

## University of Groningen

### Physically active learning

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# 6

loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14:2=7$  roos  
 $10 \times 10=100$  raam  $5+6=11$  school  $71-12=59$  oom  $36:6=6$  sam  $12+12=24$  ee  
vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
bel  $3-1=2$  boek  $10 \times 10=100$  raam  $5+6=11$  school  $71-12=59$  oom  $36:6=6$  sam  $12$   
net  $6+1=7$  vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
miep  $42:7=6$  bel  $3-1=2$  boek  $10 \times 10=100$  raam  $5+6=11$  school  $71-12=59$  oom  $36:6=6$  sam  $12$   
tol  $5 \times 5=25$  net  $6+1=7$  vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
kees  $6 \times 8=48$  miep  $42:7=6$  bel  $3-1=2$  boek  $10 \times 10=100$  raam  $5+6=11$  school  $71-12=59$  oom  $36:6=6$  sam  $12$   
kat  $5+15=20$  tol  $5 \times 5=25$  net  $6+1=7$  vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
pim  $15-6=9$  kees  $6 \times 8=48$  miep  $42:7=6$  bel  $3-1=2$  boek  $10 \times 10=100$  raam  $5+6=11$  school  $71-12=59$  oom  $36:6=6$  sam  $12$   
bus  $9 \times 11=99$  kat  $5+15=20$  tol  $5 \times 5=25$  net  $6+1=7$  vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
mus  $23+8=31$  pim  $15-6=9$  kees  $6 \times 8=48$  miep  $42:7=6$  bel  $3-1=2$  boek  $10 \times 10=100$  raam  $5+6=11$  school  $71-12=59$  oom  $36:6=6$  sam  $12$   
wip  $8-5=3$  bus  $9 \times 11=99$  kat  $5+15=20$  tol  $5 \times 5=25$  net  $6+1=7$  vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
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pet  $110:10=11$  wip  $8-5=3$  bus  $9 \times 11=99$  kat  $5+15=20$  tol  $5 \times 5=25$  net  $6+1=7$  vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
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aap  $1-1=0$  pet  $110:10=11$  wip  $8-5=3$  bus  $9 \times 11=99$  kat  $5+15=20$  tol  $5 \times 5=25$  net  $6+1=7$  vaart  $8:2=4$  weeg  $16-9=9$  loop  $20:2=10$  ik  $6 \times 5=30$  zit  $25+5=30$  boom  $14$   
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## Summary & General discussion

## AIM OF THE THESIS

The main aim of this thesis was to examine the effects of physically active ‘Fit & Vaardig op school’ (F&V) lessons on the academic achievement of socially disadvantaged children (SDC) and children without this disadvantage (non-SDC). First, the F&V program implementation was evaluated after one pilot year. Thereafter, the immediate effects of the F&V lessons on academic engagement were examined and finally, in a two-year randomized controlled trial the effects on academic achievement were examined.

## MAIN FINDINGS

Chapter 2 described the program evaluation of a one-year pilot study on six elementary schools. This study demonstrated that the F&V intervention program was successfully implemented. Teacher observations and self-reports showed that the F&V lessons were implemented as planned, and mathematics and reading scores of third-grade children who participated in the F&V lessons were significantly higher than the scores of children in the control group. Meanwhile, post-test mathematics scores of second-grade children in the intervention condition were significantly lower in comparison with control children. Some adjustments to the lessons were needed. The type of movements, the difficulty and the duration of the lessons were adjusted where necessary.

In chapter 3 children’s academic engagement was measured by time-on-task observations. It was shown that the time-on-task of SDC was lower than the time-on-task of non-SDC after regular classroom lessons and after F&V lessons. The time-on-task of all children was higher after a F&V lesson than after a regular classroom lesson. This indicates that physically active F&V lessons positively influenced the time-on-task of SDC and non-SDC. Furthermore, it was shown that the children were exercising in moderate to vigorous physical activity (MVPA) during on average 64% of the lesson time (about 16 minutes). No significant relationships were found between children’s percentage of MVPA during the F&V lessons and their time-on-task during the classrooms lessons that followed the F&V lesson.

The effects of the F&V program on academic achievement were studied in a two-year randomized controlled trial. Chapter 4 showed that children in the intervention group had significantly greater gains in math and spelling scores after two intervention years in comparison with the control group. This corresponded to about four months of extra learning. No differences were found on the reading test. In chapter 5 it was demonstrated

that at 7–9 month follow-up, when the lessons were no longer taught, the intervention group still showed significantly greater gains in math. No significant follow-up effects were found on spelling and reading. In addition, it was shown that F&V lessons significantly improved math and spelling performance of SDC after two intervention years. SDC however, did not benefit more from the lessons than non-SDC.

Summarizing, the results showed that physically active academic lessons could be implemented with success and, the lessons improved academic engagement and academic achievement of both SDC and non-SDC.

## DISCUSSION

### Physically active academic lessons

Integrating physical activity into academic lessons is a newly explored approach, promising to improve academic achievement.<sup>1-3</sup> However there is a need for additional evidence regarding its effectiveness in improving academic achievement.<sup>4</sup> The current study aimed at delivering this evidence. First, it was shown that the F&V lessons could be implemented as planned. This was not obvious at the start of the study because teachers and children had to adjust to a different way of teaching and learning. Another intervention study also found support for proper implementation of physically active academic lessons.<sup>5</sup> Apparently it is quite possible to add physically active academic lessons to the existing school curriculum of elementary school children.

Furthermore, it was found that the F&V lessons improved the academic engagement of the children that participated in the intervention. Their academic engagement (measured by time-on-task) was higher after an F&V lesson than after regular classroom lessons. These findings can be added to similar findings from previous research on physically active academic lessons,<sup>2,6</sup> and provide important evidence that physically active academic lessons can improve children's academic engagement.

Over the last few years, the number of studies that examined the effects of physically active academic lessons on academic achievement has increased. However, too few studies existed to draw firm conclusions.<sup>4</sup> The two-year randomized controlled trial in the current study showed that the F&V lessons improved children's math achievement after one intervention year. After two intervention years children's math and spelling achievement improved. At

7–9 month follow-up they still showed significantly greater gains in math. Thereby this study provides important evidence that physically active academic lessons are an effective way to improve children's academic achievement when the lessons are implemented over a longer period of time.

### Socially disadvantaged children

It is well known that SDC academically achieve less than non-SDC in the Netherlands.<sup>7,8</sup> Furthermore, the results of the current study showed that the on-task behavior of SDC was lower than that of non-SDC. Given this gap between SDC and non-SDC, new ways of teaching and learning might be necessary to improve the academic engagement and academic achievement of SDC. We hypothesized that the integration of physical activity into academic lessons might help. Meanwhile, others wondered whether this type of lessons would not widen the achievement gap because the lessons may not be suitable for SDC.<sup>9</sup> Although the current study showed that SDC did not benefit more from the F&V intervention than non-SDC, the time-on-task and the spelling and math scores of SDC who participated in the F&V lessons did significantly improve more than the time-on-task and achievement scores of SDC in the control group. This indicates that physically active F&V lessons did not widen existing achievement gaps. When physically active academic lessons are specifically taught to children from schools in disadvantaged neighborhoods, the lessons might even contribute to closing the achievement gap.

### Working mechanisms

As described in the introduction, the starting point for developing the F&V intervention was the association between physical activity and cognition,<sup>10</sup> and the evidence that aerobic physical activity can influence brain structure and brain function.<sup>11</sup> Acute effects (brain activity and enhanced attention) and prolonged effects (changes in brain functioning and brain structure) in the brain may improve children's academic achievement.<sup>12,13</sup> In the current study we did not assess the effect of the F&V intervention on the brain. Because several studies suggested that especially aerobic exercise influences the brain,<sup>12,13</sup> we developed the F&V lessons with physical exercises of moderate to vigorous intensity. We measured the levels of MVPA during the pilot year and again during the randomized controlled trial. It was shown that the children participated in MVPA for on average 64% (pilot) and 60% (RCT) of the F&V lesson time. These numbers indicate that about 15 minutes per F&V lesson were spent in aerobic exercise.

The results in chapter 3 demonstrated that there was no association between the percentage of time in MVPA during F&V lessons and the time-on-task in the lessons that followed the F&V lessons. These findings correspond to another study wherein no significant relationship was found between the time spent in the target heart rate zone and cognitive performance.<sup>14</sup> In addition, in chapter 2 it was found that third-grade children participated less in MVPA during F&V lessons than second-grade children, but only the academic achievement of the third-grade children improved significantly. Apparently spending more time in MVPA does not automatically lead to better academic outcomes. It could be that merely a modest amount of moderate intensive physical activity is necessary to influence the brain.<sup>11</sup> Surely, we did find evidence for acute effects of physical active F&V lessons on children's time-on-task, and we demonstrated prolonged effect of the F&V lessons on academic achievement.

To provide more information regarding the mechanisms through which physically active F&V lessons influenced academic outcomes, we should go beyond the focus on the aerobic exercise part of the F&V lessons. After all, the lessons also included math and language content. For example, children jumped on the spot 8 times to answer the multiplication question  $2 \times 4$ . It is possible that the influence of (aerobic) physical activity on the brain is only one of the mechanisms whereby physically active academic lessons improved academic achievement. Another explanation could be found in the theory of embodied cognition. This theory proposes that mind and body work closely together, and that cognitive processes develop from perception and bodily action. Sensorimotor information obtained by the body (for example through physical exercises) may be an effective aid to learning during childhood.<sup>15,16</sup> A theory that adds to the embodied cognition theory is the cognitive load theory, which states that by the acquisition of information (for example a learning task) different subsystems (i.e. visual, auditory, bodily action (or physical activity)) may help dividing the cognitive load imposed and prevent one subsystem to be overloaded.<sup>17,18</sup>

### Future research

The previous section indicates that the effects on academic achievement could be due to several mechanisms. However, it remains unclear if and how much each factor contributes to the effects. Future research is needed to find out if and how much each mechanism contributes to the effects of physically active academic lessons on academic achievement. Brain research is necessary to learn more about the effects of the lessons on brain activity, enhanced attention, and on changes in brain functioning and brain structure.

Additional research is also needed on the duration of the effect of improved time-on-task after physically active academic lessons. It is expected that on-task behavior would decrease as the length of work time without physical activity increases.<sup>6</sup>

Effects of physically active F&V lessons on math achievement subsisted when the lessons were no longer taught. However, no follow-up effects were found on spelling and reading. That is why it was recommended that schools should use physically active academic lessons throughout elementary school (chapter 5). Research on the PAAC intervention already found that 95% of the teachers still used the lessons after the intervention stopped.<sup>1</sup> Future research is necessary to assess the sustainability of physically active academic lessons in elementary schools and to examine the additional learning gains.

Physically active academic lessons appear to improve the academic outcomes of SDC and non-SDC from second- to fourth-grade, but what is the feasibility of implementing active lessons in other grades or in schools for children with special educational needs? Further research is required to further assess the potential of the lessons to reach larger populations.

### Implications for educational practice

The findings from the current study suggest that school principals should encourage their staff to integrate physically active academic lessons into the school curriculum. Teachers are well able to implement the lessons in their classrooms after a short training. Physical exercises can be added to existing math and language lessons wherein the emphasis is on repetition or memorization. It is recommended that these type of lessons are taught at least 3 times a week. Physically active academic lessons may be an effective way to increase children's academic engagement, and the lessons are an innovative way to increase academic achievement. More specifically, the findings indicate that physically active academic lessons should be part of the school curriculum of schools with a large number of SDC to especially improve the academic achievement of these children.

## CONCLUSIONS

Based on the findings in the separate studies, the following conclusions can be drawn:

- The F&V lessons can be implemented with success in elementary classrooms.



- Participation in the F&V physically active math and language intervention positively contributes to children's academic engagement.
- The F&V intervention contributes to the math and spelling performance of elementary school children. After two intervention years, the children that participated in F&V lessons gained four more months in spelling and math achievement in comparison with the control group. No effects were found on reading.
- The gains in math achievement maintain after children stop participating in the F&V lessons. At 7–9 month follow-up, when the children no longer participated in the lessons, the gains in math achievement maintained. No follow-up effects were found on spelling and reading.
- SDC also benefit from the F&V lessons. The lessons positively influence their academic engagement and academic achievement.

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