zweiten Messzeitpunkt. Diese Unterschiede waren nicht statistisch signifikant.

4. Die Auswertung der Lehrereinschätzliste für Sozial- und Lernverhalten ergab, dass das Verhalten der Schüler der Interventionsklasse sich zum Positiven änderte in Bezug auf ihre Aufmerksamkeit: die Fähigkeit sich auf eine bestimmte Aufgabe zu konzentrieren, nahm in dieser Gruppe zu.

5. Lehrer, die in beiden Klassen unterrichteten, wurden regelmäßig interviewt und beobachteten, dass sich die Einstellung der Schüler zueinander positiv veränderte: sie begannen zusammen zu arbeiten, sich miteinander zu unterhalten und Konflikte schneller zu lösen. Zusammenfassend wurde ihr Verhalten als respektvoller und kooperativer sowohl untereinander als auch dem Lehrpersonal gegenüber beschrieben. Diese Entwicklungen wurden in der Kontrollklasse nicht beschrieben und waren vor Beginn der Intervention nicht in der Interventionsklasse beobachtet worden.

6. Zwei körperbezogene Parameter, der Cooper-Test und der BMI, sollten vor und nach der Intervention erhoben werden. Der BMI war statistisch nicht signifikant zwischen den beiden Klassen. Aufgrund schlechter Wetterbedingungen konnte der Cooper-Test nicht mit allen Schülern durchgeführt werden und die Daten, die erhoben wurden, zeigten keine statistisch signifikanten Unterschiede.

Zusammenfassend ergab die Datenanalyse, dass die frühmorgendliche Bewegung entweder einen positiven oder keinen Einfluss auf die Interventionsklasse hatte: Die Schulnoten wurden besser oder blieben gleich und ihr Verhalten wurde durch die Lehrer als positiver beschrieben. Es zeigte sich kein negativer Effekt durch die Tatsache, dass die Schüler dieser Gruppe weniger Unterricht hatten. Aufgrund dieser Daten beschloss die Schulleitung den Stundenplan der fünften und sechsten Klassen zu ändern: Zusätzlich zu den drei Sportstunden erhalten die Schüler dieser Jahrgangsstufen zwei extra Bewegungsstunden wöchentlich.

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Appendix

The following information was given to the parents of the children involved in this study:

Universität Witten/Herdecke

Transferzentrum für Neurowissenschaften und Lernen (ZNL), Universität Ulm

Frau Dr. Sabine Kubesch

Ursula Spitzer

Email: Ursula.Spitzer@uni-wh.de

Kurzgefasst Information zur Studie:

"Auswirkung von Bewegung auf soziale Kompetenz und schulische Leistung"

Liebe Eltern,

In Zusammenarbeit mit der Schule Ihres Kindes führen eine Untersuchung zum Einfluss von Bewegung auf den Schulalltag durch, um die Lernleistung der Kinder zu fördern. Wir erhoffen uns durch die Untersuchung Hinweise darauf zu bekommen, wie sich Bewegung auf die soziale Kompetenz, die Lernleistung und das Wohlbefinden auswirkt.

Ablauf der Untersuchung

Der Untersuchungszeitraum umfasst vier Monate und beinhaltet insgesamt 36 Bewegungseinheiten. Jede einzelne Bewegungseinheit findet in der Schule während des regulären Schulalltags statt und dauert insgesamt eine Schulstunde. Die reguläre Unterrichtszeit wird nicht verkürzt.

Jede Bewegungseinheit besteht aus 30 Minuten Bewegung und einer in etwa 7-10-minütigen Cooldown Phase.

Untersuchungsparameter

- Alle 2 Wochen bitten wir Ihr Kind einen Fragebogen (Rosenberg Skala) zu seinem Selbstwertgefühl auszufüllen. Zu Beginn der Untersuchung wird einer der Untersucher (Frau Spitzer) den Fragebogen mit Ihrem Kind durchgehen um eventuell auftretende Fragen zu klären.
- Wöchentlich einmal bitten wir Ihr Kind vor und nach der ersten Schulstunde sowie am Nachmittag desselben Tages einen Befindlichkeitsfragebogen (PANAS) auszufüllen. Zu Beginn der Untersuchung wird einer der Untersucher (Frau Spitzer) den Fragebogen mit Ihrem Kind durchgehen um eventuell auftretende Fragen zu klären.
- 3. Der Klassenlehrer wird alle 2 Wochen einen Fremdbeurteilungsbogen über Ihr Kind ausfüllen.
- 4. Vor und nach dem Untersuchungszeitraum wird der Body-Mass-Index (BMI) Ihres Kindes erfasst.
- Um eine Veränderung in der Kondition Ihres Kindes beurteilen zu können, wird 2 Mal ein Cooper-Test durchgeführt. Dabei handelt es sich um einen Ausdauerlauf bei dem beurteilt wird welche Strecke während 12 Minuten zurück legt.
- 6. Die schulische Leistung Ihres Kindes wird durch Vergleichen der zu schreibenden Arbeiten und Tests erfasst. Es werden keine zusätzlichen schulischen Tests stattfinden.

Ob Ihr Kind an dieser Studie teil nimmt oder nicht hat keinen Einfluss auf Schulnoten.

Um untersuchen zu können, ob ein einfach gestaltetes Schulsportprogram einen Einfluss auf Lernleistung und soziale Kompetenz hat, vergleichen wir den Effekt der morgendlichen Bewegung auf eine Schulklasse mit einer Kontrollklasse.

Kontrollklasse: Es handelt sich um die Parallelklasse, die keine morgendlichen Bewegungseinheiten absolviert.

Wenn Ihr Kind in der Sportklasse ist, nimmt es an Bewegungseinheiten teil. Diese bestehen aus Laufspielen (beispielsweise Fußball und Basketball), Zirkeltraining und Hip-Hop Tanz. Die Hip-Hop-Stunden finden wöchentlich einmal statt und werden von einem externen Tanzlehrer, der Erfahrung im Umgang mit Kindern und Jugendlichen hat, unterrichtet. Auf jede 30-minütige Bewegungseinheit folgt eine 7-10-minütige Cool-down Phase während der ruhige Musik zur Entspannung gehört wird.

Ausführliche Information zur Studie:

"Auswirkung von Bewegung auf soziale Kompetenz und schulische Leistung"

Regelmäßiges Sporttreiben fördert die Gesundheit. Dass es darüber hinaus auch noch das Lernen erleichtert bzw. manchmal überhaupt erst ermöglicht, da Aufnahme- und Konzentrationsfähigkeit verbessert werden, ist weniger bekannt und wurde in wissenschaftlichen Studien an Hauptschulen bisher kaum untersucht. Gerade aber an einer Hauptschule wie der Albert-Schweitzer Hauptschule in Bochum ist nach der internationalen Datenlage zu erwarten, dass diese verhältnismäßig kleine, kurze Intervention einen großen, nachhaltigen Effekt erzielen wird, der sich in einer erhöhten Lernbereitschaft seitens der Schüler, einem besseren sozialen Miteinander zwischen Lernenden und Lehrenden und schließlich besseren schulischen Leistungen konkret manifestieren wird.

Ziel der Untersuchung

Ziel dieser Studie ist es zu zeigen, dass sich morgendliche Bewegung nicht nur positiv auf den Schulalltag auswirkt. Es soll darüber hinaus gezeigt werden, dass die Lernbereitschaft erhöht und die Angst vor neuen Inhalten abgebaut wird, das Selbstvertrauen zunimmt, die schulischen Leistungen sich verbessern und Aggressivität unter den Schülern abnimmt. Um den Bewegungseffekt untersuchen zu können, würden wir uns sehr freuen, wenn Ihr Kind an unserer Studie teilnehmen könnte.

Risiken und Beschwerden im Rahmen der Untersuchung

Durch die viermonatige Intervention mit den Bewegungseinheiten sind keine Komplikationen zu erwarten. Die Belastungsdauer und -intensität orientiert sich an der körperlichen Leistungsfähigkeit der Kinder. Während des Bewegungsprogramms wird ein Lehrer anwesend sein, der Ihr Kind persönlich kennt und in das Unterrichtsgeschehen eingreifen kann. Die Albert-Schweitzer Hauptschule Bochum hat dieses Projekt ausdrücklich befürwortet und steht hinter den Leitern der Studie.

Freiwilligkeit

An diesem Forschungsprojekt nimmt Ihr Kind freiwillig teil. Ihr Einverständnis können Sie jederzeit und ohne Angabe von Gründen widerrufen. Alle bis dahin erhobenen Daten und Proben werden vernichtet.

Erreichbarkeit der Projektleiter

Sollten während des Verlaufes des Forschungsprojektes Fragen auftauchen, so können Sie einen der Untersucher jederzeit erreichen:

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Email: Ursula.Spitzer@uni-wh.de

Versicherung

Während der Teilnahme an dem Forschungsprojekt besteht Versicherungsschutz. Es gelten die allgemeinen Haftungsbedingungen.

Schweigepflicht/Datenschutz

Alle Personen, welche Ihr Kind im Rahmen dieses Projekts betreuen, unterliegen der ärztlichen Schweigepflicht und sind auf das Datengeheimnis verpflichtet.

Die studienbezogenen Untersuchungsergebnisse sollen in anonymisierter Form in wissenschaftlichen Veröffentlichungen verwendet werden.

Soweit es zur Kontrolle der korrekten Datenerhebung erforderlich ist, dürfen autorisierte Personen (z.B.: des Auftraggebers, der Universität) Einsicht in die personenbezogenen Daten nehmen. Sofern zur Einsichtnahme autorisierte Personen nicht der ärztlichen Schweigepflicht unterliegen, stellen personenbezogene Daten, von denen sie bei der Kontrolle Kenntnis erlangen, Betriebsgeheimnisse dar, die geheim zu halten sind.

Datum

Name des Studienleiters

Universität Witten/Herdecke Ursula Spitzer

EINWILLIGUNGSERKLÄRUNG FÜR ELTERN

"Übe unablässig den Leib, mache ihn kräftig und gesund,

um ihn weise und vernünftig zu machen" (Rousseau 1778)

Name der Untersuchung: "Auswirkung von Bewegung auf soziale Kompetenz und schulische Leistung"

Inhalt, Vorgehensweise und Ziel des oben genannten Forschungsprojektes sowie die Befugnis zur Einsichtnahme in die erhobenen Daten haben mir/uns Frau Spitzer ausreichend erklärt.

Ich/Wir hatte(n) Gelegenheit Fragen zu stellen und habe(n) hierauf Antwort erhalten.

Ich/Wir hatte(n) ausreichend Zeit, mich/uns für oder gegen die Teilnahme meines/unseres Kindes am Projekt zu entscheiden.

Eine Kopie der Elterninformation und Einwilligungserklärung habe(n) ich/wir erhalten.

Ich/Wir willigen in die Teilnahme unseres Kindes an diesem Forschungsprojekt ein.

Name des Kindes

Unterschrift eines Erziehungsberechtigten

Datum

INFORMATION UND EINWILLIGUNGSERKLÄRUNG ZUM DATENSCHUTZ INFORMATION UND EINWILLIGUNGSERKLÄRUNG ZUM DATENSCHUTZ

Bei wissenschaftlichen Studien werden persönliche Daten und medizinische Befunde über Ihr Kind erhoben. Die Speicherung, Auswertung und Weitergabe dieser studienbezogenen Daten erfolgt nach gesetzlichen Bestimmungen und setzt vor Teilnahme an der Studie folgende freiwillige Einwilligung voraus:

- 1. Ich/Wir erkläre(n) mich/uns damit einverstanden, dass im Rahmen dieser Studie erhobene Daten/Krankheitsdaten meines/unseres Kindes auf Fragebögen und elektronischen Datenträgern aufgezeichnet und ohne Namensnennung verarbeitet werden.
- 2. Außerdem erkläre(n) ich/wir mich/uns damit einverstanden, dass eine autorisierte und zur Verschwiegenheit verpflichtete Person (z.B.: des Auftraggebers, der Universität) in die erhobenen personenbezogenen Daten meines/unseres Kindes Einsicht nimmt, soweit dies für die Überprüfung des Projektes notwendig ist. Für diese Maßnahme entbinde(n) ich/wir den Arzt von der ärztlichen Schweigepflicht.

Name des Kindes

Unterschrift eines Erziehungsberechtigten

Datum

Curriculum vitae

Name: Ursula Simone Spitzer, *9.10.1985, Freiburg i. Br.

Familienstand: ledig, Staatsangehörigkeit: deutsch

Studium

2014	Mai: Einreichung der <i>Promotionsschrift in Philosophie</i> an der Deutschen Sporthochschule Köln.
2011-2012	September bis Februar: Wissenschaftliche Mitarbeiterin am Krimino- logischen Forschungsinstitut Niedersachsen
Seit 2009	Oktober: Studium der Humanmedizin an der Universität Witten/Herdecke
2009	August: Abschluss des Masterstudiums Philosophie an der Universität von Amsterdam. Thema der Masterarbeit: From free will to freedom of agency - Basic human features explained by drawing attention to the experiences of severely ill OCD-patients after a DBS-operation. <i>Ausgezeichnet mit dem</i> <i>DGPPN-Preis 2011 für Philosophie in der Psychiatrie.</i>
2008-2009	Februar bis August: Masterstudium Philosophie an der Universität von Amsterdam
2004-2008	Oktober bis Februar: Magisterstudium zunächst der Fächer <i>Romanistik</i> (Hauptfach) und <i>Philosophie</i> und <i>Geschichte</i> (Nebenfächer) an der Ruprecht-Karls-Universität Heidelberg. Ab September 2005: Magisterstudium der Fächer Philosophie und Geschichte (als Hauptfächer)

Auslandsemester

2008-2009	Februar bis August: Universität von Amsterdam (Niederlande)
2007	Februar bis Juni: Erasmusaustausch nach Dijon (Frankreich)
2006	Februar bis Juni: Auslandssemester an der Universidad de Salamanca (Spanien)

Praktika und Auslandsaufenthalte

2013	August: Visiting fellow (bei Professor Adele Diamond) an der University of British Columbia, Vancouver (Canada).
2013	April: Praktikum (bei Dr. A. Kuck) Abteilung Gynäkologie, Paracelsus Spital Richterswil, Schweiz.
2012	Juli-August: Juli-September: Visiting Fellow (bei Professor John Ratey) an der Harvard Medical School, Cambridge, Massachusetts, (USA). Unterstützt wurde der Aufenthalt durch die Wittener Universitätsgesellschaft.

2011	Juli-September: Visiting Fellow (bei Professor John Ratey) an der Harvard Medical School, Cambridge, Massachusetts, (USA). Unterstützt wurde der Aufenthalt von der Daniela und Jürgen Westphal-Stiftung.
2010	März: Praktikum (bei Dr. N. Ghaemi) Abteilung Psychiatrie, Tuft's Medical School, Boston, Massachusetts (USA).
2009	September: Praktikum (bei Dr. N. Ghaemi) Abteilung Psychiatrie, Tuft's Medical School, Boston, Massachusetts (USA).
2009	April bis Mai: Praktikum (bei Dr. Ricardo Campos) in der Abteilung Psychiatrie am Lozano Blesa Universitätskrankenhaus, Saragossa, Spanien.
2009	Februar bis März: Krankenhauspflegepraktikum in der Abteilung Innere Medizin am Loretto-Krankenhaus, Freiburg.
2007	Juli bis September: Praktikum bei der IT-Firma ESSAY, Den Haag, Niederlande.
2006	September: Praktikum bei Prof. Andreas Schleicher, Abteilung Bildungsindikatoren und Bildungsanalysen der OECD, Paris, Frankreich.
2004	Juli bis August: Praktikum in der Traumatologie-Station am städtischen Krankenhaus, Groß-Umstadt.

Publikation

Spitzer, U. & Hollmann W. (2013). Experimental observations of the effects of physical exercise on attention, academic and prosocial performance in school settings. Trends in Neuroscience and Education, 2, 1-6.

Spitzer U, Figee M, Mantione M, Denys D (2009). Sich frei fühlen oder frei sein? Zur Psychologie und Psychopathologie des Erlebens von Zwangspatienten unter Tiefenhirnstimulation. Nervenheilkunde 28(9): 634-642.

Schulischer Werdegang

Sentitisentei II ei	
2004	Allgemeine Hochschulreife, St. Hildegard Gymnasium, Ulm
2003-2004	Februar bis Juni: St. Hildegard Gymnasium, Ulm
2002-2003	September bis Februar: Internat Schlossgymnasium Künzelsau
1997-2002	Humboldt-Gymnasium, Ulm
1996-1997	Kurfürst- Friedrich- Gymnasium, Heidelberg; erste Fremdsprache: Latein
1994	September- Dezember: Martin-Luther-King School, Massachusetts (USA)
1992	September-Dezember: Willagillespie Elementary School, Eugene (USA)
1991-1996	Grundschule Neckargemünd