Intelligence profiles of children with atopic dermatitis.

Measured by the WISC-III.

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Abstract

Atopic dermatitis (AD), also known as constitutional eczema, is a common inflammatory skin condition that causes itchy, red, and irritated skin. These symptoms associated with AD, such as itching, skin pain, sleep disturbances, and fatigue, can interfere with the mechanism behind executive functioning and the intelligence in children. Understanding the relationship between AD and intelligence is important for developing effective interventions and support for children with AD. This study explores the potential effects of AD on the intelligent profiles of children. To measure these relationships the WISC-III was administered to 55 children to measure their intelligence and analyze their intelligence profile. They were compared to a norm group based on the literature of the WISC-III. It was hypothesized that there will be peculiarities within the intelligence profile. The results show that no significant differences have been found in the total intelligence score and the processing speed. The results, however, did show a significant difference in score withing the verbal IQ and performal IQ. A significant higher verbal IQ score was obtained by the children with AD. Also 48.2% of the participants had a disharmonic intelligence profile. Preliminary findings suggest potential strengths and weaknesses withing the intelligence among children with AD, but further research is needed to establish more insight in executive functioning. Identifying cognitive peculiarities in children with AD can inform tailored treatments and interventions to optimize their treatment.

Introduction

Atopic dermatitis (AD), also known as constitutional eczema, is a common inflammatory skin condition characterized by itchy, red and irritated skin. It affects both children and adults and has a significant impact on the quality of life of those who suffer from it. 3-5% of all children in the Netherlands are diagnosed with atopic dermatitis (Atopic Eczema / Constitutional Eczema, 2022). AD is a heterogeneous condition often associated with symptoms such as itching, skin pain, sleep disturbances and fatigue. These symptoms can potentially have a negative impact on executive functioning and intelligence (Silverberg et al., 2020; Yu et al., 2023).

Intelligence is a complex and intriguing concept. It refers to an individual's ability to grasp knowledge, solve problems, reason logically, learn from experience and adapt to new situations (Goldstein et al., 2015). While intelligence is a ubiquitous part of our daily lives, it is challenging to precisely define and measure it due to the many facets and nuances associated with it. Various theoretical approaches have attempted to understand and explain intelligence.

One such approach is the Cattell-Horn Carroll model (CHC), which posits that intelligence can be understood and assessed based on performance on tasks related to skills (Schneider & McGrew, 2012). These different skills are identified as important components of intelligence such as; verbal skills, working memory, processing speed, spatial awareness and performal skills. Verbal skills include understanding and using language, such as vocabulary, grammar, and the ability to understand and express information. Memory refers to the ability to remember information and recall it later. Processing speed refers to the speed at which someone can process information and perform tasks. Spatial awareness refers to the ability to mentally imagine and understand objects and spatial relationships. Performal skills include the ability to reason logically, make connections, and apply efficient strategies to solve problems (Kaldenbach, 2007; Kort et al., 2005).

One of the most used tests for assessing intelligence in children is the Wechsler Intelligence Scale for Children (WISC) (Kort et al., 2005). This test evaluates several aspects of intelligence, including verbal skills, perceptual reasoning, working memory, and processing speed. Through standardized tasks and questions, the WISC provides an IQ score that compares a child's performance to peers. IQ is often used as a measure of a person's general intellectual abilities. An intelligence profile in the WISC-III provides an overview of the child's various cognitive abilities. The test assesses different aspects of intelligence, including verbal skills, performance skills, and processing speed. The profile includes a series of subtests that measure various aspects of intelligence, such as vocabulary, similarities, picture completion, coding, block design, and more. The intelligence profile of a child on the WISC-III can be used to identify strengths and weaknesses in their cognitive abilities and to aid in understanding their learning potential and educational needs (Kort et al., 2005).

Understanding and measuring intelligence is of great importance in various contexts, such as education and the study of individual differences in performances. It can help identify individuals' strengths and weaknesses, assess educational needs, and develop appropriate interventions. In addition, the concept of intelligence may also be relevant to understanding more in-depth cognitive development and the complex relationship between biological, genetic, and environmental factors that contribute to overall intelligence.

While this approach to specific skills and tests such as the WISC can provide valuable insights, it is important to note that intelligence is a complex phenomenon that cannot be fully understood by focusing on these aspects and skills alone. There are other theoretical perspectives and models that provide a complementary view of intelligence, such as the concepts of multiple intelligences and the triarchic theory of intelligence. In addition, contextual factors, such as cultural differences, social environment and motivation, also play an important role in the assessment of intelligence (Mayes & Calhoun, 2004; Freis et al., 2021).

Executive functioning is also a critical component of intelligence, and it plays a crucial role in our ability to learn, adapt, and succeed in various domains of life. Executive functions are closely related to other cognitive processes, such as working memory, attention, and inhibition, which are also essential for intelligence (Taylor & Zaghi, 2021; Bertelli et al., 2018). Individuals with strong executive functioning skills tend to be better problem-solvers and decision-makers. They can plan, organize, and execute complex tasks efficiently, monitor their progress, and adjust their approach when necessary. In contrast, individuals with weak executive functioning skills may struggle with these tasks, leading to poorer outcomes in academic, professional, and personal domains (Teivaanmäki et al., 2019; Smirnova et al., 2018).

Intelligence tests measure various aspects of skills, as mentioned in the paragraph above. Executive functioning plays an important role in the efficient use of these skills during the intelligence tests (Nikolašević et al., 2020; Buczylowska et al., 2020). Children with strong executive functions often have better performance on intelligence tests. For example, they can plan and organize effectively, remain attentive throughout tasks, suppress impulsive behavior, and use strategies to solve problems. These children are able to focus their attention on the relevant aspects of the test and carefully consider their answers, helping them achieve higher scores. On the other hand, children with weaker executive functions may have difficulty concentrating, acting impulsively, organizing tasks, and applying goal-directed strategies during the test. This can result in lower scores, even if they have sufficient intellectual capacity.

A longitudinal study by Segundo-Marcos et al. (2022), shows that it is important to note that executive functioning and intelligence are separate concepts, but they are closely related. This has been established through neuropsychological research within the study. Strong executive functions can increase a child's ability to use his or her intelligence effectively, while weaker executive functions can hinder this ability. Therefore, when interpreting children's intelligence test results, it is essential to consider the role of executive functioning.

In the context of severe eczema, deficits in executive functioning can further exacerbate the challenges individuals face in managing the condition. Also, the symptoms associated with eczema can influence the mechanisms behind executive functioning. Itching is one of the most common symptoms of eczema. The inflammatory response in the skin in eczema activates the itch nerve fibers, resulting in a strong urge to scratch. Itching can be intense and can lead to constant scratching, which can further damage the skin and exacerbate inflammation. In severe cases of itching, the skin may feel painful. The inflammation and irritation of the skin can lead to a burning or stinging sensation. The skin can also be sensitive to the touch, so even light pressure can cause discomfort (Lewis-Jones, 2006). This itching and skin pain can cause significant distress. When itching and skin pain persist, they can create distractions and divert attention from cognitive tasks (Strom et al., 2016; Yu et al., 2023). The constant urge to scratch or the painful sensations can affect concentration and focus, making it more difficult to think clearly and perform tasks efficiently. Itching and skin pain also impact emotional well-being. Chronic itching and pain can lead to feelings of frustration, irritation and anxiety. These emotional reactions can in turn affect other skills, such as the ability to think clearly, make decisions and regulate emotions (Evers et al., 2007; Camfferman et al., 2013). Prolonged itching and skin pain can then also lead to sleep disturbances, fatigue and increased stress levels, all of which negatively affect the executive functioning and intelligence.

The itching and skin pain associated with eczema can make it difficult to fall asleep and get a good night's sleep. Many people with AD experience increased itching in the evening and night, which can lead to repeated awakenings and disrupted sleep. This lack of sleep can lead to fatigue and reduced daytime functioning (Li et al., 2018). A good night's sleep is essential for brain recovery and optimal functioning. When there are sleep problems, such as insomnia, it can lead to impaired concentration, memory problems and a reduced ability to learn and remember new information (Behrens et al., 2023). One of the main mechanisms behind the impact of sleep disorders on executive functions is disrupted sleep architecture. During sleep, we go through several sleep stages, including Rapid Eye Movement (REM) sleep and non-REM sleep. Each phase has a specific function and contributes to different aspects of executive functioning (Yoo et al., 2021). Sleep disorders can disrupt the normal transition between these phases, resulting in patchy sleep, frequent interruptions and reduced total sleep time. Another mechanism is the disruption of sleep-related neurochemistry. During sleep, various neurotransmitters and hormones are released that play a role in the regulation of executive functioning. In sleep disorders, these chemical processes can become disrupted, resulting in an imbalance of neurotransmitters such as dopamine, serotonin and norepinephrine (Fishbein et al., 2018). This imbalance can lead to impaired attention, delayed thinking, impaired working memory and difficulties in decision making. In addition, sleep deprivation also affects the prefrontal cortex, the area of the brain responsible for carrying out executive functions. Studies by Fishbein et al. (2018) and McKenzie et al. (2020), have shown that sleep deprivation leads to reduced activity and dysfunction in the prefrontal cortex, causing difficulties in regulating impulses, planning tasks, adapting to change and maintaining goal-directed behavior. In addition, prolonged sleep deprivation can increase the risk of errors, especially in activities that require alertness and rapid processing.

Cross-sectional research by Thyssen et al. (2023) shows that persistent itching, disrupted sleep, and emotional stress associated with having eczema can lead to fatigue. Constant itching and discomfort can drain energy, and the lack of proper sleep can affect recovery and energy production. In addition, the psychological impact of having a visible skin condition can also contribute to fatigue and emotional exhaustion. Fatigue, both physical and mental, can play a major role in executive functioning. Fatigue can result from several factors. Fatigue can lead to sluggish thinking, impaired concentration, impaired memory and problems with decision-making. In addition, persistent fatigue can reduce motivation and productivity, further hindering the ability to perform tasks successfully (Tinajero et al., 2018).

Itching, skin pain, sleep disturbances and fatigue can all significantly affect the executive functioning. These symptoms and conditions can negatively affect attention and concentration, memory, executive functions and overall cognitive performance (Silverberg et al., 2020; Jackson-Cowan et al., 2021). Understanding this connection is critical to be able to reduce its impact and implement effective measures to improve the executive functioning.

Peripheral inflammation and executive functioning

Also, developing brains are susceptible to peripheral inflammation that can be caused by atopic dermatitis (Esaki et al., 2016). Indeed, atopic dermatitis is associated with over expression of TH2 cells due to inflammation in the skin. These TH2 cells may subsequently modulate immune activation in the hippocampus (Jackson-Cowan et al., 2021). The hippocampus, a crucial brain region for memory and learning, may be affected by the immune response induced by atopic dermatitis. This immune activation can lead to disruption of neural processes, such as synaptic plasticity (the flexibility of connections between neurons) and neurogenesis (the formation of new nerve cells). These processes are essential for executive functioning, including memory formation and learning performance (Esaki et al., 2016). Disruption of synaptic plasticity can lead to difficulties in forming and retaining new memories. It can also affect the brain's capacity to process and integrate new information. Moreover, disruption of neurogenesis may reduce the brain's regenerative capacity, which may affect children's ability to form new neural networks and adapt to changing environments (Jackson-Cowan et al., 2021).

As a result of these disruptions in neural processes, children with atopic dermatitis may potentially experience challenges in executive functioning. This may manifest as problems with attention, concentration, information processing, memory, and other learning abilities. Which in turn can affect their intelligence. It is important to recognize that these effects will not occur in all children with atopic dermatitis and that individual variations and other factors may also play a role (Esaki et al., 2016; Jackson-Cowan et al., 2021).

Aim of the study

Several studies have already examined the relationship between the intelligence profile or executive functioning in children with other chronic diseases such as asthma, but few have investigated the relationship between atopic dermatitis and intelligence. By defining this relationship, effective measures can be taken to optimize the treatment and school performance of children with AD. Children with AD face many more problems than just the skin. There are also psychosocial issues at play in this target group such as stress, social isolation, behavioral problems and sleep disorders (Morawska et al., 2023). There is also the clinical impression from the clinic at Erasmus MC that this group of children is overestimated in their environment, because they come across as verbally strong. Insights on intelligence, executive functioning and cognitive ability are important for the treatment of these children. On this, the approach to treatment can be better adapted to the child.

This study aims to investigate the intelligence of children with severe AD compared to the control group from the literature of the WISC-III. Also, through this study, any issues within this treatment group can be looked at from a different perspective other than just physical symptoms. If there is a specific profile in these children, this is important for practitioners to know. They can take this into account when dealing with common problems within the target group. However, many self-managed cognitive issues can hinder this.

It is important to investigate how the symptoms of AD such as itching, skin pain and the severity of eczema may affect the intelligence. In this context, the research question of this study is: *"Are peculiarities evident in the intelligence of children with severe or difficult-to-treat eczema?"*

Previous studies show that the above symptoms and overexpression of TH2 cells in the hippocampus in children with severe AD may have a negative impact on executive functioning (Silverberg et al., 2020; Camfferman et al., 2013). Based on these findings, it is hypothesized that the executive functioning, and therefore the intelligence also, will be impaired in children with AD. It is reasonable to assume that children with atopic dermatitis will score lower on the total intelligence quotient compared to the norm group, given the abnormal or reduced executive functioning observed in children with AD. In addition, it will be expected that peculiarities will be found in the intelligence profile, such as a disharmonic intelligence profile. To investigate this research question, it is important to conduct a structured study evaluating the cognitive performance of children with atopic dermatitis, possibly using standardized tests and intelligence measurement instruments.

Methods

Participants

This study focuses on children living in the Netherlands with difficult-to-treat AD who cannot sufficiently control their disease with current treatment strategies. Children between the age of 8 and 18 were eligible to participate in the study if they were: diagnosed with moderate to severe AD and fluent in the Dutch language. 55 children between the ages of 8 and 17 years took part in the study. The mean age of the total group of children was 12.59 years (SD = 2.57). 60% of the participants were boys (N = 33) and 40% of the participants were girls (N = 22).

Procedure

Children and/or their parents who were interested in the study could register directly via email. A questionnaire with items about allergic complaints, use of (topical) immunosuppressive therapy such as corticosteroids, and more specific questions about AD activity (including a self-completed eczema area and severity index (SA-EASI), questions about nocturnal itching and, if relevant, questions about asthma, rhinitis and food allergy complaints had to be answered in order to register. The degree of itching was classified into 4 number categories 0 = no itching, 1 = mild itching, 2 = moderate itching, 3 = a lot of itching, 4 = severe itching.

Potential study participants were invited by the dermatologist to the outpatient clinic and assessed for suitability. They did not have to stop or change their medication. Children who met the inclusion criteria were then informed about the study. If they were interested in participating in the study, they were invited for a full evaluation by the multidisciplinary team of the Wilhelmina Children's Hospital and informed consent was signed.

Prior to the administration of the test battery, the parents of the children are asked for their permission to administer the tests. This was recorded by means of a consent statement. In the informed consent form, the parents confirmed that they had been adequately informed about the study, that questions could be askes and were properly answered, that they had had sufficient time to think about participation, and that they were participating in the study with their child of their own free will. By signing the informed consent, they have agreed that the data collected from both parents and children will be obtained for scientific purposes only and will be carefully stored. Furthermore, they have agreed that the anonymous research data collected from both the parents and the children bay me shared and/or re-used by scientists for another research.

The WISC-III NL was administered by a diagnostically trained psychologist. The entire rest was taken in one setting. To avoid distraction, the test was conducted in a quiet, well-ventilated area where only the child and the test taker were present. The table at which the test was administered had a smooth surface, a height adapted to the child and position so that the researcher sat directly in front of the child.

Measures

A pragmatic, randomized, controlled study was set up in collaboration with the Department of Pediatric Dermatology/Allergology of the Wilhelmina Children's Hospital. The aim of this study was to find the most effective treatment strategy for children with AD that is difficult to treat. Within this study, an intelligence test (WISC-III) was administered. The third edition of the Wechsler Intelligence Scales for Children (WISC-III) is a child intelligence test in the Netherlands and Flanders. This intelligence test is intended for children aged 6 to 16. The WISC-III consists of 13 subtests. Table 1 provides an overview of the subtests with their abbreviations and intelligence aspects.

Some tasks appeal more to skills related to language (the verbal tasks are in the verbal scale and the verbal IQ score) while other subtests involve more action-oriented tasks ('do-tasks'), involving good vision, spatial insight, overview, and motor skills (the non-verbal tasks are in the performal scale and the performal IQ score). Several non-verbal tasks involve recording time. In this case, not only is the quality of a performance important, but also how long a child takes to reach this result. This allows to indicate the processing speed. The speed of visual information processing, visual associative memory and visual matching. On all subtests, the tasks are increasing in difficulty. It is assessed up to which level a child manages to keep up and when it becomes too difficult (Kort et al., 2005).

Table 1

Overview of the subtests with their abbreviations

Subtest	Abbreviation	Intelligence aspect
Incomplete drawings	*OT*	Performal IQ
Information	*IN*	Verbal IQ

Substitition	*SU*	Processing speed
Similarities	*OV*	Verbal IQ
Sorting images	*PO*	Peformal IQ
Calculating	*RE*	Working memory
Block patterns	*BP*	Performal IQ
Word knowledge	*WO*	Verbal IQ
Figure laying	*FL*	Performal IQ
Understanding	*BG*	Verbal IQ
Comparing symbols	*SV*	Processing speed

Subtest scores and IQ

On each subtest of the WISC-III, a child achieves a subtest score (often referred to as a "norm score" or "standard score"). This can range from 1 to 19, the better the performance, the higher the score. The exact mean is 10, which means that most children of the same age get a score close to 10. In large groups of children, the average deviation from this average is 3 points, this says something about the spread of scores (Kort et al., 2005). The meaning of these subtest scores can be found below in Table 2.

Based on these norm scores, a total score is calculated, the TIQ. This consists of three scores, namely the total score, the score of the performance IQ and the score of the verbal IQ. The TIQ ('Intelligence Quotient') is a number that expresses how 'intelligent' someone is. The exact mean of an IQ is 100 with a standard deviation of 15 points. The most commonly used classification of IQ scores and what they mean can be found in table 3. Both subtest scores and IQ scores say something about how the child performs compared to other children of the same age (a maximum of a few months difference in age). This means that the same performance at different ages also gives different IQ scores (Kort et al., 2005). However, a full test provides a complete picture, not all subtests are necessary to determine the TIQ.

Table 2

Subtest scores interpretation

Score	Description
>15	Very good
13-15	Good
8-12	Average

5-7	Weak
<5	Very weak

Table 3

Classification of IQ-scores

Score	Description
>130	Highly gifted
120-129	Gifted
110-119	Above average
90-109	Average
80-89	Below average
70-79	Low gifted
<70	Minor menal disability

The WISC-III NL was assessed by COTAN in 2005 (Egberink & de Lenk, 2005). The norms, reliability and concept validity are adequate; the criterion validity is inadequate. To begin with, the sample is strong with which the test is normed. The standards established for the WISC-III-NL are based on 1239 children from Flanders and the Netherlands divided into eleven age groups. This sample takes into account a number of important aspects that in themselves can cause differences, such as gender and cultural background. The reliability and validity of the test are good enough to use the test.

Analysis

The research question that has been studied in this research is: *"Are peculiarities evident in the intelligence of children with severe or difficult-to-treat eczema?"* This is an exploratory research question as the data obtained provided information about the intelligence profiles of children with severe eczema.

The dependent variable in this study is the total IQ score (TIQ). This is further subdivided into the verbal IQ score (VIQ), the performal IQ score (PIQ) and processing speed (VS).

The required data are collected by administering the WISC-III. The collected data was entered into the program SPSS. A one-sample t-test was be used to compare the calculated IQ scores with the mean of 100, this is again from the norm group based on the literature of the

WISC-III (Kaldenbach, 2007; Kort et al., 2005). This involved creating a histogram of the TIQ, the VIQ, the PIQ and VS. In addition, another one-sample t-test was used to perform a profile analysis to see if scores on specific subtests are different from those compared to the norm group. Because multiple t-tests were done on a lot of related scores, a correction was made for multiple testing. By means of probability capitalization with the Dunn-Sidak correction, the p-value has been reduced to $p = .005$.

The independent variable in this study are the severity of eczema and the degree of itching. The severity of eczema is an interval variable, and the degree of itching is an ordinal variable. On the severity of eczema, participants could score from 0 to 100. A Pearson correlation was performed to determine the degree of statistical correlation between eczema severity and TIQ. The degree of statistical correlation of the severity of itching and TIQ was analyzed by Spearman correlation. A p-value = < 0.05 was considered significant.

Any discrepancy between the VIQ and the PIQ in the participants' intelligence profiles is examined, as well as the frequency which this occurs. The average IQ of the participants was examined by school level to see if it corresponded to the total IQ score. The school levels are divided into: VMBO basis and kader, VMBO gemengd and theoretisch, MBO, HAVO and VWO.

Results

Descriptive statistics and data-inspection

Table 4 shows the descriptive statistics for all the variables in the one-sampled t-test. The table shows the mean IQ scores of total IQ (TIQ), verbal IQ (VIQ), performal IQ (PIQ) and processing speed (VS). It is notable that a higher average score on the verbal IQ scale was obtained.

All these variables were normally distributed. The scatterplots showed that there were no outliers present that possibly would strongly impact the results.

Table 4

Descriptive statistics of all the variables in the one-sampled t-test

Variables	N	Min.	Max.	Mean (M)	SD
TIQ	56	70	138	99.12	15.84
VIQ	56	74	133	103.86	15.06
PIQ	56	61	133	94.32	16.68

VS	56	62	135	95.24	15.34

A one-sample t-test was conducted to compare total IQ scores, verbal IQ scores and performal IQ scores with a test-value = 100. This test-value is based on the mean of the norm group from the literature of the WISC-III (Kaldenbach, 2007). The analyses in Table 5 shows that no significant difference can be seen within the total IQ scores, p =.340. This means that there is no significant abnormal difference seen in the total intelligence profile of children with AD. Also, no significantly lower score was obtained within the processing speed, p = .445. However, there is a significant difference seen in verbal IQ, p = .030 and performal IQ p = .009. This means that within the verbal IQ a significant higher score was obtained. Within the performal IQ, a significant lower score was obtained by the children with AD.

Table 5

Results of one-sampled t-test of TIQ, VIQ, PIQ and VS

	N	t	df	Sig.
TIQ	56	-.413	55	.340
VIQ	56	1.916	55	.030
PIQ	56	-2.460	55	.009
VS	56	-.114	51	.455
Test value = 100				

Table 6 shows the results of the one-sample t-test of the specific subtests on the WISC-III. Because multiple t-tests were done on a lot of related scores, a correction was made for multiple testing. By means of probability capitalization with the Dunn-Sidak correction, the p-value has been reduced to p = .005. The difference in mean score on the figure laying p = <.001 was significant. This suggests that children with AD scored significantly lower on this subtest than compared to norm group.

Table 6

Results of the one-sampled t-test of the specific subtests on the WISC-III

Subtests	Measurement pretense	df	N	Mean	*p*
Incomplete drawings	Perceptual reasoning	52	53	9.62	.191

Information	Verbal understanding	52	53	10.66	.049
Substitution	Processing speed	52	53	9.49	.094
Similarities	Verbal understanding	52	53	10.74	.019
Sorting images	Perceptual reasoning	52	53	9.40	.086
Calculating	Working memory	52	53	10.26	.225
Block patterns	Perceptual reasoning	52	53	9.79	.307
Word knowledge	Verbal understanding	52	53	10.42	.147
Figure laying	Perceptual reasoning	52	53	8.38	<.001**
Understanding	Verbal understanding	52	53	10.94	.023
Comparing symbols	Processing speed	50	51	10.78	.022
Test value = 10					

Note: **P<.005

Explorative results

A Pearson correlation was performed to investigate the relationship between eczema severity and total IQ score. The Pearson correlation revealed a non-significant relationship between eczema severity and TIQ, $r(1) = -.137$, $p = .187$. Suggesting that there is no correlation between eczema severity and total IQ scores. A Spearman's correlation was also performed between the degree of itching and total IQ score. The Spearman correlation showed that there was a non-significant relationship between the degree of itching and the TIQ, $r(1) = .025$, $p = .436$. This suggests that there is no correlation between degree of itching and total IQ scores.

Within the intelligence profile, there is checked whether there were any discrepancies. Disharmony shows that developing children have strengths and weaknesses in their intelligence profile. A disharmonious profile is present when there are significant differences between verbal and performance intelligence. 48.2% (N = 27) of the children had a significant discrepancy between their VIQ and PIQ. 23 children had a higher VIQ score than their PIQ score. 4 children had a higher PIQ than their VIQ-score. This means that in 23 children the language capacities are better developed than the more action-oriented capacities.

Also, the total IQ was compared to the current school level of the participants. Table 7 shows the mean total IQ score by school level. The total IQ scores are increasing, which may be correlated to the school level.

Table 7

Mean total IQ score by school level

School level	N	Mean (M)	Std. Deviation
VMBO basis and kader	5	87.80	9.09
VMBO gemengd and theoretisch	9	96.89	13.73
MBO	1	81.00	
HAVO	7	104.29	9.52
VWO	6	118.50	12.93

Discussion

As a few studies (Silverberg et al., 2020; Yu et al., 2023) have already performed research on the topic of intelligence and executive functioning in children with AD. This current study seeks to refine the perspective on the peculiarities of their intelligence profile. Only limited research has been performed into the extensive analyzing of the entire intelligence profile of this target group. In light of the beforementioned information, the following research question was made: "Are peculiarities evident in the intelligence profile of children with severe or difficult-to-treat eczema?" To answer this question, the results of this study show that, in the first analysis regarding the total IQ-scores, verbal IQ-scores, performal IQ-scores and processing speed, no significant differences have been found in the total intelligence and the processing speed. This suggests that, on average, children with AD do not exhibit abnormal deviations in their overall intelligence and processing speed compared to the general population. The first analysis, however, did show a significant difference in score within the verbal IQ and performal IQ. A significant higher VIQ-score and a significant lower PIQ-score was obtained by the children with AD compared to the norm group. This indicates that children with AD may have specific strengths in verbal and weaknesses in performance-related cognitive abilities.

When the scores on the verbal and performance parts of the WISC-III test deviate strongly from each other, we speak of a so-called disharmonic profile. After all, a VIQ-PIQ discrepancy of at least 9 IQ points is relatively common in the general population. According to Kaufman (1976), 50% of all children have a difference score of at least 9 points. A discrepancy of 12 points or more appears to be found in around one-third of all children, and a difference of at least 15 points appears to be found in approximately one-quarter of all children. Other studies have reported similar results (Iverson et al., 2001; Ryan et al., 1994). It is noteworthy that in this study, a disharmonic profile with a difference of at least 15 points was discovered in 48.2% of the research group. This is a substantially greater percentage than the general population. It can be cautiously stated that in this target group there is more often a discrepancy within their intelligence profile.

When a child has an intelligence profile with VIQ>PIQ, there is usually the risk that a child is overestimated and can therefore be over-asked (Kaldenbach, 2006). Children with a higher developed verbal IQ usually have an excellent ability to understand, use and process language. They excel at verbal communication, reading and writing, and can understand and express complex concepts with ease. This can lead to them being viewed as highly skilled, which in turn can lead to being over-asked.

Although no direct cause-and-effect relationship has been established, there are some possible explanations for the observed association between better developed verbal IQ in children with AD. Children with AD may receive more attention from their parents and caregivers because of their skin condition. This can result in a stimulating environment for developing language and communication skills. The additional interaction with adults can lead to increased exposure to language and conversation, which in turn can contribute to a more developed verbal IQ (Da Rosa Piccolo et al., 2016). Children who are exposed to a language rich environment and early stimulation of language development often have a better developed verbal IQ. Children with AD are exposed early on to an environment that requires a lot of communication. Doctors and parents who actively talk, tell stories and play interactively with, and in the presence of, these children can contribute to the development of language skills.

A potential cause for a reduced performal IQ in children with AD could lie in the influence of the symptoms of eczema on their daily life and well-being. AD can have a significant impact on a child's physical and emotional well-being, which in turn can influence several factors that affect performal IQ. Children with AD may suffer from itching, pain and discomfort, especially at night, disrupting their sleep. Sleep is essential for healthy cognitive development, and poor sleep can lead to impaired cognitive performance, including problems with attention, memory, and problem solving (Fishbein et al. (2018); McKenzie et al. (2020); Behrens et al., 2023). AD can also cause stress and anxiety in children because of the physical discomfort, possible social stigma and limitations in their daily activities. Persistent stress can negatively impact brain development and other cognitive functions (Mac Giollabhui & Catharina, 2022). Also, children with severe eczema may be limited in their physical activities and outdoor play, which is important for their overall development. A lack of opportunities for exploration and interaction with the environment can affect several aspects of a child's development (Burriss & Burriss, 2011). Eczema can also lead to social isolation, bullying and stigmatization of the child, especially if the symptoms are striking. Social support and interaction play a crucial role in children's cognitive and emotional development. However, social isolation can lead to a lack of cognitive stimulation and opportunities for learning, brain development and cognitive functions (Peng et al., 2022).

Research by Jackson-Cowan et al (2021) shows that the hippocampus, a crucial brain region for memory and learning, may be affected by the immune response induced by AD. This may influence the learning and retention of visual-spatial information. Children with AD may have difficulty learning and remembering visual stimuli and performing tasks that require visual-spatial understanding. The second analysis, regarding the eleven specific subtests showed only a significant difference regarding the subtest figure laying. Within this subtest a lower score was obtained compared to the norm group. In this subtest they need to put pieces of a puzzle together properly so that the figure is correct. This subtest measures the perceptual reasoning. These findings suggest that children with AD may face challenges in areas related to perceptual reasoning.

However, this current study possesses over many strengths and gave insight on new information. Mainly information about the domains verbal IQ and performal IQ have come to light from this study. This study contributes to the literature gap existing on this particular target group. The results do support the importance of a comprehensive assessment of the strengths and weaknesses within the intelligence profile of children with AD and emphasize the need for tailored interventions and support to address these specific findings.

In contrast, the current study also encountered complexities in the proves of executing the research. Currently, a new version of the WISC has already been released that can analyze the intelligence profile even more extensively. In this version, three indexes have been formed for complex reasoning: linguistic reasoning, visual-spatial reasoning and fluid reasoning. In addition, a representation can also be formed of the efficiency with which simple information is used: the working memory and the processing speed. This means that the influence of the language skills has become smaller, compared to the WISC-III. The influence of non-verbal reasoning has become greater, as this is not measured in the WISC-III. The heaviness of the working memory and processing speed has also increased.

Also, the focus is mainly on the intelligence levels and not on other executive functions or cognitive abilities. Further research is necessary to explore the underlying mechanisms and potential interventions to optimize their treatment. This could help understand which specific executive functions are most affected in children and how these deficits can influence their school performance and intelligence profile. With this insight, tailor-made interventions can be developed to support these children according to their specific needs. Additionally, longitudinal studies can help comprehend the development of executive functions over time and how this development is related to changes in intelligence and academic performance. This could lead to a better understanding of the reasons behind possible declines or improvements in executive functions among children with an average IQ. Future follow-up research could attempt to gather more extensive research into specific executive functioning. Children with an average IQ score can still experience problems with executive functions, which can cause difficulties within their school setting.

A third factor that could be important for further research is the sleep quality and sleep pattern of the children. This study did not investigate this factor as a mediating variable. However, based on the literature, this can have a significant impact on the functioning of this target group in general.

In conclusion, this study suggests that children with AD do not exhibit significant deviations in their overall IQ compared to the general population. However, they may demonstrate specific weaknesses in performance-related tasks and strengths withing their verbal understanding and verbal abilities. Additionally, they may face challenges in certain cognitive domains, such as perceptual reasoning. The severity of eczema symptoms and the degree of itching do not appear to be directly associated with overall intelligence in children with AD. These findings highlight the importance of considering discrepancy within the intelligence profile and specific cognitive domains when assessing and supporting children with AD in their treatment. From this research, one can take into account the possibility of overestimation in this target group, as they may come across as verbally strong. Further research is warranted to explore the more in-depth underlying mechanisms and potential interventions to address other cognitive challenges in children with AD.

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