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The audio-psycho-phonological approach according to Prof. Tomatis in the treatment of children with attention disorders

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Summary

The facts reported here relate to a comparative case study based on data from four children diagnosed with ADHD. These children have benefited from a little-known treatment called the "audio-psycho-phonological therapeutic approach", based on the works of Alfred Tomatis (1995). The analysis of their respective listening tests shows a number of features that overlap with the results obtained independently by psychological questionnaires aimed at detecting deficits in the functions of attention, inhibition, emotional control, planning/structuring, working memory, hyperactivity and concentration. After about six months, two of the children treated had improvements in the processing of auditory perception as well as a reduction of attention problems, which also resulted in changes in the associated psychological characteristics, according to their parents' testimony. The results will be discussed with the perspective of designing a larger longitudinal study, aimed at verifying the effectiveness of this therapeutic approach when applied to children with attention disorders.

Keywords: *Intervention (audio-psycho-phonology), children, attention deficit, case study.*

Theory

The phenomenon of attention disorders in children, their specific clinical picture, diagnosis, therapeutic approaches, and the related pedagogical concepts and school support, are the subject of a certain number of in-depth synthesis works (see for example, Döpfner, 2015; Mackowiak & Schramm, 2016; Simchen, 2017; Wehmeier, 2015). The audio-psycho-phonological approach based on the work of the French ENT doctor Alfred Tomatis (1995) is a little-known empirical therapeutic approach for the treatment of children with attention disorders. This method, called A.P.P., consists in identifying and treating complex auditory processes and their impact on the physical and psychological dynamics of the subject (see Beckedorf & Müller, 2012; Vervoort, by Voigt & Van den Bergh, 2007; Vervoort & Vervoort, 1998).

The starting point is a specific hearing test ("Listening Test", cf. Vervoort & Vervoort, 1998, 2017) that reports its results in the form of an individual listening profile for the left ear and the right ear. The analysis of this profile indicates where the individual problems of the child are in the context of auditory perception and auditory processing. These problems may affect, for example, the child's ability for auditory selection, attention to and concentration on auditory stimuli, the ability to locate sound signals in space ("spatialization") or to differentiate auditory stimuli. A deficiency of one of these capacities may be at the origin of behavioral and developmental disorders in children (see Böhme, 2008, Vervoort & Vervoort, 2017). Here we also find domains that mark the clinical indicators of ADD and ADHD (attention, concentration, control of impulses) (see Vervoort & Vervoort, 2017). The listening profiles of children with attention disorders present a number of features that will be highlighted by the example of the case study ("Morten") illustrated in Figure 1.

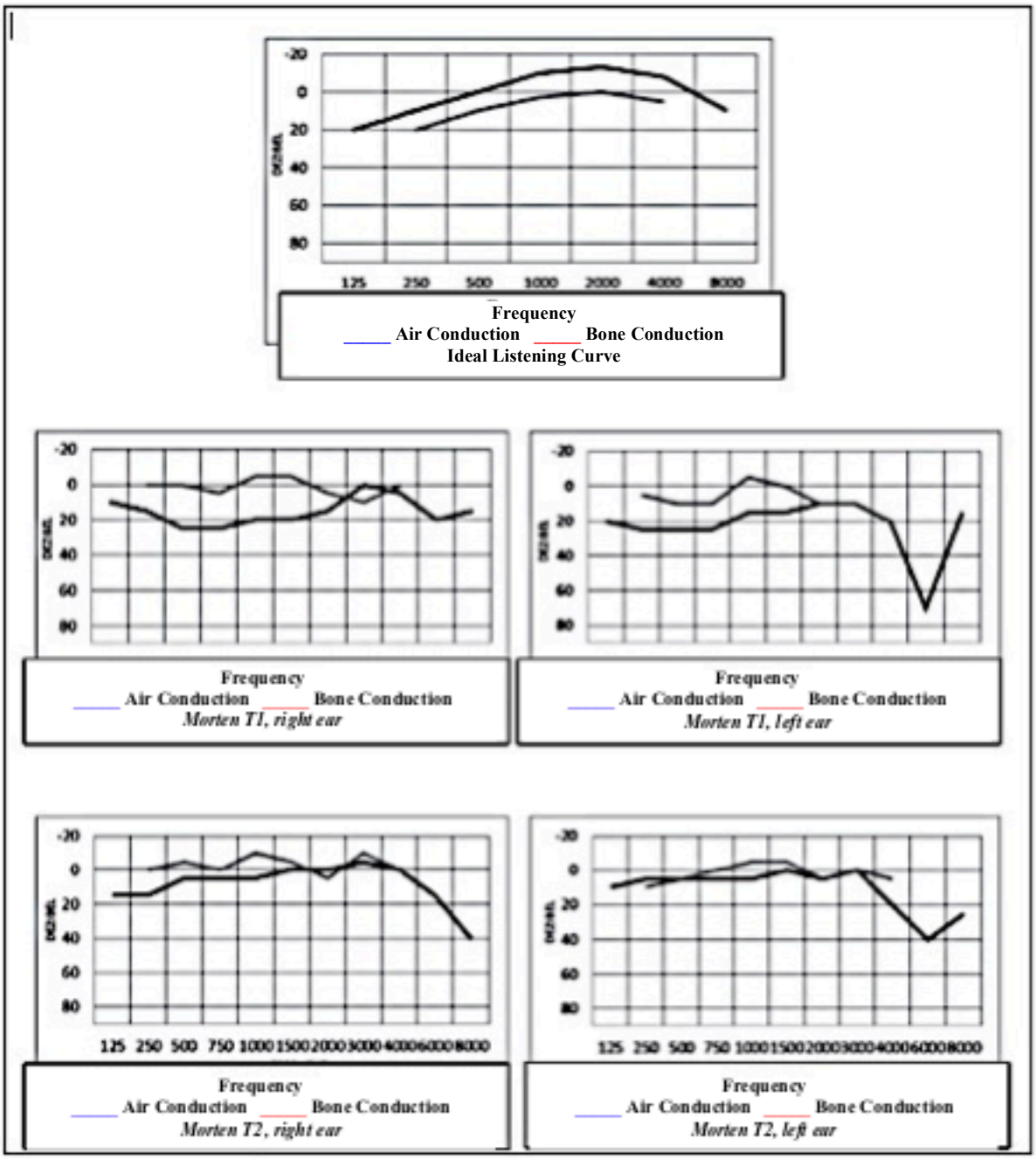

Figure 1: Representation of an ideal listening curve (top), Morten's listening curves at the time of the first (T1) and second listening tests (T2), right and left ear.

Here, we observe that, at most frequencies, the bone conduction (transmission of acoustic vibrations via the bones of the skull, for example when the subject listens to his/her own voice) is above the air conduction (aerial transmission of sound, for example when the subject listens to the voice of another person), which indicates a reinforced tendency to retreat into one's own acoustic world, thus paying little attention to one's surroundings. In addition, the left ear dominance indicates a more emotional

treatment of acoustic stimuli and emotional impulsiveness. Finally, the perception of low frequencies is too strong compared to the high frequencies, which indicates that the subject is quite agitated and easily distracted.

The basic operating principles of the A.P.P. approach, which has also an impact in the treatment of children with attention deficit disorders and inner restlessness, will only be briefly discussed in the present article (for more detailed presentations see Beckedorf and Müller, 2012 and Vervoort and Vervoort 1998, 2017).

As part of the A.P.P. treatment, the children listen to a selection of music tracks (Mozart, Gregorian Chant), to audio recordings of the mother's voice, or to their own voice, via special headphones. The recordings used in the course of the therapy are constantly modified via a system of electronic amplifiers and filters. This treatment can therefore be described as a form of brain stimulation by means of alternated listening (auditory impulses alternating in tone, frequency, volume and localization). This stimulation leads to a (re-) organization of the acoustic perception processes and to the improvement of neuronal processes. In this context, the stimulation of deep relaxation, attention and alertness also constitutes one of the key principles of A.P.P. At its core is the relationship between the sense of hearing and the autonomous nervous system. The A.P.P. therapy acts as a modulator in the interplay between the parasympathetic (relaxing, calming) and the sympathetic (toning, stimulating) (compare Vervoort & Vervoort, 1998, 2017). Over a period of time, low and high frequencies alternate, each alternation triggered by volume changes in the music. At the beginning, a gentle accentuation of the low frequencies in the music activates the parasympathetic nerve, which, overtime, helps the treated children calm down and better focus. Then, the emphasis on the high frequencies in the music stimulates the sympathetic nerve, which renders the children more vigilant and more attentive. Practice has shown that these alternations of frequencies improve attention and alertness, and in particular the attentiveness to language.

Subsequently, children learn to listen selectively and to better distinguish between important signals (such as the teacher's voice in the classroom) and background noise (Beckedorf & Müller, 2012). Another key principle of A.P.P. is the interaction between the bone conduction and the aerial conduction. This interaction is then differentiated and trained. At the beginning of the therapy, the listening profile of many children often shows a significant distance between bone and air conduction curves; in the course of the therapy, these curves tend to get closer to one another. This evolution points to a stronger integration of the self and of others. The gradual rise to the high frequencies is another key principle of A.P.P. The aim of filtering-out (suppressing) the low frequencies in the sound media (Mozart music, Gregorian chant, spoken words), is to stimulate the subject's desire to speak and to socially interact. In that context,

the repeated listening of the maternal voice (reading or singing), with the high frequencies accentuated, plays an important role. The positive impact of this approach can be interpreted as a maturation of the auditory processing and perception processes in the brain, which is also influenced by the subject's pre-linguistic and prenatal auditory experience (Vervoort & Vervoort, 2017).

This article presents the first results of an exploratory comparative study of the A.P.P. approach in the treatment of children with attention disorders. The objective of this pilot study is to explore a relatively new field of research, focusing primarily in generating new hypotheses, identifying relevant variables, and selecting appropriate data collection methods. The outcome should be to generate conceptual reflections for a long-term empirical study aimed at verifying the effectiveness of this therapeutic approach. The following is a detailed summary of the issues addressed in this exploratory study: (1) What patterns can be identified in each subject in relation to the main characteristics of ADHD, and can it be the framework of an assessment of the selected cases, in order to delimit subgroups by means of constellations of specific characteristics?

(2) How do the expert assessments, based on the analysis of the listening curves, overlap with the parents' assessment of the characteristics analyzed in the context of ADHD?

(3) What changes occur over time in the characteristics of ADHD being analyzed?

Methodology

The methodological approach here is the comparative case study (see Yin, 2014). The quantitative study is based on data from 12 children and their families, collected as part of a larger study of the A.P.P. therapy, which took place from March thru April 2015 (first data collection period, t1) and from September thru October 2015 (second data collection period, t2) at the ATLANTIS Therapy Center in Sint-Truiden, Belgium. The selection of the four individual cases was based on the diagnosis of the core symptoms of ADHD (inattention, impulsivity, hyperactivity), whereby all the children who were selected were, according to the parents, diagnosed with ADHD by a physician. All children were at the beginning of their A.P.P. treatment and lived with their birth parents; their mother tongue was German, and they all attended a regular school.

Differentiated samples:

Monika: Age (t1) 11 years 9 months, only child, 120 hours of treatment (t2), dyslexia. Judith: Age (t1) 11 years 3 months, has a 10-year-old sister, 126 hours of treatment (t2), delayed speech development, also had logotherapy sessions. Morten: age (t1) 9 years 8 months, has a 4-year-old sister, 117 hours (t2), wears hearing aid, also had occupational therapy. Lauritz: Age (t1) 11 years 3 months, has a 6-year-old brother, 120 hours of treatment (t2), congenital heart defect, and educational consultations due to behavioral problems.

At the beginning of treatment, the children receive a specific hearing (listening) test (see Vervoort & Vervoort, 1998). The results of the listening curves (see Figure 1) provide clues to the child's neurological, motor, and psychological characteristics. On that basis, an individual therapy plan is designed. A standard A.P.P. treatment plan looks like this: The first round of treatments usually takes about 12 days (three units of 90 minutes each per day). At the beginning of treatment we use the highly filtered recording of the mothers' voice. Later, we introduce selected pieces of music with specific frequency settings. While the children listen to the filtered mother voice, or to music, via special headphones, they can play quietly or draw, sit at a table, or sleep in an armchair. Beginning around the fifth day of treatment, the therapist introduces fine motor skills that children perform during listening, like playing with small balls or doing coordination exercises between hands and feet; children are also encouraged to perform motor skills exercises that prepare them to write, or to play with pearls.

For the second round of treatments, the children usually come for a five-day therapy program. The results reported below for the selected children refer to the period between the 1st and 8th listening tests (see Figure 1). At that point, the children had done approximately 130 hours of APP therapy, taking into account that, approximately every 18 to 20 hours of treatment, a new listening test was performed and that, depending on the test results, the parameters of the therapy may be modified accordingly. The assessment of the severity of the children's disabilities in the areas of concentration, attention, memory, restlessness and irritability, was made by analyzing the listening curves recorded on the first and second tests, on the basis of the established category system shown in Table 1.

The selection of characteristic areas relevant to this case study was based on the main symptoms of ADHD. Each listening test was performed anonymously (without knowing the name of the subject and the time the test was performed) and scored independently according to the description of categories (see Table 1) by three experts (experienced A.P.P. practitioners) on a scale of 1 to 5. The analysis of the listening curves was computed across all four investigated areas for the individual sample pairs using the Intra-Class-Correlation (ICC). ICC values of .95 (evaluator A-B), .85 (evaluator A-C) and .87 (evaluator B-C) were found to be very good to good. Since the impairment of executive functions is closely related to the core symptoms of ADHD, these feature areas were also considered in the case study. The children's executive functions impairments were measured by means of selected subscales of the German version of the Behavior Rating Inventory of Executive Functions (BRIEF) according to Drechsler and Steinhausen (2013), from the point of view of the parents (emotional control: ability to adequately modulate emotional reactions; working memory: retain information necessary to perform tasks; planning/structuring: plan solution steps to resolution and structuring the

information; Sorting-out/organizing: maintain order and appearance; verifying: control one's own work and/or its impact on others). Since ADHD is also characterized by specific abnormalities in the children's behavior, these characteristics are also relevant for the present case study. The children's behavioral problems according to the parents' points of view were assessed using the German version of the Strengths and Difficulties Questionnaire, SDQ-Deu (see Klasen, Woerner, Rothenberger & Goodman, 2003). The following scales were retained: Externalizing behavioral disorders, hyperactivity and attention problems, behavioral problems in dealing with peers and emotional problems as well as the overall value of the problem. The parents survey and the evaluations were carried out independently of the evaluators by university collaborators assigned to the project. The quality criteria of the data collection instruments can be considered acceptable (see the literature cited).

Table: Description of assessment categories for the analysis of the listening curves:

Evaluation Category[a]	**Description**
Concentration deficiency	Indicator of the extent of concentration deficiency: irregular plot of the bone conduction curve, right ear. Another indicator of such a deficiency is that the values measured in the lower frequencies in the bone curve are higher for both ears than the high frequencies values.
Attention deficit	Indicator of the extent of attention deficit: the magnitude of the distance between air and bone curves, for both ears, the bone conduction being higher in both cases.
Memory deficiency	Indicator of the extent of impairment of memory performance: presence of a dip (scotoma) at 4000 Hz on the air curve, or total drop of the air curve from 3000 Hz up, on left, right, or both ears. The presence of this indicator on one ear only is already a problem. If it exists on both ears, it's a serious deficiency.
Agitation, irritability	The level of agitation/irritability is indicated by a descent of the left and the right bone curves in the 250-500 Hz frequency range, or when the curves are higher in this frequency range than in the higher frequencies ranges. Other indicators include confusion between right and left in bone conduction and a descending air curve in both ears at 125 Hz. Even the presence of only one of these indicators signals internal agitation /irritability. If there are several indicators, agitation/irritability are particularly pronounced

Comments: [a] Evaluation scale (Deficiency: 1- none, 2- slight, 3- moderate, 4 - 5: strong to very strong; Agitation/irritability: 1- none, 2- slight, 3- moderate, 4 - 5: strong to very strong.

Table 2: Results of expert evaluations and parents questionnaires

	Monika	**Judith**	**Morten**	**Lauritz**
Evaluation of the listening curves[a]				
Concentration deficiency	t1 = 4.00 t2 = 4.00	t1 = 3.67 t2 = 3.33	t1 = 4.00 t2 = 3.00	t1 = 4.00 t2 = 3.00
Attention deficit	t1 = 4.00 t2 = 3.00	t1 = 5.00 t2 = 3.00	t1 = 4.00 t2 = 2.00	t1 = 3.00 t2 = 3.00
Memory deficiency	t1 = 4.00 t2 = 2.00	t1 = 2.00 t2 = 2.00	t1 = 4.00 t2 = 3.00	t1 = 2.33 t2 = 1.67
Agitation/irritability	t1 = 2.33 t2 = 4.00	t1 = 2.33 t2 = 2.33	t1 = 5.00 t2 = 2.00	t1 = 3.67 t2 = 3.67
BRIEF[b]				
Inhibition	t1: 68 t2: 58	t1: 74 t2: 77	t1: 54 t2: 52	t1: 77 t2: 80
Emotional control	t1: 53 t2: 55	t1: 55 t2: 58	t1: 70 t2: 48	t1: 60 t2: 60
Working memory	t1: 73 t2: 60	t1: 73 t2: 73	t1: 68 t2: 58	t1: 42 t2: 46
Planning/structuring	t1: 72 t2: 63	t1: 72 t2: 82	t1: 65 t2: 52	t1: 46 t2: 56
Sorting-out/organizing	t1: 58 t2: 52	t1: 67 t2: 67	t1: 64 t1: 57	t1: 47 t2: 47
Verifying	t1: 81 t2: 77	t1: 88 t2: 84	t1: 57 t2: 53	t1: 63 t2: 71
SDQ[c]				
Overall value of the problem	t1: Borderline t2: Normal	t1: Abnormal t2: Abnormal	t4: Abnormal t1: Normal	t1: Abnormal t2: Abnormal
– Behavioral problems toward others	t1: Normal t2: Normal	t1: Borderline t2: Abnormal	t1: Normal t2: Normal	t1: Abnormal t2: Abnormal
– Hyperactivity/attention	t1: Abnormal t2: Borderline	t1: Abnormal t2: Abnormal	t1: Abnormal t2: Borderline	t1: Abnormal t2: Abnormal
– Behavioral problems toward others children of same age	t1: Abnormal t2: Borderline	t1: Abnormal t2: Normal	t1: Normal t2: Normal	t1: Abnormal t2: Abnormal
– Emotional problems	t1: Borderline t2: Normal	t1: Abnormal t2: Borderline	t1: Abnormal t2: Normal	t1: Normal t2: Normal

Comments: t1: first data collection, t2: second data collection. a Scale of evaluation (deficiency: 1- none, 2- low, 3- average, 4- strong, 5- very strong) Agitation / irritability: 1- none, 2- low, 3- average, 4 to 5 strong to very strong). b Standardized T values (M = 50, SD = 10). c Categories: abnormal = PR> 90, borderline = PR 80-90, normal = PR <80.

Findings

Findings from the evaluations of the listening curves and the psychological conclusions (BRIEF, SDQ) for the four individual cases are shown in Table 2. On the basis of these findings, the four individual cases are presented below, with the individual feature constellations explained in more details and linked to the core symptoms of ADHD.

Monika suffers from major deficiencies in concentration, attention and memory, but her inner agitation and irritability are not very pronounced. The BRIEF result for inhibition (T = 68) clearly shows that Monika has a hard time holding back her impulses. In agreement with the judgment of the experts, the results of the BRIEF scale indicate a deficiency in executive functioning, associated with the main symptom of inattention. There is therefore a deterioration of the working memory (T = 73), i.e. the ability to remember the information needed to handle complex tasks. At the same time, she has a hard time planning steps for resolution and structuring the information (planning/structuring, scale T = 72) as well as verifying the completed secondary tasks (scale T = 81). Deficiencies in those areas are closely related to the main symptom of inattention (ADHD). Moreover, the range of SDQ values for hyperactivity and problems of attention and behavior towards other children is clearly apparent (PR> 90).

Judith, according to the expert analysis, has a pronounced attention deficit. In the same sense, her BRIEF results for working memory (T = 73), planning/structuring (T = 72), classification/organization (T = 67) and impulse control (T = 88) are closely related to her performance in terms of attention. A high inhibition value on the BRIEF scale (T = 74) indicates a marked impulsive behavior. The range of Judith's SDQ scores for hyperactivity and attention problems, behavior toward peers and emotional issues, is also significant (PR> 90).

Morten's results, shown on Table 2, indicate, according to the experts, strong deficiencies in the areas of concentration, attention and memory performance. These opinions correspond to the results of the BRIEF scales. The high values for working memory (T = 68), planning/structuring (T = 65) and classification/organization (T = 64) indicate significant deficiencies in these functional areas, which are close to the standard symptoms of inattention characteristic of ADHD. The high value of the BRIEF scale for emotional control (T = 70) indicates that Morten is struggling to properly regulate his emotions - an indication of emotional impulsiveness. The high values (according to expert judgment) in the areas of inner agitation/irritability are also striking. Finally, the values of the SDQ scales highlight the evidence of hyperactivity, as well as inattention and emotional problems (PR> 90).

Lauritz, the experts believe, suffers only from a deficiency in concentration. The BRIEF

results also indicate deficiencies in the areas of inhibition (T = 77) and emotional control (T = 60). It is therefore difficult for him not to react automatically in response to spontaneous impulses and to control his emotions appropriately, which indicates a high degree of impulsivity. With regard to the area of symptoms associated with Lauritz' inattention, the BRIEF results are in a deviating zone only for the "verification" scale (T = 63), indicating that he has difficulties in verifying his own performance. The high total value of SDQ (PR> 90) results from high scores on almost all subscales.

With regard to the characteristics examined for ADHD, not all four children have changes between the first and second data collections (see Table 2). For Monika, however, changes are visible in multiple areas. According to the opinions of the experts, her deficiencies in the areas of attention and memory have decreased considerably. In addition, impairments affecting the executive functions of inhibition, working memory and planning/structuring have also decreased. Hyperactivity and attention problems have also decreased, as well as behavioral problems with peers. Morten also shows significant changes over time. In the opinion of the experts, his deficiencies in concentration, attention and memory, as well as his inner agitation and irritability, have diminished. The same is true for the BRIEF scales in terms of emotional control, working memory and planning/ structuring. At the same time, his total SDQ score has also decreased, which could be due to a decrease of hyperactivity, attention problems and emotional problems. In contrast, for Judith, no significant changes were noted compared to the other symptoms, with the exception of a decrease in attention deficit. The same goes for Lauritz, who, apart from a reduction of concentration problems (according to the experts' judgment), doesn't show any changes in the problem areas examined.

Conclusion and perspectives

The rating method used for the analysis of the listening curves for the assessment of concentration, attention, memory, inner agitation and irritability, has proved to be a reliable instrument to grasp the relevant characteristics of the main symptoms of ADHD (inattention, impulsivity and hyperactivity). At the same time, it has been demonstrated that the results obtained by this rating process correspond to a large extent to standardized psychological test scores in comparable domains, providing an indication of the validity of the procedure.

An important objective of a comparative case study is to determine similarities and differences between the cases studied. Incidentally, in this instance, the four cases revealed, at the beginning of A.P.P treatment, a clear deficiency in concentration, and a limited ability to verify tasks, high hyperactivity, and serious attention problems. Those problems clearly refer to the main

symptoms of ADHD. In addition to these similarities, however, very distinct constellations of characteristics were found in each subject, confirming the rather heterogeneous nature of ADHD and associated disorders. This highlights the need for individual diagnoses and differentiated concepts of education and school support (see Mackowiak & Schramm, 2016).

As for changes in the context of A.P.P. the characteristics examined revealed very different evolutionary processes between the two periods of data collection. On the one hand, two of the children (Monika and Morten) clearly showed positive changes in the characteristics studied for the three main symptoms of ADHD. It can therefore be assumed that these symptoms can be reduced in the context of A.P.P. under specific starting conditions, and that positive developmental trajectories can therefore be supported (see Schiftan et al., 2012). On the other hand, the other two children (Judith and Lauritz) recorded very little changes in the characteristics studied during the investigating period. Conclusions from additional observations in the overall study, not mentioned in this article, clarify other relevant characteristics. For example, Judith has obvious deficits in terms of cognitive performance (below average intelligence), which could explain the persistence of attention deficit.

Lauritz appears to be experiencing persistent behavioral problems, which seem to be related to a high level of family conflict and unfavorable parental behavior toward the study as a whole. In terms of A.P.P. treatment, this could mean that the efficacy in reducing ADHD symptoms is limited by the presence of such factors as the child's overall cognitive development status or serious social risks. These characteristics should therefore be considered as relevant control variables in the planned longitudinal study.

The A.P.P. method could also be applied to children with attention deficit disorders in the school context. This goal has already been achieved with great success in several primary classes in Belgium and Poland (see Vervoort and Vervoort, 2017). However, the limitations of this pilot study are also subject to criticism since the design of this research project is based on a small population, which furthermore, was not selected at random. Therefore, the results are difficult to generalize. In addition, third-party variables (such as general developmental processes) could not be controlled in the review of the effectiveness of the treatment. Finally, concerning the survey methodology, we must keep in mind that the results presented are based solely on external assessments (expert evaluations, parental perception). This approach being open to criticism in terms of the validity of the results, the planned longitudinal study will have to rely more on psychological tests carried out directly with the children.

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