International Journal of Educational Research Open 3 (2022) 100154

Contents lists available at ScienceDirect

International Journal of Educational Research Open

journal homepage: www.elsevier.com/locate/ijedro

Attention and target shooting practice: Longitudinal results in a controlled mixed method study on adolescents in Norway

Audhild Løhre [a,b,*], Ove Østerlie [a], Odin Hjemdal [c], Ramune Grambaite [c]

[a] NTNU Department of Teacher Education, Norwegian University of Science and Technology, Trondheim, Norway
[b] NTNU Center for Health Promotion Research, Norwegian University of Science and Technology, Trondheim, Norway
[c] NTNU Department of Psychology, Norwegian University of Science and Technology, Trondheim, Norway

ARTICLE INFO

Keywords:
Intervention
WISC
Mirsky model
Working memory
Executive function
ADHD

ABSTRACT

Impaired attention is a burden for many students in educational settings. This study examined effects of target shooting practice in weekly sessions for 7 months in 12 students with attention problems. The design included objective tests giving quantitative pre- and post-data, as well as qualitative data from individual post interviews. Intervention students increased their ability to: register and immediately recall information; screen out distracting stimuli; and maintain attention on tasks. Qualitative findings supported the test results. Mixed factorial ANOVA tests showed no statistically significant improvements in 10 control students. Discussions are guided by the Mirsky model of attention and highlight neurofeedback and individual support. The findings suggest that the sequential order in target shooting may fit students with poor attention.

1. Introduction

Thirty years ago, Mirsky and colleagues pointed out that impaired attention was one of the most pervasive and least understood behavioural disturbances, also in educational settings (Mirsky, Anthony, Duncan, Ahearn & Kellam, 1991, p. 109). Poor attention remains a challenge to students and educators (Barker, 2016) and therefore, our study explores possible benefits of practicing target shooting for young adolescent students with impaired attention.

Today, there is substantial scientific knowledge on consequences of impaired attention, stating that attention plays an essential role in young peoples' life by influencing their academic achievements (Gray, Dueck, Rogers & Tannock, 2017; Polderman, Boomsma, Bartels, Verhulst & Huizink, 2010). However, educators and school psychologists still have scarce knowledge on attention, and what to do to improve students' attention. Having a gap that call for bridging between neuropsychological knowledge and clinical application in schools (Barker, 2016), one mission of this study is to translate applied neuropsychological knowledge of attention to educational settings.

The last 20 years new technologies like functional magnetic resonance imaging have confirmed theories about neural circuity in large-scale brain networks, meaning there is communication back and forth in active networks in the cortical and subcortical brain regions (Joyce & Hrin, 2015). This certainly leads to a shift in neuropsychological understanding of attention, from suggesting location in specific areas in the brain to seeing attention organized in active brain networks (Koziol, Barker & Jansons, 2015).

Attention refers to capacities or processes of how the organism becomes receptive to stimuli and how it may begin processing internal or external stimulation (Parasuraman, 1998). Mirsky developed a model where different components of attention were assessed by neuropsychological tests (Mirsky, 1987; Mirsky et al., 1991). In this study, we applied the Mirsky model of attention as a theoretical framework to better understand our findings. The model did not guide the study design from the start of data collection.

The reality in schools is that classes comprise students with a variety of talents as well as a variety of challenges. Having problems with attention, in one way or the other, often results in distress for many students and subsequently for parents and teachers. Attention deficit is one of the core symptoms of ADHD, - the attention deficit hyperactivity disorder (Tarver, Daley & Sayal, 2014) and likewise, problems with attention are central in dyslexia and dyscalculia (Peterson et al., 2016). Students without any diagnoses may also have trouble with attention, and thus, it is obvious that attention deficits are of great concern in schools. Due to negative outcomes associated with attention deficits (Barkley & Fischer, 2010, 2011; Danckaerts et al., 2010), researchers have conducted interventions aiming to reduce harmful outcomes. We present an overview of recent reviews and single studies that report on intervention effects relevant for the present study.

In general, we find few studies that have explored attentional problems in mixed groups (Gray et al., 2017; Løhre, Vedul-Kjelsås & Østerlie, 2021). Clinical studies typically prefer to study selected groups with specific disorders, as the huge number of publications on ADHD exemplify. From our point of view, it is a limitation that most interventions include

* Corresponding author.
E-mail address: audhild.lohre@ntnu.no (A. Løhre).

https://doi.org/10.1016/j.ijedro.2022.100154
Received 19 June 2021; Received in revised form 2 March 2022; Accepted 4 March 2022

selected groups because they do not reflect 'real life', resulting in low ecological validity due to large heterogeneity seen in disorders and sets of symptoms. Our intention is to add to the knowledge base by studying mixed groups of students with attentional problems.

The present study

According to Creswell (2014), this study has an explanatory sequential mixed method design. First, there is a quantitative section including pre- and post-data on test results for intervention and control students. Thereafter, a qualitative section is related to individual post interviews of the intervention students.

The quantitative study

This explorative study is to the best of our knowledge the first worldwide to use the applied measurements to assess possible changes in attention after target shooting practice. The study aims to explore possible changes from pre- to post-tests on four subtests from the Wechsler Intelligence Scale for Children (WISC-IV) (Wechsler, 2009) for the intervention group and the control group, and as well to compare the two groups.

The qualitative study

No known publications have reported on student experiences or perceptions that we look for in this study. Moving between deductive and inductive strategies, the following research question guided us: How is it inside your mind when you have prepared yourself and are ready to shoot?

2. The Mirsky model of attention

The science of neuropsychology has developed rapidly the last decades, especially because new technologies with computerized pictures of the brain can support theories and behavioural observations. It was those links, theory–brain–behaviour, Koziol, Joyce and Wurglitz (2014) aimed to explore when they reviewed the Mirsky model. We refer to the original works of Mirsky and colleagues (Mirsky, 1987; Mirsky et al., 1991) and the publication by Koziol et al. (2014) for first-hand information on the model. In the discussion of our results on attention, we use these publications as a theoretical anchor. However, before we present the model, it is expedient to clarify the concepts 'working memory' (WM) and 'executive function'.

Working memory and executive functions

After a lifetime studying WM, Baddeley (2012, p. 18) stated: "I see WM as a complex interactive system that is able to provide an interface between cognition and action, an interface that is capable of handling information in a range of modalities and stages of processing." It is important to note that WM is considered different from short-term memory (STM), although the two terms sometimes are used interchangeably. STM represents the simple temporary storage of information whereas WM implies a combination of storage and manipulation (Baddeley, 2012, p. 4). Further, Barker (2016) pointed out that both working memory and short-term memory "differ from what we refer to as long-term memory, which is a system for permanently storing, managing, and retrieving information for later use, and may remain there for the rest of our lives." (p. 183).

Executive functions refer to several mental processes that control and organise other mental processes (Gilbert & Burgess, 2008), which are crucial for planning complex behaviours and adapting to the situation (Miller & Wallis, 2009).

The five elements of attention in the Mirsky model are presented below.

The encode element

In accordance with Mirsky, Koziol and colleagues (2014) state that "The 'encode' component refers to the ability to initially register information" including "immediate recall as well as the capacity for holding information briefly in mind while performing some action or cognitive operation upon it" (p. 298). The authors agree that the 'encode' element or component of attention includes some aspects of 'working memory' and point to research with 'positron emission tomography scan' that shows an overlap in brain activity caused by the 'encode' component and 'working memory'. Mirsky suggested that encoding should be assessed with the Wechsler *Digit Span*, as well as some other tests. We have applied the Wechsler *Digit Span* and *Letter-Number Sequencing.*

The focus/execute element

Concerning 'Focus' Koziol et al. (2014) refers to "the ability to allocate attentional resources on a specific task and to simultaneously screen out distracting peripheral stimuli" (p. 299). The authors underline that speed of performance is important in this element of attention, and continue: "Because 'focusing' could not be differentiated from the task demand of rapid response output, the term 'focus/execute' was coined to capture a more refined essence of this attentional component (…)." To measure the 'focus/execute' element, Mirsky suggested the Wechsler *Digit Symbol* (also denoted *Coding*) subtest as well as the *Symbol Search* subtest, both of which have been used in this study.

The sustain, stability and shift elements

In line with Mirsky, Koziol et al. (2014) define the 'Sustain' element as "the capacity to maintain attention on some aspect of the environment for an appreciable interval of time for the purpose of successful task completion" (p. 298). We used *Digit symbol/Coding* and *Symbol Search* to assess this element. The 'Stability' element is about the reliability of attentional effort. We do not present data that illustrates the 'Stability' element in this study.

Mirsky operationally defined 'shift' as "the capacity to move from one salient aspect of the environment to another" and this capacity reflected flexibility in moving from one stimulus feature or idea to another. Mirsky recognized that the shift element could also be a feature of 'executive functioning', illustrating blurred boundaries between 'attention' and 'executive function' (Koziol et al., 2014, p. 299). We used the WISC-IV subtest *Letter-Number Sequencing* to assess the 'shift' element.

In this mixed-method study, we use the objective test results as well as qualitative findings to evaluate the students' attention based on Mirsky's model.

3. Interventions aiming to improve cognitive functions

Starting in 2012, Denmark was the first country to introduce target shooting practice for students with ADHD or symptoms like those seen in ADHD. Altogether, 462 students were included in a project denoted FOKUS from 2012 to 2015 (Månsson, 2015). Positive experiences led to a research project (Månsson, Elmose, Dalsgaard & Roessler, 2017) to evaluate effects of six months of target shooting practice in intervention students ($N = 64$) compared to controls ($N = 64$). The improvement seen in the intervention group did not reach statistical significance, but the difference between the intervention group and the control group showed a statistically significant increase in tests of reaction time and omission errors, due to non-significant improvements in the intervention group and non-significant impairments in the control group (Månsson, Elmose, Mejldal, Dalsgaard & Roessler, 2019). The Quantitative Behavioural Test was applied to measure reaction time and omission errors. In the terminology of Mirsky (Koziol et al., 2014), those measures correspond to both the 'Sustain' and the 'Stability' elements of attention.

Further, qualitative data added valuable knowledge about the influence of target shooting practice (Månsson, Elmose, Dalsgaard & Roessler, 2019). What the participants learned at the shooting range they seemed to implement in the classroom; it was easier for them to be quiet and focused on schoolwork. Observations as well as teachers' and parents' stories indicated that the changes increased when a child participated in the training for two or more years. The qualitative data was interpreted in a phenomenological perspective. From our point of view, it is also interesting to see the findings in a neuropsychological perspective. For instance, one example from an interview situation demonstrated how a student managed to inhibit his impulsiveness (Månsson et al., 2019). In Mirsky terminology (Koziol et al., 2014), this might correspond to the Focus/execute element and illustrates that the student was able to control his behaviour. Previously he was unable to do so, he told the interviewer.

Below we report on three systematic reviews, two quantitative reviews and one literature review, assessing intervention effects on cognitive capacities in students with ADHD. First, the meta-analysis by Cornelius, Fedewa and Ahn (2017) exploring effects of physical activity. With rigorous inclusion criteria, 20 studies out of 970 records published 1980–2015 were included. There were no significant effects on children's attention, disruptive behaviour, or academic achievements. Otherwise, the results indicated an effect on overall functioning and a significant effect on internalizing problems. Further, aerobic activity (e.g., running or cycling) benefitted the children more than non-aerobic activity (e.g., relaxation training or yoga). There was no statistically significant effects of frequency, intensity, or length of the physical activity.

The literature review (Den Heijer et al., 2017) comprises 29 studies published before April 2016. Of those, nine studies were included in the meta-analysis reported above. The literature review uses the labels cardio activities (e.g., treadmill running or cycling) and non-cardio activities (e.g., yoga). In line with the meta-analysis (Cornelius et al., 2017), the authors find some improvements on various outcomes after interventions with cardio activities whereas the results of non-cardio activities were questionable. Regarding attention in children, the authors find the results to be inconclusive as some studies showed significant effects and others showed no effects.

The second meta-analysis (Lambez, Harwood-Gross, Golumbic & Rassovsky, 2020) is especially interesting to us because it explores studies with cognitive outcomes in non-pharmacological intervention studies. Applying rigorous inclusion criteria, such as objective neuropsychological outcomes, 18 studies out of 854 records, published 1980–2017 were included. This meta-analysis addressed two research questions: "(1) which leading non-pharmaceutical intervention for ADHD's cognitive symptomology is most effective? and (2) which cognitive symptoms are most amenable to change?" (p. 42). The authors found physical exercise (Morris $d = 0.93$) to be most effective, followed by cognitive behaviour training (Morris $d = 0.70$), neurofeedback (Morris $d = 0.61$), and cognitive training (Morris $d = 0.45$). Due to the low N, the different interventions could not be related to specific cognitive functions. However, to answer the second research question, cognitive functions were sorted into five functions. Regardless of intervention type (again due to low N), inhibition showed the highest improvement, thereafter flexibility, and higher executive functions whereas attention and working memory were least amendable to change. In terms of attention specifically, the studies that measured this function produced 14 effect sizes, with an average Morris $d = 0.41$. The studies comprised different types of interventions, and studies with neurofeedback were among those with highest effect sizes (p. 52). In a closing-up message, the authors recommend that interventions and clinical assessments should be conducted outside the lab. They acknowledge that the significant effects reported in their meta-analysis were limited to laboratory task.

4. Material and methods

Including quantitative and qualitative data (see Fig. 1) the present controlled intervention study has an explanatory sequential mixed method design (Creswell, 2014).

4.1. The intervention

This study relates to a school-based intervention (program) with 7 months of target shooting practice at one Norwegian public school in 2016/2017. The target shooting practice was arranged weekly during school hours from October to May, in an indoor shooting club about 5 minutes' walk from the school. Each session lasted for 90 min, including theoretical lessons, shooting training, and time for play.

In the theoretical lessons, the students learned how to behave and how to handle the weapon. Practicing on how to control breathing to get a calm body was a central topic. This was necessary to be able to focus on the shooting situation. At the shooting range, the students got adapted and individual help, see Picture 1. The instructors taught them step by step what to do and how to do it. One obvious strength in this learning situation was the immediate response on the target, see the picture, signaling the precision of each shot. Additionally, the instructors gave constructive and positive verbal feedback. The students appreciated this, and typically admired the instructors (Sløgedal, 2018). Groups of four rotated so that while four students practiced at the shooting range, eight others were in an adjoining room called the café. Here they relaxed, played cards or board games.

In relation to the use of weapons, safety and respect was strongly underlined. The instructors were certificated by Norwegian Civilian Marksmanship Association (Det frivillige Skyttervesen, DFS). The intervention built on collaboration between the school, the municipality, and the local shooting club of DFS. There were always a mix of certificated veterans from the club and certificated teachers from the school as instructors in the sessions.

4.2. Ethics

The participants were recruited by the schools. In the intervention school, 16 parents met together with teachers to be informed about the program and the planned research to evaluate the intervention. Thereafter, information letters and consent forms were sent by post to the parents. The control schools had a corresponding procedure: teachers, the student, and parents decided whether the student could be a candidate for the control group. After receiving lists of names, information and consent forms were sent by post to 13 homes. All students/parents were informed about confidentiality and that they were free to withdraw from the evaluation study at any time without explanations. The research was approved by the Norwegian Centre for Research Data. The photographer and shooting instructor have accepted Picture 1 to be published.

4.3. Participants

For the 2016/2017 intervention period, 16 students from grade 5 to 10 were considered candidates, based on the following inclusion criteria: the student experienced concentration problems interfering with schoolwork, agreed upon by parents and teacher, and one exclusion criteria: the student had previously participated in this school-based program or practiced target shooting in the spare time.

Out of the 16 candidates, 12 students (denoted S01 to S12) attended the intervention at the local school, after returning written consents. The students comprised a mixed group where most of them had one or more diagnoses (seven were diagnosed with ADHD or ADD and some had other diagnoses e.g., dyslexia). The control students were recruited from grade 5 to 10, by the same inclusion and exclusion criteria as the

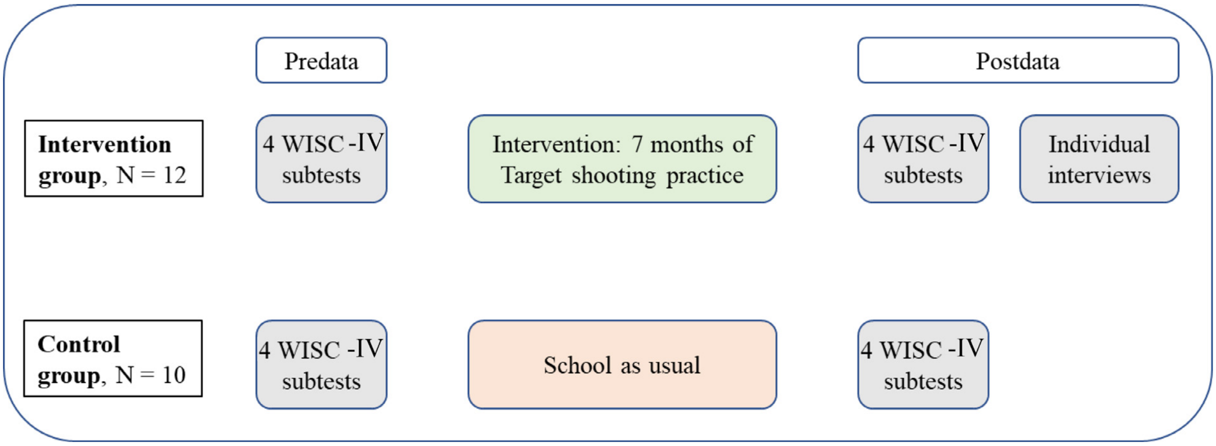

Fig. 1. The study design.

Picture 1. Illustrating target shooting practice, with the student aiming, the monitor giving immediate feedback, and the supportive certificated instructor. Photo: Trond Jære.

Table 1
Distribution of gender and age in the intervention group and the control group.

	Intervention group($N = 12$)	Control group($N = 10$)
Gender		
Male	7	6
Female	5	4
Age-groups		
10–11	1	4
12–13	7	5
14–16	4	1

intervention students. Altogether, the research team received 13 written consents, but one was withdrawn after a while. Due to long-term illness one control student was unable to participate in the tests, and another was lost to follow-up because of disease. Thus, a mixed group (some with diagnoses and some not, corresponding to the intervention students) of 10 control students participated, recruited from three public schools (two primary and one secondary) in nearby communities. The distribution of gender and age is presented in Table 1. The mean age (13.59) of intervention students was significantly higher (One-way ANOVA test, $p = .023$) than the mean age (12.01) of controls.

4.4. The quantitative study

We used data from pre- and post-tests. For the intervention students, the pretest was done in September–October 2016, before the intervention started, and the post-test was done in May 2017 after the intervention. The control students performed the tests in 2018, with a corresponding time span between Time 1 (T1) and Time 2 (T2). To ensure the same procedure in administrating the tests, one experienced researcher/clinician administered the tests for all included students, at both points of time.

Measurements. To assess attention, we applied four subtests from the fourth edition of Wechsler Intelligence Scale for Children (WISC-IV) (Wechsler, 2009): *Digit Span Total*, *Digit Symbol/Coding*, *Symbol Search*, and *Letter-Number Sequencing*. In addition to *Digit Span Total*, the parts *Digit Span Forward* and *Digit Span Backward* were used. Hence, we report on six measures. The clinical researcher decided to apply the mentioned tests because they have been frequently used in the first-line pedagogical-psychological services in Norway, and the researcher knew them beforehand. Thus, the choice of tests was convenient and the only ones at hand for the researcher. For readers with scarce neuropsychological competence to better understand the results, the tests will be elaborated upon in the discussion section.

Statistical approach. The descriptive statistics are presented with mean, standard deviations (SD), range, and three percentiles. A series of One-way ANOVA tests (Repeated measures) showed no statistically significant differences between the intervention group and the control group on any of the WISC-IV measurements at T1. To answer the study aim, we applied Mixed factorial ANOVA with the six WISC-IV measures as dependent variables, converting raw scores to scaled scores using the normative tables provided in the manual. The use of scaled scores instead of raw scores made controlling for age redundant in the statistical analyses. The two groups (intervention and control) and the two points of time (T1 and T2) constituted the independent variables. All dependent variables were normally distributed as assessed by Shapiro-Wilk's test of normality ($p > .05$), except *Symbol Search* was not normally distributed in the control group ($p < .05$). Nevertheless, we decided to run the test for *Symbol Search* because ANOVAs are considered 'robust' to deviations from normality (Blanca, Alarcón, Arnau, Bono & Bendayan, 2017). Further, the variables showed homogeneity of variances ($p > .05$) and covariances ($p > .001$), as assessed by Levene's test of homogeneity of variances and Box's M test, respectively.

Comparing means, the Mixed factorial ANOVA was used to determine whether the test results had changed over time. This ANOVA statistics calculates a main effect of time and a main effect of group belongings, and additionally interactions between time and group belonging. Main effect of time informs whether there are changes across time when all participants are included. Main effect of group belonging informs whether differences between the groups can explain changes across time. To explore changes from T1 to T2 in the intervention group and the control group separately (simple effect of time), we run Repeated measures for each of the two groups. In calculating effect size, we used partial eta squared (η^2), with benchmarks of 0.0099 for small, 0.0588 for medium, and 0.1379 for large (Richardson, 2011). The analyses were performed with SPSS version 27, and p-values < 0.05 were considered statistically significant.

4.5. Methodological approach of the qualitative study

The individual post interviews were performed in May 2017 by one of the researchers using a semi-structured interview guide. Topics in the guide covered preferences among school subjects, perceptions of mastery in subjects, daily life with friends, experiences in the target shooting program, perceptions of the body and mental state at the shooting range, and feelings of mastery in the target shooting practice. In this qualitative study, we concentrate on the question: How is it inside your mind when you have prepared yourself and are ready to shoot? Additionally, we use parts in the dialogues related to this core question as well as the participants' descriptions of their tasks at the shooting range.

Two of the researchers knew the data material very well beforehand and triangulated the findings. In the first steps of the analysis, the researchers wrote comments (codes and memos) in the text. Further, the analytical process was inspired by theoretical reading (Brinkmann & Kvale, 2015). Theoretical reading follows no strict procedure, but there are some necessary prerequisites: The material must be based on a theoretical perspective, and the material must be rich enough for a theoretical approach. In our case, the research question formulated in various ways to the students was theoretically founded, and the material invited to support a theoretical discussion.

We began deductively by sorting out material related to perceptions of mental state at the shooting range, perceptions of the body, and descriptions of practical preparations prior to the shooting. With this material at hand, the next step was a process moving between inductive and deductive strategies. We decided to include short presentations of the bodily experiences in the frame describing the situation at the shooting range and denoted this theme *Preparing to shoot at the target*. Further, we found that most of the participants were unconscious of their mental state and denoted this theme *Unconscious of his/her mental state*. Some of these students started to talk about what they felt, others about what they thought about in the situation. However, when challenged with follow-up questions, all of them told they were concentrated and able to skip away irrelevant thoughts. Only a few participants seemed to have reflected on what happened to them mentally, and their perceptions are presented under the theme *Verbalizes clear perceptions of his/her mental state*.

5. Quantitative results

Descriptive statistics with scaled scores are displayed in Table 2. For the intervention group, Digit Span Forward showed the lowest mean scaled score (6.17) and Symbol Search the highest (8.83) at T1, and at T2 the scores had increased about 1.5 and 1.1 scores, respectively. The control group did not have corresponding increases across time on the two variables. Further, the dispersion of the Digit Span variables is worth noticing. In the intervention group, $\frac{1}{4}$ of the students had a scaled score below 3.25 at Digit Span Forward, half the students scored below 6.00, and $\frac{3}{4}$ below 8.75. The scores for Digit Span Backward were somewhat higher. After the intervention, the scores for Digit Span Forward had increased substantially. Changes in the control group from T1 to T2 were smaller and to note, the 25th percentile for Digit Span Forward had the score 4.00 at both times of measurement.

The ANOVA results showed for *Symbol Search* (Fig. 2) a statistically significant interaction between group belonging and time ($p = .005$), and no main effects of group belonging or time. We proceeded with tests (Spilt file and Repeated measures) to determine whether there were any statistically significant simple effects. There was a statistically significant effect of time on *Symbol Search* for the intervention group, $F(1, 11) = 9.158$, $p = .012$, partial $\eta^2 = 0.454$, while not for the control group.

For *Digit Span Total* (Fig. 3) there was no interaction between group belonging and time ($p = .626$), and no main effect of group belonging, but there was a main effect of time, $F(1,20) = 6.511$, $p = .019$, partial $\eta^2 = 0.246$. Further testing with Spilt file and Repeated measures, showed an effect of time for the intervention group, $F(1,11) = 7.184$, $p = .021$, partial $\eta^2 = 0.395$ whereas there was no effect of time for the control group.

Like the sum variable (*Total*) above, *Digit Span Backward* showed no interaction between group belonging and time ($p = .751$), and no main effect of group belonging, but a main effect of time, $F(1,20) = 5.783$, $p = .026$, partial $\eta^2 = 0.224$. However, there were no simple effects of time in any of the two groups, measured by Spilt file and Repeated measures.

For *Digit Span Forward* there was no interaction between group belonging and time ($p = .394$), and no main effects of group belonging or time. The same was true for *Digit Symbol/Coding* and *Letter-Number Sequencing,* no interaction ($p = .089$, $p = .270$, respectively) and no main effects of time or group belonging.

6. Qualitative results

Before introducing the main question about mental state when shooting, the interviewer aimed to awaken the students' consciousness related to the shooting situation. Therefore, many of the students, especially the younger, were asked to tell what they did at the shooting range when they prepared to shoot at the target. Below are some answers to the question: "Tell me the order of what you do when you shoot."

Preparing to shoot at the target

As we see, the students had learned exactly what to do and they applied a lot of technical terms associated with rifle shooting.

S02: First, I retrieve the earmuffs and then I lie down (…) then I take a few dry fires, and then I put in the magazine and then I begin to shoot. First, a test stage and then three stages which are counted.

Table 2
Cognitive tests scores* for the intervention group ($N = 12$) and the control group ($N = 10$).

Groups	TIME 1					TIME 2				
	Mean (SD)	Range	Percentiles			Mean (SD)	Range	Percentiles		
			25th	50th	75th			25th	50th	75th
Intervention										
Digit Span										
-Forward	6.17 (2.98)	3–11	3.25	6.00	8.75	7.67 (2.02)	4–11	6.00	8.00	9.50
-Backward	8.17 (2.66)	3–12	7.00	7.00	11.00	9.08 (2.23)	6–12	7.00	9.00	11.00
-Total	6.58 (2.61)	2–11	5.25	6.00	9.00	7.92 (1.78)	5–10	6.25	8.50	9.00
Letter-Number	7.92 (2.31)	4–11	6.00	8.50	9.75	7.67 (1.92)	5–11	6.00	8.00	9.00
Coding	7.17 (2.73)	3–13	4.50	7.50	8.75	6.67 (2.67)	3–12	4.25	6.00	8.75
Symbol Search	8.83 (1.85)	6–12	7.25	9.00	9.75	9.92 (2.11)	6–14	9.00	9.50	11.75
Control										
Digit Span										
-Forward	6.00 (1.63)	4–8	4.00	6.00	8.00	6.50 (2.42)	3–10	4.00	7.00	8.25
-Backward	7.20 (1.99)	4–9	5.50	7.50	9.00	8.40 (1.96)	6–12	7.00	8.00	9.50
-Total	6.00 (1.70)	3–8	4.75	6.50	7.25	6.90 (1.91)	4–10	5.00	7.00	8.25
Letter-Number	6.40 (2.76)	1–10	4.75	6.50	9.00	7.10 (2.51)	1–10	6.50	8.00	8.25
Coding	7.50 (2.72)	2–12	5.75	8.00	9.00	8.10 (3.18)	2–14	6.50	8.00	10.00
Symbol Search	9.70 (2.50)	3–12	9.75	10.00	11.00	9.20 (2.66)	2–11	9.50	10.00	10.25

* Scaled WISC-IV scores.

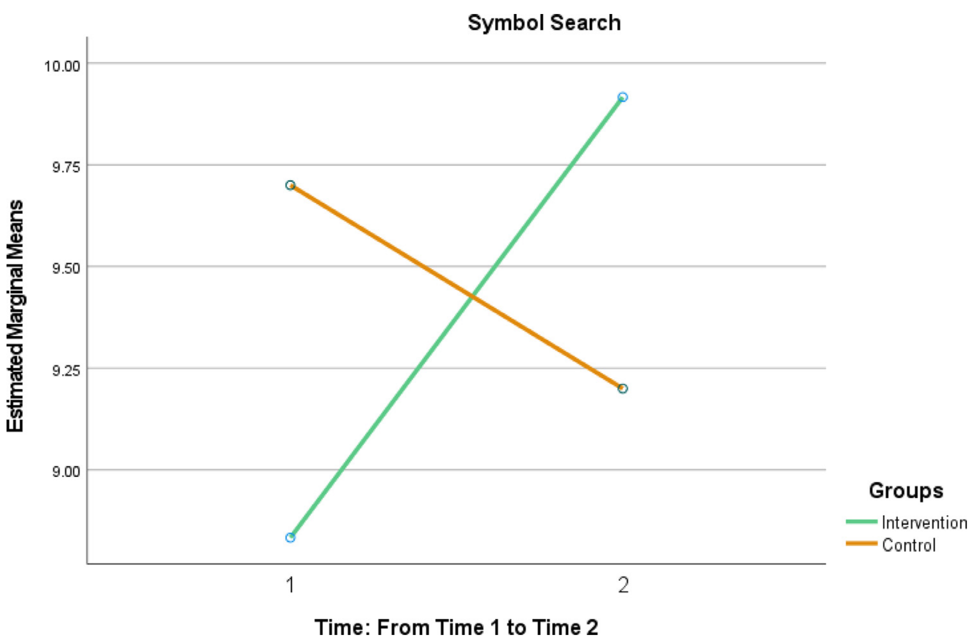

Fig. 2. Changes from time 1 to time 2 on *Symbol Search* for the intervention group and the control group.

S05: I'm aiming, and then I get myself ready, and press until I come to the trigger break. Then I press a bit more and a bit more until it goes bang. And then, I follow-through and then I load again.

S03: And it is also important to breathe, two or three times. You'll have to find that out for yourself. And then you must concentrate on the target and to get a good shot.

Unconscious of his/her mental state

Coming to the question about mental state when shooting, most of the participants looked surprised and the question seemed to be unexpected, as exemplified by this student:

S09: How it is in my mind? I don't believe I think about it very much.

Picking up what each student told ahead, the interviewer typically formulated an introducing sentence, like: "When you lie there and have loaded the weapon and then aim at the target and start preparing to pull off" followed by the core question: "How is it inside your mind then?" In response to this question, some of the students seemed to answer another question, namely: "How do you feel?"

S02 Um, I don't know. I'm actually very calm. I don't know.

S01 Good.

S11 Relaxed, maybe.

Other students seemed to answer yet another question: "What are you thinking about?"

S06: I think about the task and about what I'm going to do.

S03: It's good to think about that one is going to do something that is not related to school. Concentrate on something that is a bit fun, too.

S10: It's that I have to be focused, I don't think so much then, I guess it's more afterwards that I think about that I could have done better. Yes.

Although some participants initially answered how they felt or what they thought, all of them expressed that they were concentrated when the interviewer challenged them asking if they for instance though about friends or leisure activities. In some of the dialogues, the interviewer, in a way, helped the student by using the word chaos: "How is it inside your mind? Is it chaos or is it silence?" Some students answered shortly, illustrated in the two first extracts below. However, in the dialogue with student 03, the interviewer challenged the student to answer more than

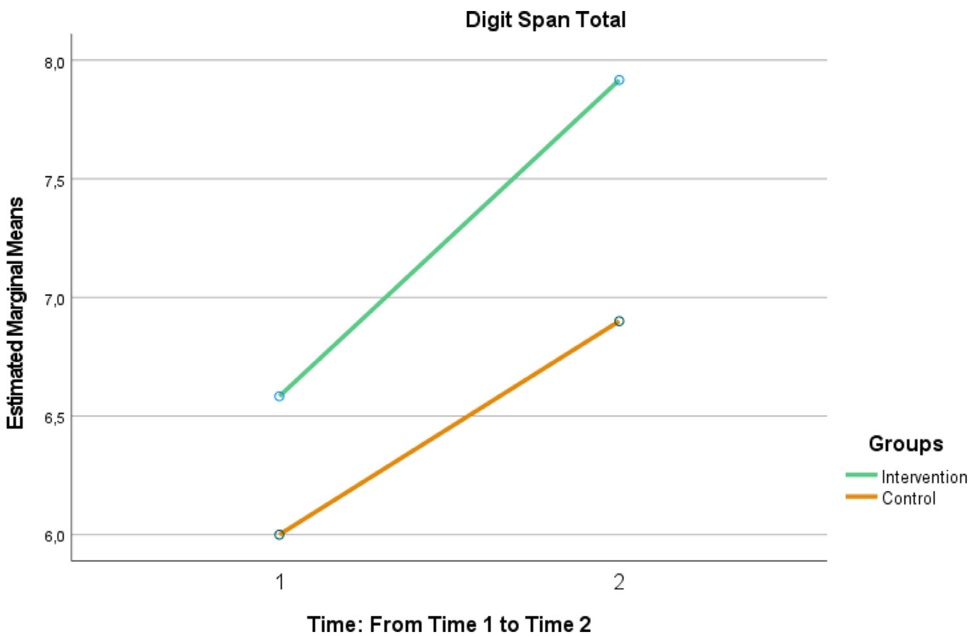

Fig. 3. Changes from time 1 to time 2 on *Digit Span Total* for the intervention group and the control group.

"no", and consequently the student gave an informative answer, also relating it to school:

S04: Then it is silence.

S06: Calm.

I: [...] when you lie there, at that moment, is it chaos in your mind?

S03: No.

I: Not chaos?

S03: No, it's not.

I: No, how would you describe what goes on in your mind at that moment, then?

S03: It's somewhat tidy in my mind.

I: Is it different from what you experience in the lessons?

S03: It is tidier when I'm lying down to shoot. There's more to think about at school.

Verbalizes clear perceptions of his/her mental state

Three of the older participants expressed clear thoughts about their mental state in the situation. When the interviewer asked: "How is it inside your mind?" one of these students answered:

S05: I don't think about anything. I just lie there and aim and relax and try not to move. And when I'm almost certain I'll hit the Bullseye, I shoot. Try to aim as precisely as I can.

The two dialogues below indicate that the students had reflected on this previously.

Student 12 says he/she emptied his/her mind and that he/she could not imagine how it was possible, and commented: "[Target] Shooting, of all things". In the last dialogue, student 07 tells he/she goes into another world, fully concentrated and without thoughts. He/she finds this mental state to be comfortable.

S12: No, I only think about the shooting. Then I don't think about anything else. I just empty my mind completely. I don't know how I manage to do it, I just do.

I: You have no idea how you manage to do this?

S12: No, it just suddenly happens, I only think about how I do the shooting and then yes, it goes.

I: Yes, and will you say that you are concentrated?

S12: Yes, then I'm concentrated!

I: Fully concentrated?

S12: Then, I am! I don't know how it works. [Target] Shooting, of all things.

S07: I'm in a completely different world, then.

I: What does that mean?

S07: Well, like, now I'm in this world. Now I'm in reality, but when I lie down on a shooting range and take really deep breaths, then I'm in a completely different world. Then I'm in my own world. Like in a different universe, a different world.

I: Is that comfortable?

S07: Hmm. I'm fully concentrated, my mind is clear. It's so much fun. To shoot. A completely different world. Then it's thoughts out and shooting in.

7. Discussion

This controlled intervention study with a mixed design explored effects of target shooting practice on students' attention, among 12 intervention students and 10 controls from grades 5–10 in public Norwegian schools. Mixed factorial ANOVA tests were used to assess possible differences in four WISC-IV subtests that measure different aspects of attention between the intervention students and the controls, as well as changes across time. Only on the *Symbol Search* subtest there was an interaction between group belonging and time, with increased scores in the intervention group and decreased scores in the control group. For the intervention group, simple effects showed statistically significant improvements from T1 to T2 on *Symbol Search* and *Digit Span Total*. The analyses showed no simple effects of time for the control group. Qualitative data from individual post interviews underpin the quantitative results. During the exercise with target shooting practice, the students felt focused and in a calm state of mind, - quite different from what they experienced in the classroom. A couple of the older students reflected on how they emptied their mind when they were about to aim at the target.

7.1. Our results, the Mirsky model, and practical relevance

Because cognitive tests like the ones we have used, typically capture only parts of a person's cognitive functioning, the students' voices through individual interviews add valuable information on cognitive perceptions in this study.

Let us start with the classroom. We suppose every teacher has experience with students who do not follow given instructions. Then a question arises; is the student unable to follow the instructions, and if so, why? For instance, in the lower grades, when the teacher asks students to pick up the math book, turn to page 47 and read Exercise 9 most students do so, but there are some who cannot follow an instruction with three items. This is about the 'Encode' element in the Mirsky model of attention (Mirsky et al., 1991). The student must be able to initially register the information and hold the information briefly in mind before performing some action or cognitive operation upon it (Koziol et al., 2014, p. 298). The inability to focus on specific tasks can lead to difficulties of memory and other cognitive functions.

In *Digit Span Forward*, the administrator reads a sequence of figures. The student must register the figures, keep them briefly in mind and then repeat the figures in the same order as read aloud by the administrator. This was difficult for intervention as well as control students. It may be added that, compared to norms (Wechsler, 2009), 17 of the 22 participants had T1 achievements corresponding to mean achievements of children 6–8 years old. Related to the learning context in grades 5–10 (ages 10–15) it is understandable that the mismatch between actual capacity and expected capacity according to age, could contribute to students' feelings of being uncomfortable in the classroom (cf. Løhre, 2020; Løhre et al., 2021).

After the intervention, the *Forward* scores in the lower half of the intervention group had increased substantially, especially scores below the 25th percentile, while the control group did not show corresponding changes (see Table 2). Hence, the results might suggest that the intervention was most advantageous for students with very low achievement related to the 'Encode' element. It is, however, important to note that these descriptive results are only indicative of under-group differences as we do not present statistical results on the small under-groups because of low N.

The AVOVA tests on *Digit Span Forward* (for all participants) showed no statistically significant effects of time. On the other hand, the ANOVA results on *Digit Span Total* support the suggestion of an intervention effect. The high effect size (partial $\eta^2 = 0.395$) of the statistically significant increase from T1 to T2 in the intervention group demonstrated a strong improvement, according to Richardson (2011), while there was no simple effect of time in the control group. May be the weekly training with repeated exercise on the sequential procedure of preparing to get ready to shoot followed by moments of aiming, had helped the students.

There might be several reasons why the change in the improvement direction on *Digit Span Backward* did not reach statistical significance in separate analyses of the two groups; first, the students' mean achievement at T1 was closer to mean normal capacity (score 10) (Wechsler, 2009) quite different from the lower achievements at the *Forward* subtest providing more space for improvement (see Table 2). Additionally, the *Backward* subtest is recognised to be more complicated, as the student must repeat the figures in a backward order. This cognitive operation requires more of the working memory capacity than the *Forward* subtest, and review of previous studies (Lambez et al., 2020) has shown that working memory was least amendable to change among the measured cognitive functions.

One reason why the students had better results on the Backward subtest compared to the Forward subtest, might be related to the number of figures included. Each separate task in the *Backward* subtest consists of fewer figures to remember than the corresponding task in the *Forward* subtest. The standardisation is so because the *Backward* subtest is suggested to be more complicated (Wechsler, 2009). To examplify, in the *Backward* subtest, the student gets higher credit (higher scaled scores) compared to credit in the *Forward* subtest by handling the same number of figures. Thus, the better results on the *Backward* subtest might rely on fewer figures to register, keep in mind, and do some action upon. If this reasoning is correct, it can indicate that the ability to handle information in line with the Encode element is a basis for learning, - at least among students who perform relatively low, in our case measured by *Digit Span*.

Further, the *Letter-Number Sequencing* subtest showed no signs of improvement in the intervention group. This might depend on less room for improvement compared to the *Forward subtest* and that the *Sequencing subtest* requires combined activation of attention, working memory, and executive functions. In the *Sequencing* subtest, the student must remember a mix of letters and figures, sort them out and repeat them in an alphabetic and a numeric order.

One of the main aims of target shooting practice is exactly what the 'Focus/executive' element is about: "the ability to allocate attentional resources on a specific task and to simultaneously screen out distracting peripheral stimuli" (Koziol et al., 2014, p. 299). In the theoretical lessons as well as on the shooting range, the students were encouraged to focus and keep away distracting stimuli. Mirsky et al. (1991) suggested that this ability could be measured by *Digit Symbol/Coding*, a subtest that requires capacities in speed and motor control in addition to attention and working memory. The figures 1 to 9 are first presented at the top of a sheet, each with a respective symbol and thereafter, the student is asked to fill in the correct symbol in rows of mixed figures (1–9), and of course students with a sharp memory, good motor control, and fast speed are better off than slower peers with impaired memory. Although the students showed no improvement on this subtest, there was a statistically significant improvement in the intervention group on *Symbol Search*. This subtest might be perceived as easier than *Digit Symbol/Coding* because it is not dependent on motor control and requires the student to keep only two different symbols in mind and then explore a row of symbols to detect if any of the two first symbols are among those in the row. Speed is also an issue in this subtest. The mean improvement was about 1 point on the scaled scores for the intervention students (see Table 2), with the ANOVA test showing an effect size (partial $\eta^2 = 0.454$) considered to be high (Richardson, 2011).

The qualitative data supports suggestions of improvement on the 'Focus/executive' element. Typically for the students, they often experienced chaos in their mind in classroom situations before the intervention (Løhre et al., 2021), and some admitted they still felt disturbed in the classroom after 7 months of target shooting practice. Therefore, the students' stories about cognitive experiences at the shooting range is important. Most of the students looked astonished when they were asked the question: How is it inside your mind? Some seemed to answer what they thought about or how they felt and replied for instance: 'calm' or 'focused'. To be 'calm' and 'focused' are what the students are taught in the theoretical lessons as well as at the shooting range, and hence, these terms might be considered an echo of the instructors. Nevertheless, when the students were challenged to describe in more details, we understood that their attention was fully and completely related to the shooting. Two of the older students seemed to previously have reflected on their mental state at the shooting range. One of them said he/she thought about nothing and continued: "I just empty my mind completely. I don't know how I manage to do it, I just do." The other student also conveyed that he/she was able to screen out distracting stimuli: "I'm fully concentrated, my mind is clear. […] Then it's thoughts out and shooting in."

In terms of the 'Sustain' element of the Mirsky model, the qualitative data has indicated that the students experienced they were able to maintain attention as long as needed to fulfil their tasks at the shooting range. Regarding the 'Shift' element, responses on the *Letter-Number Sequencing* subtest showed no signs of improvement in the intervention group, as previously mentioned.

7.2. What are the active ingredients in the intervention?

The intervention seems to include many of the elements found in other interventions with documented effects on cognitive variables. The situation at the shooting range produces a series of neurofeedback to the student. Picture 1 illustrates how the shooters immediately get visual feedback reporting the degree of success in the shot. According to the leader of the school program, each student typically gets 20 such visual feedbacks during the weekly training. Neurofeedback is known to positively influence attention and cognitive functioning in general (Lambez et al., 2020).

Although the intervention did not have a formalized cognitive training or cognitive behaviour training program, the intervention included elements of both. The instruction on how to handle the weapon and how to perform, activates different aspects of cognition in the participants. Further, the instructors told the students how to breath and how to behave. This teaching goes beyond the sessions in the program; the instructors gave advice to use some of the technics also in other settings. Even though cognitive training/cognitive behaviour training has shown no or small effects on attention specifically, both types of intervention have resulted in improved cognitive functioning in general (Lambez et al., 2020). Thus, it is possible that the cognitive components in the intervention were beneficial to the students both in respect to attention and other cognitive functions.

The school program may also be categorized as physical activity, and recent review studies and meta-analysis (Cornelius et al., 2017; Den Heijer et al., 2017; Lambez et al., 2020) have shown impact of physical exercise on cognitive functioning in general. However, and most importantly, there was no or questionable effects on attention. Among different cognitive functions, attention and working memory seems to be least amendable to affect by interventions (Lambez et al., 2020). In this perspective, results in the current study are promising.

In addition to the active ingredients discussed above, the school-based intervention involves two more potentially active elements. The first is development of trustful relationships between students and instructors (Sløgedal, 2018; Østerlie et al., 2018). The students respected and admired the instructors who gave them adapted support and constructive verbal feedback (see Picture 1). The second additional agent is the impact of peers. Due to the logistics in the shooting training session, the participants got the possibility to talk and support each other before and/or after the training at the shooting range. The older students experienced they became role models for the younger (Sløgedal, 2018). Several studies have documented a positive influence of including peers in training programs for students with ADHD (Cordier, Vilaysack, Doma, Wilkes-Gillan & Speyer, 2018).

We suppose that all the above-mentioned components (neurofeedback, cognitive and cognitive behaviour training, physical activity, trustful relationships between students and instructors, adapted teaching and support given by instructors, as well as peer relationships and support) together contribute to positive changes in the participants. All participants were happy about attending the program and experienced mastery (Østerlie et al., 2018). However, turning to the reported improvements related to attention in the current study, we suggest that especially the instructions, the neurofeedback, the verbal feedback and personal support related to repeated training, as well as personal experiences of success, had an impact on attention.

One can ask if target shooting practice is special compared to other sports, and we think that at least one feature is special. In many sport activities, the actor needs to take several circumstances into account simultaneously. Mountain climbing can illustrate an example. The climber must be concerned about securing himself/herself, where to put hands and feet and simultaneously be aware of potential possibilities and challenges ahead. In team sports, like football, good players are aware of here and now situations and simultaneously they anticipate what can happen if so, and so. Target shooting is different. It is a sequential handling of bits of behaviour in the process of shooting. Some of the participants described the procedure in detail; first you do this, next that, and so on. We hypothesize that the sequential order in target shooting fits students with poor attention. Many teachers may recognize the example of team sports where students with attention deficits typically perform bad and do not like it. Looking back at the classroom we know that students with poor attention have problems following the teacher's instructions. In this research project, we have no data from the classroom after the intervention, but Danish research has shown promising results in this respect. Students who had attended the program for more than a year, continued a positive development also observed in class (Månsson et al., 2019). However, there is a need for more longitudinal research on target shooting practice to investigate changes in participants across years.

7.3. Strengths, limitations, and future research

By assessing impaired attention among students, the study is relevant to most educational societies. It is a strength that the intervention was carried out on the premises of the local target shooting club just 5 minutes' walk from the school. This created a natural 'real life' situation as called for by Lambez et al. (2020) in contrast to lab interventions.

The location and contributions from the local shooting club and the municipality ensures implementation of a long-lasting school program. Contrary to explore homogeneous groups suggested to have only one disease, many students in this study had one or more diagnoses and some had none. Studying such a mixed group mirror the classroom. Therefore, the mixed group is a strength in this respect. Also considered a strength is the fact that the same researcher/clinician administered the pre- and post-tests and did the individual post interviews. However, this may also be considered a bias as the researcher knew the identity of students (intervention or control).

There are several models or views on attention in the rapidly developing field of neuropsychology. We have chosen the Model of Mirsky since it fitted the data and illuminated the results. As pointed to in our presentation of the model, Mirsky acknowledged blurred boundaries between some components of attention. We agree on this and hence, we have applied the same subtests (*Digit symbol/Coding* and *Symbol Search*) to evaluate a couple of components ('focus/execute' and 'sustain') that include aspects of executive function. Similarly, *Letter-Number Sequencing* was applied to assess both the 'encode' and the 'shift' elements.

Moreover, in concluding remarks Koziol et al. (2014) state that their discussions of the model should be looked upon as an "interim solution" that forms a foundation for further research and development within the field of applied neuropsychology. This fits well with our view, as we recognize that each test employed in the study measures several cognitive functions, including different aspects of attention, and that many brain functions are subservient of each other and function as an integrated system.

The low number of participants is an obvious weakness. Nevertheless, the chosen robust statistics revealed strong results, with high effect sizes. Because the results are promising, there is a need for more research with higher numbers of participants, across two or more years. Even though including four subtests from the same test battery (WISC-IV) and using the same normative data is a strength, additional assessment tools, such as the *Continuous Performance Test*, could have shed light on the 'Stability' as well as other elements of attention (see Koziol et al., 2014). Researchers may also consider observations at school, in classrooms, and at the shooting range; and to collect protocols of academic achievements. Further, the voices of parents, teachers, and instructors are welcomed.

7.4. Conclusions

This controlled study with an explanatory sequential mixed method design has shown an effect on attention among 12 intervention students. After seven months of weekly sessions with target shooting practice, the students had increased ability to register and immediately recall information. They had also increased ability to screen out distracting stimuli and allocate their attentional resources on specific tasks. The mentioned areas of progress correspond to the 'Encode' element and the 'Focus/Executive' element in the Mirsky model of attention. Qualitative data supported the objective test results, and additionally showed that the students were able to maintain attention to fulfil their tasks, corresponding to the 'Sustain' element. In theory, the observed improvements would reflect students who more easily could follow the teacher's instructions, and students who were less mentally tired of doing academic tasks. Contrasting the positive changes among intervention students, the 10 control students showed no improvements.

We hypothesize that the sequential nature of rifle shooting at a target, where bits of activities are performed sequentially, is a good match for students with impaired attention. It is still an open-ended question if and how the target shooting practice affects academic achievements and occupational outcomes later in life, and we have scarce information on behaviour changes after the intervention. Supported by Danish results (Månsson et al., 2019, 2019) the present study calls for longitudinal research that may follow intervention and control students across two or more years.

Funding

Rennebu Municipality, Gjensidige stiftelsen, and The Norwegian Civilian Marksmanship Association funded the data collection.

Declarations of Competing Interest

The authors declare to have no conflicting interests.

Acknowledgments

We thank the students, parents, schools, and instructors for contributions to the study.

References

Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology, 63*(1), 1–29. 10.1146/annurev-psych-120710-100422.

Barker, L. A. (2016). Working memory in the classroom: An inside look at the central executive. *Applied Neuropsychology: Child, 5*(3), 180–193. 10.1080/21622965.2016.1167493.

Barkley, R. A., & Fischer, M. (2011). Predicting impairment in major life activities and occupational functioning in hyperactive children as adults: Self-reported executive function (EF) deficits versus EF tests. *Developmental Neuropsychology, 36*(2), 137–161. 10.1080/87565641.2010.549877.

Barkley, R. A., & Fischer, M. (2010). The unique contribution of emotional impulsiveness to impairment in major life activities in hyperactive children as adults. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(5), 503–513. 10.1016/j.jaac.2010.01.019.

Blanca, M. J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2017). Non-normal data: Is ANOVA still a valid option? *Psicothema, 29*(4), 552–557. 10.7334/psicothema2016.383.

Brinkmann, S., & Kvale, S. (2015). *Interviews. learning the craft of qualitative research interviewing* (3rd ed.). SAGE.

Cordier, R., Vilaysack, B., Doma, K., Wilkes-Gillan, S., & Speyer, R. (2018). Peer inclusion in interventions for children with ADHD: A systematic review and meta-analysis. *BioMed Research International, 2018*, Article 7693479. 10.1155/2018/7693479.

Cornelius, C., Fedewa, A. L., & Ahn, S. (2017). The effect of physical activity on children with ADHD: A quantitative review of the literature. *Journal of Applied School Psychology, 33*(2), 136–170. 10.1080/15377903.2016.1265622.

Creswell, J. W. (2014). *Research design. qualitative, quantitative, and mixed methods appraches*. SAGE (Vol. 4).

Danckaerts, M., Sonuga-Barke, E. J. S., Banaschewski, T., Buitelaar, J., Döpfner, M., Hollis, C., et al. (2010). The quality of life of children with attention deficit/hyperactivity disorder: A systematic review. *European Child & Adolescent Psychiatry, 19*(2), 83–105. 10.1007/s00787-009-0046-3.

Den Heijer, A. E., Groen, Y., Tucha, L., Fuermaier, A. B. M., Koerts, J., Lange, K. W., et al. (2017). Sweat it out? The effects of physical exercise on cognition and behavior in children and adults with ADHD: A systematic literature review. *Journal of neural transmission, 124*(Suppl 1), 3–26 (Vienna, Austria: 1996). 10.1007/s00702-016-1593-7.

Gilbert, S. J., & Burgess, P. W. (2008). Executive function. *Burrent Biology, 18*(3), R110–R114. 10.1016/j.cub.2007.12.014.

Gray, S. A., Dueck, K., Rogers, M., & Tannock, R. (2017). Qualitative review synthesis: The relationship between inattention and academic achievement. *Educational Research, 59*(1), 17–35. 10.1080/00131881.2016.1274235.

Joyce, A., & Hrin, S. (2015). Attention: An evolving construct. *Applied Neuropsychology: Child, 4*(2), 80–88. 10.1080/21622965.2015.1005476.

Koziol, L. F., Barker, L. A., & Jansons, L. (2015). Attention and other constructs: evolution or revolution? *Applied Neuropsychology: Child, 4*(2), 123–131. 10.1080/21622965.2015.1005482.

Koziol, L. F., Joyce, A. W., & Wurglitz, G. (2014). The neuropsychology of attention: revisiting the "Mirsky model". *Applied neuropsychology. Child, 3*(4), 297–307. 10.1080/21622965.2013.870016.

Lambez, B., Harwood-Gross, A., Golumbic, E. Z., & Rassovsky, Y. (2020). Non-pharmacological interventions for cognitive difficulties in ADHD: A systematic review and meta-analysis. *Journal of Psychiatric Research, 120*, 40–55. 10.1016/j.jpsychires.2019.10.007.

Løhre, A. (2020). Identity formation in adolescents with concentration problems, high levels of activity or impulsiveness: A pragmatic qualitative study. *International Journal of Educational Psychology*, 9(1), 23. https://doi.org/10.17583/ijep.2020.4315.

Løhre, A., Vedul-Kjelsås, V., & Østerlie, O. (2021). Enjoyment as a learning resource: Stories told by students with harmful concentration problems. *Nordic Journal of Pedagogy and Critique*, 7, 1-18. https://doi.org/10.23865/ntpk.v7.2663.

Månsson, A.G. (.2015). *Evaluering af projekt FOKUS – ro og koncentration gennem skydeidræt 2012 - 2015*. https://www.dgi.dk/media/7294/faerdig-evaluering-af-fokus-2012-2015.pdf.

Månsson, A. G., Elmose, M., Dalsgaard, S., & Roessler, K. K. (2017). The influence of participation in target-shooting sport for children with inattentive, hyperactive and impulsive symptoms - a controlled study of best practice. *BMC Psychiatry, 17*(1), 115. 10.1186/s12888-017-1283-5.

Månsson, A. G., Elmose, M., Dalsgaard, S., & Roessler, K. K. (2019). Skydeidræt som kropsforankret læring. *Pædagogisk Psykologisk Tidsskrift, 5*(6), 30–47.

Månsson, A. G., Elmose, M., Mejldal, A., Dalsgaard, S., & Roessler, K. K. (2019). The effects of practicing target-shooting sport on the severity of inattentive, hyperactive, and impulsive symptoms in children: A non-randomised controlled open-label study in Denmark. *Nordic Journal of Psychiatry, 73*(4–5), 233–243. 10.1080/08039488.2019.1612467.

Miller, E. K., & Wallis, J. D. (2009). Executive function and higher-order cognition: Definition and neural substrates. *Encyclopedia of Neuroscience, 4*, 99–104. http://earlkmiller.mit.edu/wp-content/uploads/2013/03/Miller-and-Wallis-Encyclopedia-2009.pdf.

Mirsky, A. F. (1987). Behavioral and psychophysiological markers of disordered attention. *Environmental Health Perspectives, 74*, 191–199. 10.1289/ehp.8774191.

Mirsky, A. F., Anthony, B. J., Duncan, C. C., Ahearn, M. B., & Kellam, S. G. (1991). Analysis of the elements of attention: A neuropsychological approach. *Neuropsychology Review, 2*(2), 109–145. 10.1007/BF01109051.

Parasuraman, R. (1998). The attentive brain: Issues and prospects. In R. Parasuraman (Ed.), *The attentive brain*. MIT Press.

Peterson, R. L., Boada, R., McGrath, L. M., Willcutt, E. G., Olson, R. K., & Pennington, B. F. (2016). Cognitive prediction of reading, math, and attention: Shared and unique influences. *Journal of Learning Disabilities, 50*(4), 408–421. 10.1177/0022219415618500.

Polderman, T. J. C., Boomsma, D. I., Bartels, M., Verhulst, F. C., & Huizink, A. C. (2010). A systematic review of prospective studies on attention problems and academic achievement. *Acta Psychiatrica Scandinavica, 122*(4), 271–284. 10.1111/j.1600-0447.2010.01568.x.

Richardson, J. T. E. (2011). Eta squared and partial eta squared as measures of effect size in educational research. *Educational Research Review, 6*(2), 135–147. 10.1016/j.edurev.2010.12.001.

Sløgedal, S. (2018). *E har lært kor avslappa og konsentrert e egentlig kan vårrå* [I have learned how relaxed and concentrated I can be.] Norwegian University of Science and Technology. http://hdl.handle.net/11250/2565014.

Tarver, J., Daley, D., & Sayal, K. (2014). Attention-deficit hyperactivity disorder (ADHD): An updated review of the essential facts. *Child Care Health Dev, 40*(6), 762–774. 10.1111/cch.12139.

Wechsler, D. (2009). *Wechsler intelligence scale for children: Manual*. NCS Pearson, Inc (Norwegain translation 2009).

Østerlie, O., Buaas, I. Ø., Vedul-Kjelsås, V., & Løhre, A. (2018). *Skytetrening for elever med konsentrasjonsvansker - Evaluering av et tiltak i skolen*. [Shooting practice for students with concentration problems Evaluation of a schoolbased intervention.] NTNU Oppdragsrapport 2018. NTNU Open. https://brage.bibsys.no/xmlui/handle/11250/2478346.