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Attention and Learning Disabilities

Audhild Løhre

Abstract

Impaired attention is known as a pervasive behaviour disturbance, with a negative influence on learning processes. Attention deficit is one of the main symptoms of Attention Deficits Hyperactive Disorder, ADHD. Further, impaired attention is often part of learning disorders in dyslexia and dyscalculia as well as in students with no medical diagnoses. In schools and higher education knowledge on attention and challenges caused by impaired attention, is typically scarce. Hence, this chapter aims to inform educational institutions by applying Mirsky's model of attention, discuss challenges of impaired attention, and point to intervention effects. The positive effects of real-life interventions comprising target shooting practice are explained by immediate neurofeedback combined with individual adaption and caring. Moreover, as previously hypothesised, the sequential order of behaviour at the shooting range may benefit students with impaired attention. The term concentration is frequently used in Norwegian schools and counselling services. A definition of concentration in natural situations is suggested, and possible overlaps between concentration and attention are discussed. The chapter opens for empirical and theoretical questions and hopes for more research on target shooting practice as well as on other educational programmes applying neurofeedback in the school context to investigate attention.

Keywords: impaired attention, pervasive behavioural disturbance, the Mirsky model of attention, enjoyment and concentration, individual adaption, mental and physical shielding, interventions, target shooting practice, neurofeedback, non-governmental organisation (NGO)

1. Introduction

An ordinary classroom, in an ordinary public school in Mid-Norway. The desks were nicely placed, one by one, for the seven-year-old students. At the first row by the window, there was a girl, whom I did not yet know. With books and pencils on her desk, like all students had. However, something appeared to be different. She took a box of grapes from her bag, placed it at the corner of her desk and started to eat. It must be added that the students were not allowed to eat in the middle of a lesson, but the teacher overlooked the situation. After the first grape, the girl spits the stones on the floor. One more grape, and again spitting stones, letting them fall beside her at the floor. She continued without being interrupted. Sitting there observing, I thought it was rather strange. This is one of the situations I remember very well from more than 20 years as a school psychologist. This girl, let us call her Martha, was later diagnosed with ADHD. I had the pleasure to follow Martha and her family for about 10 years until she left the municipality to attend other schools. Luckily, I met her again later.

Together with hyperactivity and impulsiveness, attention deficits are the main symptoms of ADHD [1]. Most empirical studies on impaired attention are related to young people diagnosed with ADHD. Further, interventions are typically evaluated in selected groups, like ADHD. However, in an ordinary classroom, a variety of reasons may lead to attention problems. It has been claimed [2] that there is a gap between neuropsychological knowledge on attention and clinical applications in schools. Thus, this chapter aims to illustrate how Mirsky's model of attention [3, 4] may be useful in educational institutions and further, I will add some information to inspire theoretical reflections as well as practical skills in schools.

First, I present a theoretical section on attention mainly based on Mirsky's model of attention [5], and thereafter, a section on attention, concentration, and learning difficulties, where the two concepts attention and concentration are discussed. Next, the chapter refers to relevant interventions and highlights possible differences between laboratory experiments with selected groups and real-life interventions with mixed groups. Because of promising results, one real-life intervention comprising target shooting practice is described in more detail. Towards the end, before the conclusion, I reflect on theoretical and practical implications.

2. Attention

Scientists have studied attention since research on 'reaction time' in mid-1800 [6], and theories have been developed according to scientific evidence available at the time. Mirsky and his colleagues [4] considered impaired attention to be one of the most pervasive and least understood behavioural disturbances (p. 109). So, how can we understand attention? Parasuraman [7] refers to attention as capacities or processes of how the organism becomes receptive to stimuli and how it may begin processing internal or external stimulation. During the last two decades, the fast development of new technologies like functional magnetic resonance imaging (fMRI) has shown neural circuitry in large-scale brain networks. This tells us there is communication back and forth in active networks in the cortical and subcortical brain regions [6] and leads to a neuropsychological shift from suggesting attention located in specific areas in the brain to understanding attention organised in active brain networks [8]. The new findings support Mirsky's theory suggesting several components or elements of attention [5]. Further, and important to educational settings, Mirsky suggested that the components could be assessed by neuropsychological tests [4]. Below I will present the components, also denoted elements, together with practical examples. Actual tests are mentioned for the first two components. Others [5] have given a broader overview of actual tests related to each element.

The Encode element "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" ([5], p. 298). To test this component, one of Mirsky's suggestions was Wechsler's subtest *Digit Span*. In this sub-test, the administrator reads some numbers, and the student is supposed to repeat the numbers in forward or backward order. Concerning Martha, she performed rather badly at this subtest. As school psychologists, we sometimes experience that 14- to 16-year-old students manage at the mean level of children aged from 6 to 8. For students who otherwise have the normal or above capacity in abstract thinking and other cognitive processes, it is frustrating to fall behind in the lessons. It can be stressing not to capture what the teacher says in messages of several paragraphs, for instance in the lower grades; "When you come home, you must tell your parents to read this information, and return the book on Monday" or "pick up your math-book, go to page 13 and start at task number 9". Thus, deficits

related to the Encode element may lead to learning difficulties in many subjects or specific subjects even though the student could have other cognitive capacities to intellectually understand and manage the tasks.

Another Mirsky component of special importance in schools is the *Focus/executive element*. Being able to focus is necessary for schoolwork, as it is in most circumstances in life. This component is about “the ability to allocate attentional resources on a specific task and to simultaneously screen out distracting peripheral stimuli” ([5], p. 299). Koziol et al. [5] continue by pointing to the importance of speed performance in this element: “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 (...).” Some students with learning disabilities experience that it is very difficult to screen out distracting stimuli. If the student is unaware of deficits in screening out external stimuli, it is my experience that this may result in anger outbursts when there are more noise and disturbances than bearable. Behavioural problems can often be a challenge to teachers, and therefore, the teacher needs to know each student and remember that the limit for what is bearable differ among those in class. Mirsky suggested using the Wechsler *Digit Symbol (Coding)* and the *Symbol Search* subtests to measure the *Focus/executive element*. These two subtests include time limits for performance, and hence, students who are fast working may perform well enough although they have problems with screening out disturbing stimuli in the classroom.

Also, the next three components may be useful for teachers to recognise. First, the *Sustain element* referred by Koziol et al. [5] 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). It is a typical teacher experience that this capacity varies a lot among students in class. Some students complete their tasks easily whereas others have challenges, maybe because they are distracted, or the task is not engaging to them. For children and adolescents diagnosed with ADHD, it is typical to have problems related to this element. However, if the task is perceived as really engaging, some may sit for hours reading, playing, or drawing [9]. Further, the *Stability element* tells us how reliable a student is in attentional efforts in performing a task. Does the student typically put efforts into doing the task or does the efforts vary from time to time? The last component to mention is the *Shift element*. This component is about flexibility in changing from one idea or activity to another, defined by Mirsky as “the capacity to move from one salient aspect of the environment to another” ([5], p. 299). Many individuals with attention deficits have problems because of rigidity. It can be perceived as painful to do a change in what you have planned to do, and sometimes the person needs time to be able to agree in a change. For teachers, this is of course a challenge. Nevertheless, it is useful for people in educational settings to know the struggle that may go on in the head and body of students who have problems with the *Shift element* of attention.

Some of the elements of attention mentioned above may have blurred boundaries with other cognitive capacities. Mirsky recognised for instance that the Shift element could be seen as a feature of executive functions ([5], p. 299). ‘Executive functions’ refer to several mental processes that control and organise other mental processes [10] which are crucial for planning complex behaviours and adapting to the situation [11]. In considering attention, it may also be useful for teachers and other professionals to have features of memory in mind. ‘Short term memory’ is the simple temporary storage of information whereas ‘working memory’ implies a combination of storage and manipulation ([12], p. 4). At the same time, both short-term memory and working memory differ from the permanent storing of information, denoted ‘long-term memory’, where information can remain for the rest of our lives ([2], p. 183).

For professionals like psychologists and educators to understand possible reasons leading to learning difficulties, I consider it an advantage to know some aspects of attention. With such knowledge and insights, you have a better chance to be able to help children and adolescents with impaired attention.

3. Attention, concentration, and learning difficulties

Compared to the huge neuropsychological literature on attention, there has been far less interest among scientists on the term 'concentration'. Sometimes the two terms attention and concentration are used interchangeably, both orally and in text. However, they are not synonyms although there might be some overlap between the concepts. In the last couple of decades before the millennium, neuropsychologists, especially in Germany, discussed how to differentiate the concepts of attention and concentration [13]. Translated to English, concentration was suggested to be defined as the "ability to work quickly and accurately under conditions that normally make cognitive performance difficult" ([14], p. 9). At the end of this section, I will discuss whether this suggested definition is adequate and appropriate related to observed and perceived concentration in school lessons.

Below I present and reflect on research done in a school programme intending to increase students' concentration [15]. All 12 students aged 10–16, had harmful concentration problems, that hampered their learning. Each student, the parents, and the teacher had to agree on the student's participation in the programme. When we talked with the students in individual tape-recorded interviews, some of them initially told us their concentration was fine, but later in the interview, they detailed out how they lost their concentration when something took place at the other side of the classroom [16].

The in-depth work with the qualitative material gathered before the intervention programme started, enwidened my insight into students with so-called concentration problems. Half the students had an ADHD diagnosis, some had dyslexia or other diagnoses, and some had no medical diagnoses. None was diagnosed with dyscalculia, although most of the students had challenges in Mathematics and clearly expressed that they disliked the subject [9]. We can look at one citation where the student finds it difficult to cope with arithmetic: "Mathematics, I don't like maths because it is very difficult ... for instance some multiplication and division tasks. But I know how to do it." This student had the self-confidence that the knowledge was there, that he/she *was able* to solve the tasks, but all the same, division and multiplication stood out as challenging.

Regarding foreign language (English), only one student liked this subject, half the students disliked it, and two of those claimed it was because of dyslexia. Among the subjects, there was one favourite: Physical Education (P. E.). Eight students spontaneously said they loved P. E. and they argued it was because of activity: "It is activity, and we get to be outside."; "Because then I can move around and such things."

However, for me as a professional (psychologist, researcher, and lecturer in teacher education) the diversity in the students' likes and dislikes of subjects was interesting. For instance, a subject that one student might appreciate, another disliked and vice versa. The authors could not find any pattern related to subjects except the ratios mentioned above on Mathematics, foreign language, and P. E. On the other hand, we found an interesting pattern when we related perceived concentration with the theory of play [17, 18] and the theory of motivation; the situated expectancy-value theory [19]. There was a clear relationship between perceived concentration and enjoyment (like we find enjoyment in the theory of

play as well as in intrinsic motivation). With higher enjoyment, the concentration was perceived as better, and when the student felt concentration was bad, the enjoyment was correspondingly low. The qualitative data indicated a high correlation, illustrated below in the previously published **Figure 1** [9].

What is special with this qualitative material? On one hand, the group is mixed, meaning that some students do not have medical diagnoses whereas others have one or more diagnoses. Both genders were included, seven boys and five girls, representing a relatively large age span from 10 to 16 years. Despite all those differences, we find the clear relationships presented in **Figure 1**. Another aspect I want to highlight from the empirical data is the importance of context versus content. Illustrated in **Figure 1**, we see that content is related to the whole range of concentration/enjoyment whereas the context was more important when the student had challenges with the tasks. To cope with those challenges, the empirical data showed both institutional strategies and personal strategies [9]. And worth noticing, all strategies were about shielding.

The institutional strategies are well known to educators. They included going to a separate room to work in small groups or individually with a teacher. Those students who told they had the opportunity to be alone with the teacher in some lessons or together with a few others, appreciated this situation. We found two reasons for their appreciation of the small room. First, they felt calmer because often there were many disturbances in the classroom, like one student said: “It is no problem if I sit by myself or together with only a few others. But if I sit in the classroom and there are many students talking I kind of become more interested in what they are doing.” ([9], p. 91). This corresponds to the Focus/executive element in Mirsky’s model of attention [5]. It was difficult for the students to screen

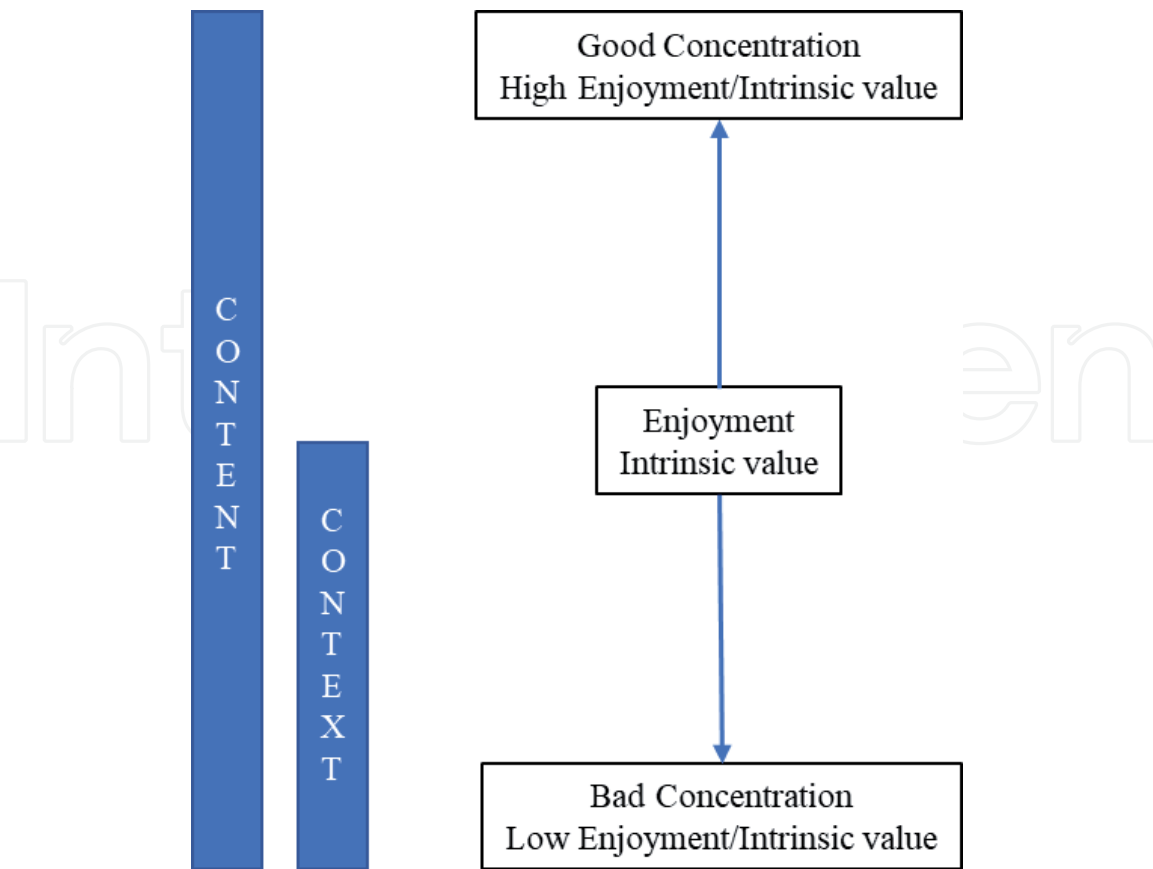


Figure 1.
The importance of content and context for concentration and enjoyment © Løhre, Vedul-Kjelsås, Østerlie ([9], p. 88).

out peripheral stimuli and simultaneously allocate attentional resources to their work. Additionally, the next reason was adapted help when needed, for instance in Mathematics. Municipalities and counties in Norway are obliged to offer special education to students considered to have this right [20]. However, it has for years been debated whether it is necessary to anchor special education as a right in the school laws. Some argue it is important to secure the rights of students with learning disabilities whereas others claim each school must support every student without binding resources to individuals [21, 22].

As we see, the institutional strategies included both mental and physical shielding. The personal strategies, on the other hand, were mostly some sort of mental shielding. Some students consciously paused from studying when they felt exhausted and unable to concentrate. Several of them started to draw or scribble and some raised to move around a little. The following citations ([9], p. 92) illustrate the students' autonomy in a shift of activities: "I cannot sit too long, then my concentration disappears, it does. Then I need to take pauses and such"; "[...] Oh, yeah, I need to have a little pause now and then."; "Then I take a few minutes off." Regarding this last citation, the interviewer asked what the student did in those "few minutes" and the student answered: "Draw a little. When I draw, I become quiet. My thoughts sort of disappear." The interviewer followed up the conversation and wondered if someone had suggested for the student to take pauses, upon which the student answered: "No, it's something I have found out for myself." The empirical data does not tell us if any of the other students' shifts in activities were agreed upon with the teacher, but obviously, teachers accepted.

From a professional point of view, I find the conscious shift in activities interesting. Like teachers who typically think students are daydreaming when they sit scrabbling on a paper and do not listen, I had thought the same when I was observing in classrooms. The finding of autonomous shifts was thought-provoking to me. I had often in my years as a school psychologist advised teachers to find ways to give a student pause when needed, for instance, leave the classroom to do something else, but it was new to me that impaired attention triggered some students to initiate pauses, almost to survive. Going back to Mirsky and the Encode Element [5], the exhausted student was not even able to register new information. In accordance with Danish findings [23], this shows us that classroom behaviour is not always what we think it is. The researcher who studied students with ADHD and their peers from a sociocultural perspective suggested that the behaviour and actions of students with ADHD often were intentional and led to interaction with peers in the classroom. Thinking of Martha, the little girl who introduces this chapter, I might have drawn the wrong conclusions the first time. I considered it obedient to eat grapes and spit stones on the floor. Perhaps she needed a mental pause. Talking with Martha thirty years or so later, she did not remember the grape episode, but reflecting around it she proposed the lesson might have been boring to her and therefore she started to eat the grapes.

Martha was a quick, smart girl and creative with a fabulous fantasy. She did the best to make her world funny. This is in line with what we found in the material with the 12 students [16]. Those with hyperactive behaviour often initiated something to have fun, and their high levels of activity were perceived as nurturing friendships. When the interviewer asked how friends would characterise him/her, one student answered: "hyper, funny and frisky" (p. 12). Concerning Martha, she did not have specific learning difficulties, no dyslexia or dyscalculia, but the impaired attention gave her challenges in learning. Hence, she did not go straight forward and finish an education. She needed more years than her peers.

At this point, I would like to go back to the earlier presented definition of concentration ([14], p. 9): "ability to work quickly and accurately under conditions

that normally make cognitive performance difficult”. We must keep in mind that the suggested definition was derived from experimental tests. For our purpose, we need to analyse the content, and therefore I divide it into parts:

1. ability
2. to work quickly and accurately
3. under conditions
4. that normally make cognitive performance difficult

I fully agree that ability (point 1) is necessary to be able to concentrate. This corresponds to Mirsky’s model of attention [4]; you need the ability to succeed in the different components. In terms of the second point, I think you should not ask a student with impaired attention to work quickly and accurately. In my opinion, the student must be allowed to work in an individual tempo to avoid getting stressed. The empirical material cited above [9], showed that some students consciously paused from studying when they felt exhausted and unable to concentrate: “I cannot sit too long, then my concentration disappears [...]”

The third point indicates *certain* conditions, *not all* conditions that we find in ordinary classrooms. The fourth and last point says those conditions are abnormal, as they normally make cognitive performance difficult. Surely, noise and movements might challenge concentration in classrooms, but this should not be the normal situation. Hence, the suggested definition above seems irrelevant to students with perceived concentration problems in school, although it might be valid in experimental test situations.

Concerning students with perceived concentration problems, our data, as well as field observations, indicate that both ability and effort are necessary to be able to concentrate. The term effort is what the person does and may comprise the person’s energy and motivation to engage. Based on the knowledge and experiences presented above, I suggest the following definition of concentration: the ability and effort to apply cognitive resources to an object or topic of interest. As proposed by others [13], I think there are overlaps between attention and concentration. Furthermore, the definition indicates that concentration is a broader concept that may include other cognitive resources in addition to attention.

4. The impact of laboratory interventions

Although associations of attention with academic achievements have been explored in population studies, including mixed groups, in municipalities [24, 25], most intervention studies measure effects on attention in selected groups. Three recent reviews report intervention effects among children and adolescents diagnosed with ADHD. Two of them are quantitative and one is a literature review, and all applied rigorous inclusion criteria.

The literature review [26] explored 29 studies published before April 2016. The authors looked at the effects of physical activity on cognitive capacities. They divided the material into cardio activities, such as cycling or treadmill running, versus non-cardio activities, for instance yoga. The cardio activities showed some improvements on various outcomes whereas the results of non-cardio activities were questionable. In terms of attention in children, the results were inconclusive. Some studies reported no effects whereas others found significant effects.

One of the quantitative reviews [27] also studied the effects of physical activity. This review included nine of the same studies as the literature review [26] above. The meta-analysis of 20 studies demonstrated no significant effects on children's attention, and there were neither any effects on academic achievements nor disruptive behaviour. However, the analyses showed significant improvements for internalising problems. In general, the cardio activities with running and cycling (here denoted aerobic activities) benefitted the children more than relaxation training and yoga (denoted non- aerobic activities).

Exploring studies with cognitive outcomes in several types of non-pharmacological interventions, the second meta-analysis [28] is of special interest to discussions in Section 5. With rigorous inclusion criteria including objective neuropsychological outcomes, the analysis comprised 18 out of 854 records published in the period 1980–2017. The authors had two research questions. First, they asked which non-pharmaceutical intervention was most effective for ADHD's cognitive symptomology and secondly, they asked which cognitive symptoms were most amenable to change (p. 42). The analysis showed physical exercise (Morris $d = .93$) to be most effective. Thereafter, followed cognitive behaviour training (Morris $d = .70$), neurofeedback (Morris $d = .61$), and cognitive training (Morris $d = .45$). The different types of interventions were not assessed in relation to specific cognitive functions, due to the low number of interventions. The results answering the second research question demonstrated attention and working memory to be least amenable to change. The highest improvements were seen for inhibition, followed by flexibility and higher executive functions.

In addition to the main analyses, the review [28] presents an overview of studies that specifically assessed attention outcomes (p. 52). These studies altogether produced 14 effect sizes, showing an average Morris $d = .41$. Among the various types of interventions, neurofeedback turned out to be one of the types with the highest effect sizes. This is interesting related to the findings in target shooting practice, reported below. Lambez and colleagues [28] acknowledge that the results reported in the review were limited to laboratory tasks and therefore, they recommend in a closing-up message that interventions should be performed outside the laboratories.

5. Interventions with target shooting practice

In accordance with the recommendation from Lambez and colleagues [28], target shooting practice is conducted in real-life situations. As far as I know, we find target shooting practice integrated with public-school education only in two Scandinavian countries. Denmark was the first country to introduce this type of intervention for students with ADHD or ADHD-like symptoms. In the years 2012–2015, altogether 462 students were included in the FOKUS project [29] where instructors participated voluntarily. As both students and leaders reported positive experiences, further research was planned [30].

The Danish initiative soon spread to Norway, and in 2014, a public school in Mid-Norway started an educational programme for students with harmful concentration problems [15]. The programme is still running, and the selection of students is based on the agreement between the student, parents, and the school, assisted by professionals in the counselling services. Students are recruited from classes 5 to 10, corresponding to the age-group from 10 to 16 years. All training takes place outside the school area, in localities about five minutes' walk from the school, and consists of theoretical lessons as well as shooting exercises. Step by step throughout the school year, the theoretical lessons prepare the students to improve in the target shooting practice. The theory includes how to behave, how to treat the weapon, and

how to breath to be able to focus on the target. And above all, security is highlighted. All instructors in the programme are certificated by the Norwegian Civilian Marksmanship Association (Det frivillige Skyttervesen, DFS), and both certificated teachers and certificated volunteers from the local club of the NGO organisation DFS participate.

At the shooting range, each student gets adapted help by one of the instructors, see **Figure 2**. Typically, the students appreciate the care and involvement they receive from the instructors. The young adolescents thrive and perceive mastery [15, 31].

Researchers at the NTNU Department of Teacher Education were hired to evaluate the implemented intervention. Data were gathered in the school year 2016/2017 and included questionnaires, individual interviews, observation at the shooting range, and objective neuropsychological tests [15]. Two qualitative publications on pre-data [9, 16], gathered before the seven months' intervention started, have already informed this chapter. Additionally, quantitative results have shown statistically significant improvements on neuropsychological tests [32]. To the best of our knowledge, those results are the first worldwide to show significantly improved attention after one school year of target shooting practice. Further, the improved attention corresponds to basic components in the Mirsky model of attention [5], indicating that the intervention made everyday life easier for the students. It must be added that controls showed no statistically significant improvements on the neuropsychological tests. Concerning the intervention students, qualitative post-data from individual interviews support the quantitative results [32]. Moreover, Danish results [33] have recently demonstrated increased differences between intervention students and controls on a couple of other cognitive tests, not included in our study.

Getting promising results after target shooting practice, urge us to analyse what can be possible active ingredients in the intervention. We have suggested [32] that immediate neurofeedback is one of the important ingredients. When the student shoots and the bullet reach the target, an electronic visualisation of the target, placed beside the student, immediately shows the result, see **Figure 3**. Supporting our suggestions, the importance of neurofeedback is shown in the review by Lambez and colleagues [28]. Otherwise, we think the whole package included in the intervention; theoretical lessons, and adapted help by caring instructors, contribute to the results.

Also of great interests, are qualitative Danish findings [34] that report inhibition of impulsiveness after two or more years with target shooting practice. Our preliminary findings [15] indicate the same. However, a one-year intervention is possibly too short to impact impulsiveness outside the shooting range. In accordance with the Danish



Figure 2.
Adapted help by the certificated instructor. Photo Trond Jære.



Figure 3.
Immediate response on electronic target. Photo Mona Isene.

findings [34], the Norwegian instructors underline that they see this sort of change in students who have participated in the programme for at least two years. Maybe the length of intervention time is one of the reasons why a review [27] found no effects of physical activity on disruptive behaviour. Except the length of intervention, another reason behind the promising Danish results [34] as well as the Norwegian instructors' experiences, maybe the theoretical lessons advising how to breathe and behave.

6. Implications for practice

I agree with Mirsky [4], who thirty years ago argued that impaired attention is a pervasive behavioural disturbance. Attention seems to be one of the ground pillars for learning. Having impaired attention the student will meet a lot of challenges, and so will parents and teachers. To help the student, there are two main roads to follow. One is to facilitate improved attention through interventions, and the other is to facilitate learning in the here and now situations.

The great variety among students with perceived concentration problems [9], points to the benefits of knowing each student. The teacher needs to know individual preferences and learn to understand signs of poor attention as well as individual signs of a student losing attention during work. This is of course a high-hanging star and aim to reach but anchored in the Norwegian school laws [20], school leaders and teachers must do their best to reach the aim.

Previous research [9] has shown the importance of enjoyment in subjects and tasks for students with perceived concentration problems. The better they enjoyed the subject, the better was their concentration, cf. **Figure 1**. Further, the students highlighted adapted help and shielding, in accordance with their preferences. It was obvious that students who were to be included in the target shooting programme, administered their pauses in class when perceived as necessary to calm down, like one of them said: "When I draw, I become quiet. My thoughts sort of disappear." This reminds me of the title: "ADHD attention deficit hyperactive disorder: an autobiography of survival" [35] and corresponds to autonomy as the suggested main force in motivation [36]. More autonomy could be given to students who struggle with impaired attention, – making agreements on self-regulated pauses and other individual learning strategies might create trust and strengthen the relationship between teacher and student.

At the first glance, ideas of student autonomy might seem to contradict previous recommendations [37] of structure and predictability for students with ADHD. Nevertheless, the two strategies can be combined, as exemplified in an ordinary public classroom [38]. Teachers make the frame and rules, and students fill the reserved time, for instance three hours, with self-chosen activities in the tempo and order they decide for themselves. Comprising the whole class, every child in class, is a great advantage of this educational programme, and as such, it is a health-promoting strategy aiming for thriving and wellbeing among all students. At the same time, there are some indications of better concentration for students with ADHD attending the programme [39].

For cognitive capacities in general, hard exercise has proved to be better than relaxing practices [26, 27]. Turning back to impaired attention, the theoretical and empirical knowledge we have to day points to specifically designed programmes to improve attention. Being recognised as one of the cognitive capacities most difficult to change [28], it is important to search for effective programmes. Interventions offering neurofeedback are among those with the most positive results [28]. In target shooting practice referred to above, immediate neurofeedback plays an essential role together with adapted help and caring. For countries that have target shooting sport in their communities, it might be an idea to initiate a partnership between local NGO shooting clubs, schools, and the municipality. The human resources found in the local shooting clubs in Denmark and Norway have provided valuable individual and adapted help at the shooting range, meaning a lot to young adolescents. Offering human resources, materials, and localities for free, the local NGO clubs additionally contribute to the school economy.

7. Further research and theoretical aspects

We have many challenges related to attention and impaired attention among students in educational institutions. First, the knowledge is scarce on the impact of attention in different age groups. Next, we need to do more real-life interventions to investigate possible effects on attention. Further, more controlled longitudinal studies are needed to measure the effects of target shooting practice.

Although our research on target shooting practice is small-scaled, it has opened some windows into the understudied world of attention in students, and opening windows, gives room for new questions: Are our results on improved attention reliable? Will studies in other communities and other countries show corresponding results? What about the time span; is more than one school year of target shooting practice necessary to observe changes in the classroom? With higher numbers of students included, will possible differences between age groups and gender be uncovered?

Aiming to improve attention with neurofeedback seems promising. Thus, alternative interventions comprising neurofeedback should be developed, for instance with computer-based programmes in schools. Moreover, we need to expand the knowledge on autonomy and self-regulation in students with impaired attention.

In a paper reporting on results after target shooting practice [32], we hypothesised that the sequential order in shooting is beneficial to students with impaired attention. Hence, the role of sequential order must be further investigated, and if this point is crucial, it could be adopted to other educational situations. Furthermore, it is interesting in a theoretical perspective to study the impact of sequentially ordered activities versus activities based on simultaneous handling. Do persons with impaired attention prefer and succeed better in sequentially ordered activities?

The last theoretical question for me to present is about relationships between attention and concentration. Will the suggested definition of concentration be reliable in other settings and is it appropriate to see concentration as a broader concept than attention?

8. Conclusion

In this chapter, I have highlighted that more students than those diagnosed with ADHD have impaired attention. This may apply to students with other diagnoses like dyslexia, dyscalculia, or for example, undiagnosed or not well-medicated hypothyroidism that can occur in childhood or adolescence. Thus, we understand that many students in school and an ordinary classroom may have challenges due to impaired attention.

To help students with learning disabilities, it is beneficial to have knowledge on attention. One main goal of this chapter was to inform professionals in educational institutions by illustrating attention through Mirsky's model of attention. Insight into the different components of the model can support teachers to better understand academic achievements, behaviour, and emotional reactions in students with impaired attention, and thus, give foundations for individually adapted teaching. For instance, realising that an otherwise smart 15-year-old student register and recall information (c.f. the Encode element in Mirsky's model) at the mean level of students 8-year-old, can be thought-provoking for the teacher.

The term concentration is widely used by students and teachers in Norwegian schools. In our research, concentration was closely linked to enjoyment in school-work, despite great variations among the students in a heterogenous community group [9]. On the other hand, concentration did not seem to influence wellbeing or friendship [16]. The terms concentration and attention are sometimes used interchangeably, but they are not synonyms. I have suggested a definition of concentration for natural settings.

Further, the chapter presents interventions designed to improve cognitive capacities. Attention is found to be among the capacities least amendable to change [28]. Nevertheless, a seven month's intervention comprising target shooting practice demonstrated increased attention on objective tests, and the results were supported by qualitative data [32]. Reasons of the success may be related to immediate neuro-feedback in a caring and educational context at the shooting range. The suggested effect of neurofeedback finds support in other studies [28]. Proposals for practical implications and further research are put forward.

In this text, my purpose was to write in a language understandable for professionals outside neuropsychological circles, and thus, reduce what is pointed to as a gap of knowledge [2] in the field of practice. Additionally, one goal has been to remind me and the reader about possibilities of turning impairment into success. *Just look back at Martha. Now she is about 40. She is well educated and recognised in her professional job. She has a lot of energy and gets things done. Her friends envy her energy.*

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