Human Movement Sciences

Master Research Project 2016-2017

Combining multiplication table practice with learning to juggle to improve enjoyment in a classroom setting

Vrije Universiteit Amsterdam
Department of Human Movement Sciences
Qualification: MSc in Human Movement Sciences
Master Research Project

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December 2017

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Abstract
An emerging field of research reports a weak positive relationship between academic performances and involvement in physical activities (PA) of children. However, less is known about how children could benefit from qualitative PA integrated in the classroom curriculum. Thus, we designed two classroom-based interventions, each consisting of twenty lessons over a period of five weeks: a) a juggling-math-intervention (JMI) in which we combined learning a new, complex motor task with practicing multiplication tables and b) a seated multiplication intervention (MI) with the same math content as the JMI. The aim of this study was to investigate 1) if JMI would lead to better recall on a multiplication table test compared to MI; 2) if JMI is feasible to be incorporated into the regular curriculum; and 3) if JMI leads to higher enjoyment compared to MI.
Fifteen seventh grade classes of nine primary schools were recruited. Interventions were divided equally and random between classes within schools. When a school had only one class, the school was coupled to another school with one class. In case of three classes in one school, one class followed their regular program (REG) without an intervention. Seven classes (N = 170) participated in the juggling-math-intervention, seven classes (N = 153) participated in the math-intervention and one class (N = 29) had no intervention.
We assessed children's' performance on a multiplication task, juggling performance, and enjoyment, before and after the intervention. We also collected data about their daily physical activities, academic performance and motor skill level.
Regression analysis showed no differences of performance on the multiplication task posttest when controlling for pretest score between the intervention groups ($b = .115$, $p>.05$). The enjoyment scores of the juggling group were significantly higher ($b = 22.718$, $p < .05$) compared to the seated group.
The juggling and multiplication table program was successfully implemented in the classroom setting and led to higher enjoyment levels of the children.

Introduction

It is commonly known that physical activity (PA) is beneficial for physical and mental health , but little is known about suggested relationship between PA and cognitive and academic performances (Biddle & Asare, 2011; Janssen & LeBlanc, 2010). According to reviews in this field there is weak positive, but still inconclusive, evidence for the relationship between PA and cognitive/academic performances (Norris, Shelton, Dunsmuir, Duke-Williams, & Stamatakis, 2015; Singh, Uijtdewilligen, Twisk, van Mechelen, & Chinapaw, 2012; Trudeau & Shephard, 2010). These reviews also reported that increasing the amount of time spent on PA could be incorporated in the school curriculum without harming academic performances. The weak but positive relationship between PA and academic performances is an import motive to further investigate the effects of incorporating PA in a classroom setting.
Over the last decades, interventions have been developed to increase PA during school time by increasing hours of physical education (PE), implementing activity breaks or integrate PA in theory lessons (e.g. (Beck et al., 2016; Mavilidi, Okely, Chandler, Louise Domazet, & Paas, 2018; Mavilidi, Okely, Chandler, Cliff, & Paas, 2015; Mullender-Wijnsma et al., 2016; Norris et al., 2015)). Although reviews mention anxiety of teachers to increase time spent on PA during school time, they report

evidence that there is no decrease of academic performance of children when the amount of time spent on PA during school hours was increased. Therefore, interventions are developed to combine PA with theory lessons (math, spelling, reading) and challenge children simultaneously on a physical and cognitive level (Beck et al., 2016; Mavilidi et al., 2015; Mullender-Wijnsma et al., 2016; Vazou & Smiley-Oyen, 2014).
In a laboratory setting, Vazou and Smiley-Oyen (2014) tested children individually to examine the effects of math practice with integrated physical activity compared to a session of seated math practice. The children were asked to solve multiplication problems written on flashcards for ten minutes,. During the math practice with integrated physical activity participants had to follow instruction on how to move twenty feet between the flashcards (movement tasks like skipping, jumping or crab walking). They did not find any differences in math scores between the two conditions. Despite higher scores on enjoyment for the integrated math practice, this intervention seemed not suitable for classroom settings due to the amount of space required to let twenty children move twenty feet between every (math) assignment. Also, participants were standing still while solving the multiplication problems and only moved in between the tasks, and were therefore not physically active during the problem solving part of the exercise. Mullender-Wijnsma et al. (2016) trained teachers to implement simple physically active movements (e.g. jumping jacks, sprints) during special developed math and language lessons. The children hopped or were jogging in place in between the tasks and had for example to make 10 jumping jacks to solve '5 times 2'. Mullender-Wijnsma et al. did not find an increase in academic performance after one year of intervention, but found significant improvement in grammar tests and math speed tests after two years of intervention. These results were compared to a control group which followed the regular curriculum, without any additional math or spelling lessons.

Interventions in educational settings are primarily focused on simple, quantitative physical activities (based upon intensity, duration) which intend to increase health benefits (Diamond, 2015; Mullender-Wijnsma et al., 2016; Pesce, 2012). They focus less on the qualitative benefits of activities, like improving coordination and fine motor skills. Nevertheless, it has been determined that qualitative and skillful PAs are more effective in increasing cognition, memory and everyday life skill performance for elderly and Alzheimer patients (Pesce, 2012; Yágüez, Shaw, Morris, & Matthews, 2011).
The theory of embodied learning argues that cognitive processes are grounded in the interaction between observer and environment and therefore the quality of the motor task is more important than the quantity to enrich cognitive tasks (Beck et al., 2016; Chandler & Tricot, 2015; Mavilidi et al., 2015). Memory and recall of information improves when there are more modalities (such as visual, verbal and motor modalities) connected to the way information is being learned (coded), independent of the intensity of the motor task. In preschool Australian children, Mavilidi et al. (2015) did not find significant differences in recalling words between children who learned fourteen Italian words while participating in a integrated physical exercise program (physical exercise during the learning task and perform the meaning of the word), in a non-integrated physical exercise program (physical exercise during the learning task, but unrelated to the learning task), or in a gesturing program (enact the actions indicated by the words, while remaining seated). Children in all three conditions could recall more words than children who participated in a conventional program (verbally repeating words while remaining seated). In a classroom setting where children had to participate in fine (sitting behind their desks manipulating LEGO^{R} bricks) or gross motor movements (inter-limb dynamic and static movements e.g. skipping, one-legged balance) during math practice, the largest improvement in math scores over a short time was shown in the gross motor movement group (Beck et al., 2016). Both Mavilidi et al. (2015) and Beck (2016) found evidence that meaningful or congruent motor tasks can be integrated in the school curriculum to improve memorization and recall of different subject matters.
In the above mentioned studies, a cognitive task was combined with a familiar motor task to support the learning task (dual task learning). In sport, training a new motor skill is often combined with a

(rhythmic, complex) cognitive task (e.g. counting backwards or performing a random letter generation with a metronome) for implicit learning (Dienes & Perner, 1999; Masters, van der Kamp, & Capio, 2013). This training method leads to unconscious knowledge of motor skills (i.e. automatize the motor skill) and results in more stable motor performance under pressure (Masters et al., 2013). Results about performance of the cognitive task during the dual task are, to the best of our knowledge, not mentioned in research, so there is not much known how dual task learning can be used for learning a cognitive task while participating in a motor task simultaneously.

The aim of the present study is first to investigate if combining a new, rhythmic, and complex motor task (cascade juggling) and an important academic skill (multiplication tables) in a classroom setting can lead to better recall of the multiplication tables compared to a group of children who did not participate in the physical task. The second aim is to present an intervention (lesson program) that can easily be incorporated into the regular classroom practice for teachers in primary education and improves the motivation and enjoyment of the children.

Method

Participants

We invited about 150 schools with a request to participate in the present study. The invitation was also spread via social media channels (i.e. Facebook and LinkedIn). Forty-one schools all over the Netherlands responded to our invitation. After providing further information via email or telephone, one school did not respond and five schools unsubscribed during or after contact due to lack of time or inability to adjust their schedule to the study requirements. Out of the remaining 35 schools, 25 schools were excluded because they did not meet the following requirements: homogeneous 7th grade (classes which only contained 7th grade students (no combination with 6th or 8th grade) (n=10); more than twenty students per class (n=3); two or more 7th grade classes in the same school, or one 7th grade class with a school nearby which also signed up (n=12). One school which was included at first but did not give permission to use the standardized scores on academic performance (i.e. CITO score) of the children, and was therefore excluded. This resulted in nine schools geographically spread all over the Netherlands that were included: one school with three classes, four schools with two, and four schools in the same city with one 7th grade class each.

Prior to the start of the study, we informed all children and their parents about the study aims and parents were asked to sign an informed consent form, giving their permission to use the children's data for this research project.

Because the intervention became part of the daily curriculum of the classes, the children without informed consent also participated in the adapted math classes, but they were not tested and therefore not included in the study. The study was approved by the Ethics Commission of VU Medical Centre Amsterdam.

Intervention

To assess the effect of PA on automatizing the multiplication tables, a math program was developed, that could be executed with and without juggling. The program consisted of twenty lessons, spread over five weeks (four lessons a week), to practice the multiplication tables (MT) 2 to 9.

Program structure:
Week 1: MT 2, 4 en 5
Week 2: MT 6
Week 3: MT 7
Week 4: MT 8
Week 5: MT 9 and repeating all tables.

MI Program
Twenty lessons, 3 – 5 minutes each, wherein the MT were practiced collectively with the teacher. The lessons consisted of different exercise like repeating the MT in order, backwards or girls and boys alternately.

JMI program
Twenty instruction videos (5 – 8 minutes) were made of a juggler who introduced the juggling exercises and then combined these exercises with the MT program to the children.
Children were instructed to answer the MT problems when they caught the ball.

All videos had the same structure:
Part 1: Repeating the prior juggling exercises
Part 2: New juggling exercise
Part 3: Variation on the new exercise
Part 4: Juggling combined with the MT program

Structure of juggling exercises per week:
Week 1: Pillar with one ball
Week 2: Crossing with one ball
Week 3: Pillar with two balls
Week 4: Crossing with two balls
Week 5: Juggling (cascade) with 3 balls

In every school with two or more 7th grade classes , the interventions (math with or without juggling) were assigned randomly by lot between the classes. In case a school had three classes, there was a third lot which stated to follow the regular curriculum. The schools with only one 7th grade were coupled and also draw a lot, so the interventions were randomly assigned with equal distribution of both interventions between these schools.

Measures:
Multiplication table test
The Multiplication table test was developed by experts from the Freudenthal Institute (Utrecht University). Due to the intervention, a new test was designed to fit to the practice circumstances. It was based on high speed- tests used in primary education, which tests simple, essential knowledge. The test consisted of thirty random multiplication tables (table 2 to 9) which were read out loud by the main researcher in front of the class. The pace of reading was based on the pace the tables would be practiced in during juggling, so the test fitted to the learning circumstances. The pace of reading was 'sum one… three times four … (wait to two seconds) sum two … etc.
Prior to the test the students were clearly instructed (with an example question) that it was a high speed- test and if they missed an answer, it was okay and they had to move on to the next question instead of wandering about the previous answer.
The score was based on the number of right answers and ranged from a minimum of 0 to maximal 30.

Juggling test
The juggling test consisted of eight exercises increasing in difficulty. The test exercises were based on the steps described in 'Het Basisdocument' (Mooij et al., 2014) on juggle didactics. The main researcher led the test for three to six students at the same time. An example of the exercise was provided before the start of each exercise. The group was asked to simultaneously perform the exercise ten times, on a pace verbally set by the researcher (And… Throw… One…, etc.). The exercises were: Pillar with one ball, Crossing with one ball, Pillar with two balls, Crossing with two balls and (cascade) Juggling with three balls. All the exercises with one ball where done with the hand of

preference first and then repeated with the other hand. If there were more than five errors at crossing the two balls for every student in the group, the test was ended.
Two assistants observed the children during the test and scored their test performance (i.e. catch or no catch) for every throw.

Math, comprehensive reading and spelling.
We used standardized scores for a national test on math, comprehensive reading and spelling. The CITO M7 test is a standardized test to follow the development of students halfway during 7th grade. The country wide collected scores leads to quintiles where the academic development level of every student can be interpret to the national scores (Hollenberg, Lubbe, & Sanders, 2017). Schools were asked to provide these scores of the students participating in our study.

Motor Skill level
Teachers were asked to rate the participants on their level of motor skills in PE lessons. The levels ranged from 0 (worrisome) to 3 (lessons are too easy for this student), based on the skill levels as described in 'Het Basisdocument' (Mooij et al., 2014).

Sport participation
Sport participation was measured using the RSO (Richtlijn Sportdeelname Onderzoek). This questionnaire was developed in 2000 to investigate sport participation of large populations and to standardize these results. It contains questions about if someone is involved in sport and how many minutes per week ("RSO," 2017).

Regular physical activity level
The PAQ-C (physical activity questionnaire), a self administrated questionnaire for children (8-14y) was used to measure the moderate tot vigorous activity during a regular week (Kowalski, Crocker, & Donen, 2004; Kowalski, Crocker, & Faulkner, 1997). The eight multiple choice questions cover activity during school time (PE and breaks) and after school activity (playing en sport participation). The overall score was the mean of the eight five-item questions with a high score implicating a high activity level during the week. The scores ranged from 1 to 5.

Athletic identity
Ten items of the Athletic Identity Measurement Scale (AIMS) were used to measure the sport identity of the children. The ten items covert statements on how the student relate themselves to sport on a seven point Likert scale ('strongly disagree' to 'strongly agree'). The score was overall summated between 10 and 70, with a higher score indicating higher athletic identity. Item eight and ten were constructed negative. The internal consistency (alpha= .93), test-retest reliability and construct validity (.83) of the AIMS is high (Cieslak, 2004; Lau, Fox, & Cheung, 2004).

Enjoyment
Enjoyment was asked after the intervention. Students in the Math and in the Juggling and math intervention group had to score how they enjoyed the program at a 100mm Visual analog scale, ranging from 'Not at all' to 'Highly enjoyed' (Bandura, 2006). For control and for future implementation possibilities, the children were also asked if they would like to have lessons like this again by choosing a smiley that fits best: Smiling: 'Yes please'; Neutral: 'Don't know/no opinion'; or Sad: 'No, rather not'.

Posters and contact
To control the feasibility of the lesson program, posters were spread among all the classes where every lesson could be checked off with a sticker.
Every week there was a contact moment between researcher and the teachers to answer questions and solve problems when necessary.

Data analyses
We analyzed all data using the Statistical Package for Social Sciences (IBM SPSS statistics 23). Differences in MT pretest scores, age, motor skill level, CITO scores, physical activity level and minutes of sport per week and sport identity were tested using the independent-samples T-test.
We assessed the effects of the intervention on multiplication performance and enjoyment by multiple regression analysis. Distribution of residuals was assessed for normal distribution. The parameters of interest are the regression coefficients of the multiple regression models, indicating the effect of the intervention compared with the control group. In the crude model, the outcome score post intervention was adjusted for pretest score. Possible effect modification was checked for gender, motor skill level or CITO Math score by including Intervention × Gender, Intervention × MV and Intervention × CITO math score interaction terms in the regression analyses.
We also performed multiple regression analyses for all separate covariates: gender, age, motor skill level, enjoyment, practice of multiplication tables in spare time, CITO math scores, PAQ-C, AIMS, sport participation, minutes of sport per week, juggle experience and practice of juggling in spare time.
Enjoyment was analyzed with a linear regression analysis to compare the scores between JMI and MI. The mean scores were calculated to evaluate the enjoyment scores for both groups.

Table 1 **Descriptive statistics**

		All participants		JMI		MI		REG	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Gender	Boy	186	52.8	85	50.0	84	54.9	17	58.6
	Girl	166	47.2	85	50.0	69	45.1	12	41.4
Sport participation	Yes	314	92.4	150	90.9	139	94.6	25	89.3
	No	26	7.6	15	9.1	8	5.4	3	10.7
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age		10.37	0.55	10.41	0.54	10.36	0.59	10.17	0.38
Score MT pretest		23.2	6.61	24.34	5.88	21.41	7.17	25.89	5.16
Score MT posttest		24.88	6.02	25.9	4.84	23.34	7.08	26.89	4.39
Motor Skill level*		1.91	0.75	1.95	0.79	1.91	0.68	1.66	0.86
Did you enjoy the program?		59.19	26.96	69.77	25.35	47.06	23.47		
CITO Mathematics		103.82	11.81	104.14	12.23	102.8	11.63	107.21	9.68
CITO score**		295.08	25.64	295.93	24.55	292.63	26.7	302.59	25.31
Score PAQ-C		3.29	0.8	3.28	0.73	3.35	0.91	3.02	0.51
Score AIMS		42.59	9.98	42.22	9.51	43.27	10.69	41.11	8.81
Minutes sport per week		193.99	123.42	186.69	114.79	197.25	129.8	219.64	137.85

* Motor skill level ranges from 0 (worrisome) to 3 (excellent)

** CITO score = CITO score Math + comprehensive reading + spelling

Table 1 Descriptive statistics

Results

352 Children, of nine elementary schools, were assigned between the juggling and multiplication table intervention (JMI) (N = 170) the Multiplication table intervention (MI) (N = 153) or followed their regular program (REG) (N = 29). There were no significant differences in mean age, motor skill level, CITO score, regular activity level, sport identity or minutes of sport per week between the three groups). *Table 1* presents the mean scores of the multiplication table test and the mean scores of the covariates. On average the scores on the MT pretest for JMI (M = 24.34, SE = .458) and MI (M =

21.41, SE = .592) were significant different t (310) = 3.95, $p < .05$). This was also the case for the MT pretest scores from MI and REG (M = 25.89, SE = .975) t (173) = -3.15, $p < .05$. No significant differences were found between MT pretest scores of JMI and REG (t (191) = -1.31, p = .190).
At pretest, 340 children were measured and 342 during the end test. A common reason for not participating in the measurements was absence from school.
Because no significant Intervention × Gender, Intervention × MS or Intervention × CITO math score interactions were found, analyses were not stratified for gender, MV or CITO math score.
There was also no modification effect of gender, motor skill level or CITO math score in either of the intervention groups compared to the regular group.

MT scores
The results of the multiple regression analysis can be found in *table 2*. The results show no significant effect of intervention on improvement of the MT scores at the posttest relative to the pretest (b = .115, $p > .05$, CI: - .660 to .889).
None of the assumed predictors (age, pretest score, motor skill level, CITO score, regular activity level, sport identity or minutes of sport per week) had a significant effect on the results of the MT posttest relative to the pretest.

Although the absolute difference between pre and post MT test was higher for the JMI and MI groups compared to the REG group, there were no significant differences in relative MT scores between both JMI and REG and between MI and REG.

Enjoyment
Linear regression analysis showed that the JMI group scored the program significantly higher on enjoyment compared to the MI group (b = 22.718, $p < .05$, CI: 17.204 to 28.233).
Children in the JMI group had a mean score for enjoyment of 69.77 out of 100 (SD = 25.35), and 70% of this group said they would love to have lessons like this more often (Figure 1). On contrary, the MI program scored 47.06/ 100 (SD= 23.47) on the enjoyment scale and 80% of this group said they did not want to (18%), or did not know (62%) if they want to have lessons like this again.

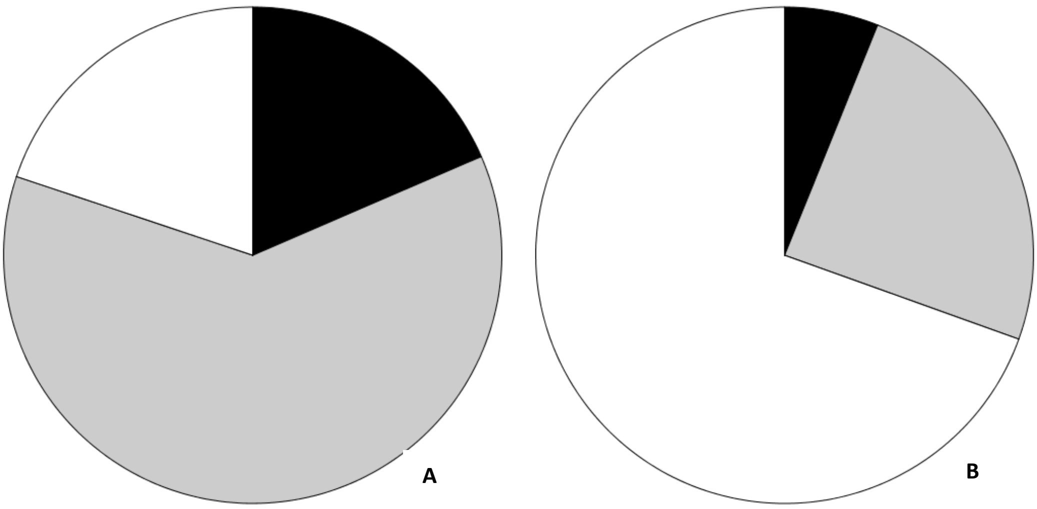

Figure 1 **Pie figure showing answers on the question if the children would participate in lessons like this again.** A: MI program, B: JMI program
Black: rather not; *Grey:* Don't know/no opinion; *White:* Yes please.

Table 2 **Results regression analysis**

	MI (0) and JMI (1)			REG (0) and JMI (1)			REG (0) and MI (1)		
Independent	**b**	**95% IC**	**p**	**b**	**95% IC**	**p**	**b**	**95% IC**	**p**
Crude	.115	- .660 / .889	.771	- .109	- 1.309 / 1.090	.858	.152	- 1.376 / 1.679	.845
Gender	.088	- .687 / .863	.824	- .102	- 1.305 / 1.101	.867	.139	- 1.392 / 1.670	.858
Age	.164	- .612 / .940	.678	- .012	- 1.226 / 1.203	.985	.226	- 1.305 / 1.756	.771
Motor skill level	- .132	- .922 / .657	.742	- .199	- 1.415 / 1.016	.747	.273	- 1.308 / 1.853	.734
Enjoyment	- .136	- .994 / .721	.754						
Practiced MT	.229	- .555 / 1.013	.566	- .135	- 1.336 / 1.067	.825	.084	- 1.457 / 1.624	.915
CITO Math	.041	- .735 / .818	.917	- .085	- 1.290 / 1.119	.889	.178	- 1.324 / 1.680	.815
Cito total	.063	- .714 / .839	.874	- .096	- 1.302 / 1.109	.875	.159	- 1.337 / 1.655	.834
PAQ-C	.155	- .620 / .930	.695	- .119	- 1.333 / 1.094	.846	.084	- 1.469 / 1.637	.915
AIMS	.154	- .617 / .925	.695	- .099	- 1.305 / 1.108	.872	.018	- 1.501 / 1.538	.981
Sports Yes or No	.136	- .641 / .914	.730	- .103	- 1.307 / 1.101	.866	- .021	- 1.535 / 1.493	.978
Minutes sport/week	.183	- .592 / .957	.643	- .055	- 1.259 / 1.149	.928	.130	- 1.387 / 1.646	.866
Ever juggled before	.109	- .693 / .911	.789	- .070	- 1.293 / 1.153	.911	.158	- 1.413 / 1.729	.843
Practiced Juggling	-.058	- .865 / .749	.887	- .346	- -1.561 / .869	.575	.065	- 1.460 / 1.590	.933

Dependent variable: MT score end

Crude: intervention and pretest score

Discussion

The aim of the present study was to investigate in a classroom setting whether 7th grade children could improve their test scores on a multiplication table test after five weeks of practicing the multiplication tables combined with participating in juggling lessons, compared to children who practiced the multiplication tables while remaining seated and children who did not had any changes in their regular curriculum. Results showed that children in both intervention groups had higher scores on their posttest than they had on their pretest. The intervention groups showed more improvement than the regular group (*table 1*), but no significant differences between the groups were found in relative progress. Same results were found in the laboratory setting of Vazou & Smiley-Oyen (2014). However, in a classroom setting Mavilidi et al. (2015) and Beck et al. (2016) did find better performance after practicing language and math skills when PA was integrated in the school curriculum, compared to children who were to remaining seated during practice. This gives positive prospect of physical activities being integrated in a classroom setting.
According to the embodied learning theory, intensity (quantity) of the activity is not required but the activity has to fit in with the learning task (Beck et al., 2016; Chandler & Tricot, 2015; Mavilidi et al., 2015). It can do so literally through making movements or gestures that represent the meaning of a word or correspond to a certain number during math practice (i.e. step size or movement corresponds with a number or magnitude), or it could be a motor task congruent with the learning task. Juggling was assumed to be congruent with the MT practice and support the practice, due to the rhythm of the task. Multiplication tables are often practiced with rhymes or songs with a certain rhythm, so we hypothesized that juggling could provide the same rhythm to better memorize the MT. Burdette, Chadwick & McGraw (2004) tried to investigate the support of rhythmic activities to improve reading and learning mathematic skills, but the relationship remained unclear after their study with ADHD children. Although the theory of embodied learning supports this assumption, to the best of our knowledge, no other research has been done to test this hypothesis. Based on our findings in the current study we are not able to further strengthen this assumption.
Based on results of previous studies, long term interventions have more effect compared to short period interventions (Norris et al., 2015). Mullender-Wijnsma et al. (2016) for instance only found significant differences in academic performance for the intervention group after two years of intervention. Although all participants showed improvement in our five week intervention from pre- to posttest, there was no significant difference between the groups. This could not only be due to the short intervention period, but also be due to the chosen level of multiplication tables (only 2 to 9), the chosen age group or the test itself. Teachers are worried children in grade 7 do not master their MT subject material well enough, but the overall mean score on the pretest was already 22 out of 30. This could indicate that the children master the multiplication tables better than expected. There also could be an influence of the newness of the test method, which was new at pretest, but not at anymore at the posttest. Another explanation could be that the test was not suitable for testing the effects of the interventions we designed, however it was designed to fit the practice circumstances: it contained a summary of the practiced subject material and fitted the tempo the MT were practiced in during juggling, but it was not tested for validity before use.
The results of Beck et al. (2016) showed different effects of motor activities for normal math performers compared to low math performers, whereas the normal math performers performed better after practice with gross motor activities. Because there was no interaction effect of intervention*CITO math scores, the present study did not led to different learning effects on low or normal math performers, and seems suitable for all children, independent of math level.

Despite concerns of the teachers for motivation and keeping up with the juggling intervention for children who scored low on motor skill level, motor skill level did not showed to be related to the MI test results. Enjoyment was also not related to motor skill level, but enjoyment did significantly differ between the two intervention groups. The children who participated in the juggling and MT program scored their enjoyment significantly higher than the children in the MI program and they also wanted

to participate in lessons like this more often. Although enjoyment is assumed to led to better academic performance (Diamond, 2014; Zimmerman, 2000), no differences in MT scores were found in the present study, despite the difference in enjoyment scores. Similar results were found in previous studies, when meaningful and non-meaningful physical activities were integrated in math practice, scores for enjoyment were higher compared to seated math practice (Mavilidi et al., 2018; Vazou & Smiley-Oyen, 2014).
Enjoyment and motivation can lead to a longer term commitment to learning, which lead to better results over time. A longer intervention period could contribute to a higher learning effect compared to a five week intervention period.
Feasibility of incorporating the lesson program in the school curriculum was checked through posters where the teachers had to check off every lesson they participated in. In both MI and JMI group only one lesson out of twenty was missed in two schools, due to extracurricular activities. This, combined with the high scores on enjoyment, seems positive for future development and incorporation of the present and similar lesson programs in classroom settings to increase enjoyment and motivation in (primary) school children.

Conclusion
The juggling-math program proved to be feasible to incorporate in the curriculum and increased enjoyment in a classroom setting. Both intervention groups and the control group progressed on their multiplication test after five weeks. No significant differences were found between the groups, which could be because the high scores on the pretest. There was no difference in learning effect between children with high or low math skills and also motor skill level of children did not influence the progress on the MT test.
More research is needed to draw clear conclusions about combining qualitative motor skill activities with math practice in a school setting. The high scores for enjoyment in the juggling group should be an important starting point for incorporating physical activities in the classroom setting more often, scientific monitoring of the results should lead to more insights in the effects of physical activities on academic performance.

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