Executive Function in Elementary Students with Nonverbal Learning Disabilities and Autism Spectrum Disorders

https://doi.org/10.69685/WLAK2563

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Abstract

It is said that the neuropsychological profile of children with Nonverbal Learning Disabilities (NLD) and children with Autism Spectrum Disorders (ASD) bears considerable similarities. Ten children with NLD (117.70±11.42), and ten children with ASD (119.60±9.54) participated in this study, in order to examine their Executive Function (EF) skills (planning). NLD participants performed low planning skills by exhibiting a gradually descending achievement. ASD participants performed low planning skills, as well. However, the ASD group performed more intense differences (extreme low and high scores). Both groups performed achievement below the mean. However, they differed in the type of errors, underlying the importance of individual assessment and qualitative analysis. The current study extends previous findings indicating differences between NLD and ASD groups. Relations between errors and cognitive characteristics of each group are discussed, as well as implications of the above findings are discussed for understanding the neurocognitive substrates of both NLD and ASD.

Keywords: Nonverbal Learning Disabilities, Autism Spectrum Disorders, Executive Functions, Planning

Introduction

Non-Verbal Learning Difficulties (NLD) have been under the heterogenous category of Specific Learning Difficulties (SLD). Research data and information are limited worldwide, when in my home country, Greece, the category is hardly known within the therapeutic and educational community. Individuals with NLD are identified as perform deficits in visual-spatial abilties or a discrepancy between visual-spatial and verbal ability accompanied by difficulties with mathematics and relatively good reading skills. Moreover, problems with visual-spatial memory, attention, executive functions, fine motor and social skills are often present. There is a need to highlight the specific characteristics of the NLD group, in order to be better identified and lead to more appropriate support for the NLD individuals, by receiving suitable therapeutic and educational services. A way to better emerge the profile of NLD individuals, is to compare them with another, more famous, group with which they share common neuropsychological characteristics. Such a group, with similar profile, is the Autism Spectrum Disorders (ASD) group.

It has been established that individuals with Nonverbal Learning Disabilities (NLD) or Autism Spectrum Disorders (ASD) may show difficulties with Executive Function (EF) skills (Lee, Ward, Lane, Aman, Loveland, Mansour, & Pearson (2023); Kouhbanani et al., 2020).

EF refers to a set of cognitive skills that allows the person to focus on a particular task, organize and finally complete it by using appropriate way(s) (Doebel, 2020). Specifically, the EF umbrella includes: working memory, planning, shifting, inhibition and mental flexibility (Doebel, 2020). The above skills are implemented within the understanding situations process (Semrud-Clikeman, Fine & Bledsoe, 2014).

The importance of the typical development of EF is clearly seen in the correlation between EF-reading-writing skills, EF-self-control, and thus behavior, all of the above related to academic success and social skills (Butterfuss & Kendeou, 2018). In addition, it has been proved the contribution of EF in mathematical skills (Živković et al., 2022).

Nonverbal Learning Disabilities

NLD concept was initially introduced by Myklebust and Johnson (1967). It was Rourke (1989), however, who investigated the NLD population in depth. The NLD concept itself is a controversial one, with research dealing mostly with the symptomatology of the disorder (Broitman and Davis, 2013). There have been a set of criteria as the most usually encountered in the NLD population, namely Performance IQ < Verbal IQ, low mathematical achievement versus a relatively good reading decoding ability, visuoconstructive and fine motor impairments, spatial working memory deficits, social and emotional difficulties (Mamarrella and Cornoldi, 2013).

Their difficulties in visuo-spatial tasks may result in deficits with EF. There is research showing that NLD children have difficulties with EF (Semrud-Clikeman et al., 2014). However, research addressing EF in NLD population is limited and the current study wants to look at specific measures of EF in more depth in NLD individuals.

It is also worth mentioning that despite the rise of public awareness and interest in NLD, this category has yet to be included in any classification system. Neither the International Classification of Diseases (ICD) nor the Diagnostic and Statistical Manual of Mental Disorders (DSM) provide a description or criteria for the NLD to be diagnosed.

Identification of NLD individuals and their discrimination from individuals with other diagnoses, with whom they share common characteristics, are research projects in progress that have not been well researched worldwide and almost not studied in Greece (at least in relation to other subcategories of SLD).

Hence, reduced awareness leads to reduce in depth knowledge of the NLD profile and thus, restricted therapeutic and educational services for the NLD individuals. So, there is no appropriate management of these individuals from the therapeutic community and as a result, inappropriate inclusion of them within the academic and social community.

To better unfold the cognitive profile of individuals with NLD and thus, specialize and improve their therapeutic services, a comparison with a more well-known diagnostic category that shares common characteristics with NLD individuals seems critical. This group is ASD.

Autism Spectrum Disorders

The Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM–5; American Psychiatric Association, 2013) is the most widely accepted nomenclature used by clinicians and researchers for the classification of mental disorders. Individuals with ASD face difficulties with social interaction and communication, and exhibit stereotyped behaviors and/or interests with symptoms present from the early developmental period (DSM-5). The fifth revision of the DSM-5 collapses the Asperger Syndrome (AS) diagnostic category (along with Pervasive Developmental Disorder-Not Otherwise Specified and Autistic Disorder) into a single category of Autism Spectrum Disorders (ASD). Nevertheless, distinct cognitive profiles may be useful for clinical intervention. Hence, individuals involved in the said research would be mostly described as having ASD without intellectual disability or early language impairments and specifically under Level 1, based on the DSM-V.

ASD have been thought of as executive disorder and specifically, individuals with ASD have been found to have difficulties with planning, mental flexibility, inhibition and self-regulation (Cavalli et al., 2022).

Nonverbal Learning Disabilities and Autism Spectrum Disorders

It has been mentioned that the neuropsychological profile of individuals with ASD and NLD are similar (Frechette et al., 2024). Rourke (1995) has mentioned that many NLD characteristics are also present in ASD, such as: good verbal abilities versus poor visuospatial skills, prosody difficulties, hyperlexia with pragmatic difficulties, and social perception difficulties. However, it is of great importance to know whether there is a clear distinction

between these two disorders or the overlapping is not too extensive to posit the existence of two diagnostically separate conditions.

It has been accepted that a difference between the groups is the absence of stereotyped patterns of behaviors of the NLD group (Rourke, 1995). However, research investigating the neuroanatomical structures in NLD children in comparison to the neuroanatomical profile of children with ASD is rather scant (Semrud Clikeman et al., 2014).

Based on the assumption that stereotyped behaviors and interests are related to executive dysfunction (Sadeghi & Pouretemad, 2022) it might be expected that NLD individuals would exhibit different executive profile from ASD individuals. In addition, we would rather expect that both groups would show difficulty on planning tasks. However, research is very limited in direct comparisons of EF between these two groups.

Executive Functions

EF is a cognitive, multidimensional construct, known as an umbrella that includes a variety of skills such as working memory, planning, impulse control, inhibition, cognitive flexibility, organization, self-monitoring and shifting; some of which are related or dependent upon one another (Cristofori, Cohen-Zimerman & Grafman, 2019). EF is related to problem solving, as well as it involves maintenance of multiple goals, self-monitoring and self-regulation in the everyday life (Lamberts, Evans, & Spikman, 2010).

Planning

Planning is a complicated process, in which a set of particular actions should be monitored, reassessed and upgraded in order to reach the desire goal (Hill, 2004). It is the process on which an individual fluently produces an efficient strategy in order to achieve a goal. In order for a successful plan to be generated, both the cognitive and behavioral components should be organized by an individual in order to achieve a goal (Kegel, 2010). The above could be better understood if thinking of the planning assessment procedures. Specifically, tower tasks - where planning is being assessed - involve the arrangement of colored discs or balls on a series of pegs, in the same order as seen in a picture image, and following specific number of moves. So, the ability of the individual to plan a sequence of moves to successfully achieve an outcome is examined. However, working memory is probably involved, as the individual is enforced to sustain a representation of the possible move while acknowledging its consequences (Ozonoff, South, & Provencal, 2005). The above means that tower tasks achievement, is partially based on the individual's working memory. Moreover, apart from working memory it is supposed that both spatial abilities and/or motor skills that an individual performs are correlated with the successful completion of the tower task (Pennington & Ozonoff, 1996).

As it can be understood, EF development is very important for a variety of reasons such as school achievement, social adaptation, problem solving, adaptive behavior, and decreased independence (Gunzenhauser & Nückles, 2021; Raskova et al., 2025). Thus, executive dysfunction may result in increased rigidity, social and emotional difficulties, and academic failure. The above implications offer a critical role to EF. Hence, executive function assessment and intervention planning seems to be beneficial for cognitive and behavioral improvement.

Executive Function in Nonverbal Learning Disability and Autism Spectrum Disorders

Rourke (1989) introduced a theory of NLD suggesting that NLD students perform difficulties with visual spatial skills, novel materials and situations, non verbal problem solving. In addition, he underlined the role of white matter in the cognitive profile of students with NLD, proposing that damage in white matter fibers may lead to limited communication between the right and left hemisphere. Hence, it is possible that the above difficulties may result to

deficits in EF. Even though current formal research direct assessing EF in NLD population is limited, Kegel (2010) found that NLD individuals face EF difficulties.

On the other hand, there is research available in EF in ASD. Specifically, ASD individuals face mixed EF profile including strengths and difficulties in various aspects of EF such as cognitive flexibility, planning and working memory (Kegel, 2010). The EF theory of ASD proposes that EF difficulties are related to abnormalities of the prefrontal cortex and the connections between the brain structures (Pennington and Ozonoff, 1996).

Even though students with NLD perform similarities with students with ASD; however, current research is limited in the field of EF in NLD and in direct measures on these two diagnostic groups.

Kegel (2010) examined comparisons in EF between individuals with NLD and ASD. He found that ASD individuals faced greater difficulty in cognitive flexibility/shifting compared to NLD. Ismirlidou (2019) examined both planning and cognitive flexibility between students with NLD and ASD. She found that in planning ability ASD students outperformed NLD students with statistically significant difference, when in cognitive flexibility ability, NLD students performed a slightly better achievement in comparison to students with ASD (with no statistically significant difference).

The current study

The current study aims at offering a picture of the EF profile of the two groups, and evidence regarding the possible differences and/or similarities they exhibit.

Based on the above-mentioned theoretical background, the research questions of the study are:

- Are there similarities and/or differences between NLD and ASD individuals in planning and what is their nature?
- Does age affect EF achievement in groups? Or is there an improvement in EF, across age in groups?
- Which educational implications at school for individuals with NLD and ASD derive from their similarities and/or differences in planning?

Hypotheses:

1st hypothesis:

- Null hypothesis: The two groups do not differ statistically in their achievement in planning.
- Alternative hypothesis: The two groups differ statistically in their achievement in planning.

Methodology

Participants

The participants were students attending primary public schools in a large urban area of Northern Greece, populated mostly by families of medium socioeconomic level. Regarding NLD, it has to be stressed that the Greek agencies for the diagnosis of disabilities, have no procedures and tools for identifying students belonging to this group, as a result of the fact of that NLD is not included in the list of special educational needs and disabilities endorsed by the Greek Ministry of Education (Law 3699/2008). In other words, NLD is practically unknown as a diagnostic category in Greece. Hence, at first phase I asked from health care professionals work at private offices, to suggest me students with Specific Learning Difficulties (SLD). Then, I contacted them and only those happy to participate, continued to the second phase of the research project. At that stage, I utilized the criteria previously used in Greek students in order to identify them as having NLD (Ismirlidou, 2019), based on criteria used in other countries. Specifically, in order to qualify for inclusion in the NLD group of the study, students had to

meet the first of the following criteria, and also at least two of the criteria 2-4, whereas the fulfillment of the 5th criterion was optional:

1. Performance IQ (PIQ)< Verbal IQ (VIQ) and overall IQ score ≥80
2. Performance in visual motor skills one standard deviation below the mean
3. Poor mathematical achievement with relatively good reading decoding ability
4. Visuospatial working memory deficits
5. Emotional and/or social difficulties (Mammarella and Cornoldi, 2013)

Exclusionary criteria include a history of any syndrome (Asperger Syndrome, Down Syndrome etc), neurological and/or sensory problems, seizure disorder, traumatic brain injury, or other medical conditions (Mammarella and Cornoldi, 2013). In the said study, ten students with NLD participated (3 boys and 7 girls, mean age in months 117.70±11.42) (Table 1).

In accordance to ASD group, ten students were included in the sample (10 boys, mean age in months 119.60±9.54) who had an official diagnosis from Greek public hospitals. It was decided to cross-check the diagnoses by asking the parents to answer the Autism Spectrum Quotient (ASQ) (Cohen et al, 2001). All diagnoses of the ASQ were verified.

Assessment procedure took place in a quiet environment. A clinical psychologist participated in the study in order to provide the PIQ, VIQ and overall IQ scores. Two to three sessions were needed in order to provide all the tests for the NLD identification, and one session for the planning assessment.

Table 1: ***Participant Age Characteristics for NLD and ASD groups***

Group		NVLD	ASD	Total
Mean		117,70	119,60	118,65
95% Confidence Interval for Mean	Lower Bound	109,53	112,78	113,84
	Upper Bound	125,87	126,42	123,46
Median		116,50	118,50	118
Variance		130,46	90,93	105,82
Std. Deviation		11,42	9,54	10,29
Minimum		102	104	102
Maximum		139	134	139
Range		37	30	37

Instruments

For the VIQ, PIQ and overall IQ scores to be measured, two verbal and two practical subtests from the Wechsler Intelligence Scale for Children-Third Edition (WISC-III) were used (Georgas et al.,1997).

The Grooved Pegboard Test (GPT; Klove, cited in Rourke, 1989) was used in order to measure the visual-motor coordination of the participants. This test has been widely used for the identification of the NLD group (Galway and Metsala, 2011), and specifically for the differentiation of this group from children with other Learning Difficulties (Durand, 2005). Specifically, participants are required to put 10 pegs in the wholes as quickly as possible with their dominant hand and then with non-dominant. In the end the time needed to complete the test, the pegs put correctly and the drops-which are the number of times a peg was unintentionally fall in the table- are sum up to give the final score, which is then compared to same age group. The participant receives a "D" flag if the hand that is not being tested turns the pegs over. The normative data are provided by Knights and Moule (1968).

The Screening Test of Mathematical Achievement (STMA) was used as a measure of the participants' mathematical abilities. It is a short screening tool for detecting children with specific mathematical disorder (Papaioannou et al., 2011). Specifically, a paper with mathematical activities is given to participants and they asked to solve as many as possible. For right answers the participant takes 1 point and 0 for false. There is a percentile scale score for each class.

The reading abilities of the participants (decoding and fluency) were measured through the A test (Panteliadou & Antoniou, 2007). For decoding, there were three activities including: reading non words, reading real words, reading words and chose which were real. Then, the above scores were sum up and the total score showed the percentile score for each class. For the fluency measure, the participant was asked to read for one minute. In the end, the number of the correct answers was sum up and showed the percentile score for each class.

The Rey Complex Figure Test (RCFT; adapted from Osterrieth, 1944) was used for measuring visuospatial construction and visuospatial memory of the participants (Lezak, 1983). There have been developed different ways to administer the test: copy, immediately recall, and delayed recall. Copying is used for assessing the visuospatial constructive ability, whereas the immediate and delayed recall assess the visuospatial memory (Lezak, 1995). The scoring system includes an 18 part scale with a top score of 36 points (Corwin and Bylsma, 1993). As this measure has not been translated and used in Greece for school aged children, Italian norms were used.

The Strengths and Difficulties Questionnaire (SDQ) was used in order to explore social and or emotional difficulties of the NLD group. It is a screening questionnaire for children 3-16 years, including 25 questions related to: emotional symptoms, conduct problems, hyperactivity/ inattention, peer relationship problems, prosocial behaviour. The SDQ has been standardized in Greece (Stogiannidou et al., 2014).

Child and Adolescent Scale of Participation (CASP - Bedell, 2009) was used in order to measure the social participation of the NLD. The Scale is based on parents' and teachers' reports. The CASP consists of 20 ordinal-scaled items and four subsections: home participation, community participation, school participation and home and community living activities. In the present study the home-community and school participation parts were used. It is a four point scale with high scores reflecting greater age-expected participation. For the purpose of the said study, the score was in percentile scale.

The Detection and Investigation Tool of Executive Functions for A-E classes of Primary School (Simos, Mouzaki, & Sideridis, 2007) was used and specifically the "tower trial", which assesses planning.

Specifically, for the tower trial, participants were asked to use ring tower puzzle and three different color cubes in order to replicate a picture motif. They were instructed to move one cube at the time, when specific number of movements and time limit were given too. Participants earned 1 point for doing the same tower with the specific number of movements and 0 points for not doing or for using more or less movements. The tool includes 10 subtests. Then, the above score (0-10) was converted into percentile score in accordance to school class.

Analyses

Mann Whitney u test was used to determine whether there were group differences between ASD and NLD children.

Results

The mean scores in planning were 3.30±1.89 for the NLD group, and 4.20±2.25 for the ASD group. The minimum score for the NLD group was 2 and the maximum 7; respective values for the ASD group were: minimum 1- maximum 7. Obviously, none of the groups approached the

mean score of general population, as their performance is about 1-2 SD below it. There is no statistical significant difference between the groups.

Group profile analysis showed that both groups perform poor achievement across subtests. Figure 1 shows the percentile of correct answers of both groups. A significantly poor achievement is observed in the third subtest, especially for the NLD group. Overall, the ASD group did score better than the NLD group. However, both groups exhibit gradually decreased achievement.

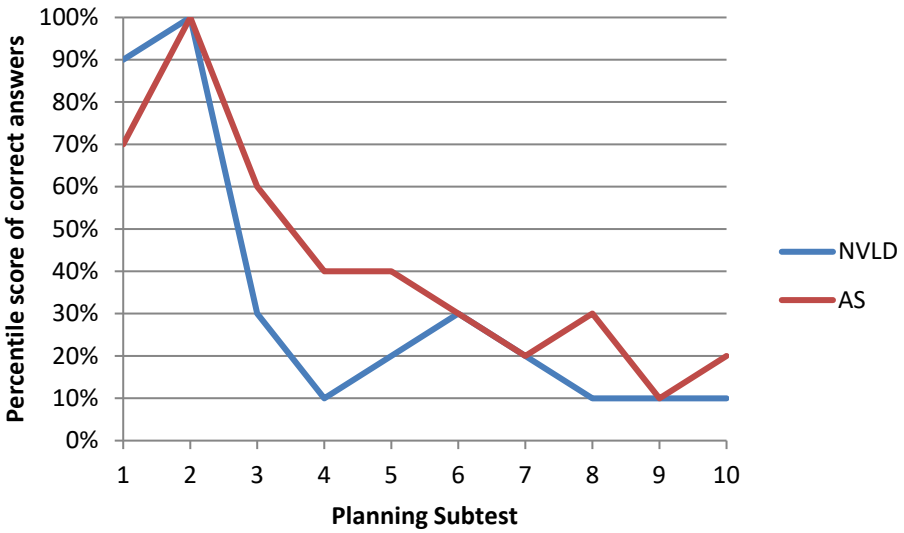

Figure 1: ***Percentile score of correct answers per groups***

Figure 2 shows the percentile score of errors due to wrong number of movements used (which are correctly completed answers but with wrong number of movements used and which are considered as errors by the tool). Figure 3 shows the score of errors due to wrong result (which are not correctly completed answers), respectively for both groups.

The analysis of the percentile score of errors due to wrong number of movements used, shows that both groups perform almost similar behaviour for subtests 1-4. However, ASD group perform higher percentile than NLD group for subtests 5-10 that means that the ASD group exhibited more often errors due to wrong number of movements. The above differentiates the two groups. Specifically, it seems that ASD participants tend to try to complete the planning subtests even though they perform wrong number of movements used. The above may be correlated with low comprehension of the directions given and/or impulsivity and/or with other poor EF skills.

The above indication is strengthened by the findings shown in Figure 3, where the errors due to wrong results per group are given. As it can be seen, NLD participants failed to complete the subtests most of the times -even by exhibiting wrong number of movements- in comparison to ASD participants. In summary, figures 2 and 3 shows that NLD participants do face a greater difficulty in completing a subtest than ASD participants; who seem to tend to complete the subtests but they do not follow the directions given.

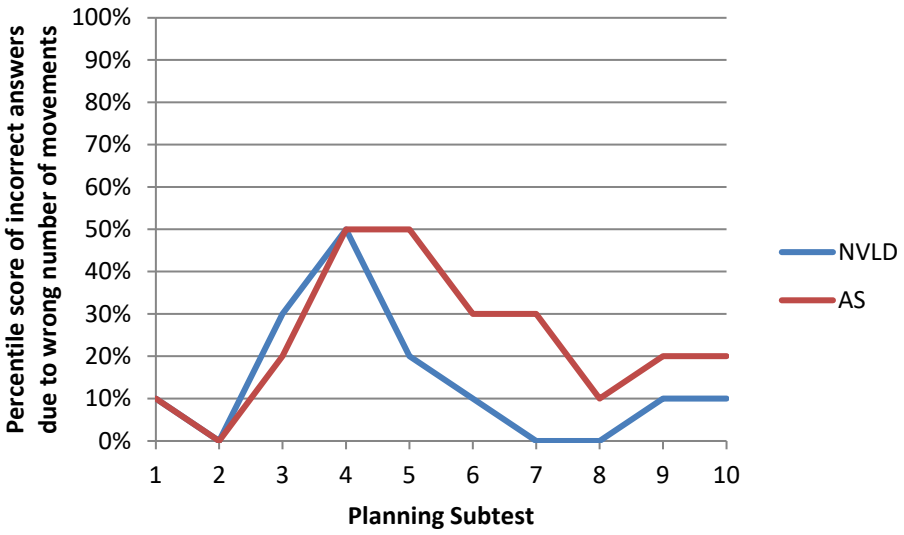

Figure 2: ***Percentile score of incorrect answers due to wrong number of movements used per groups***

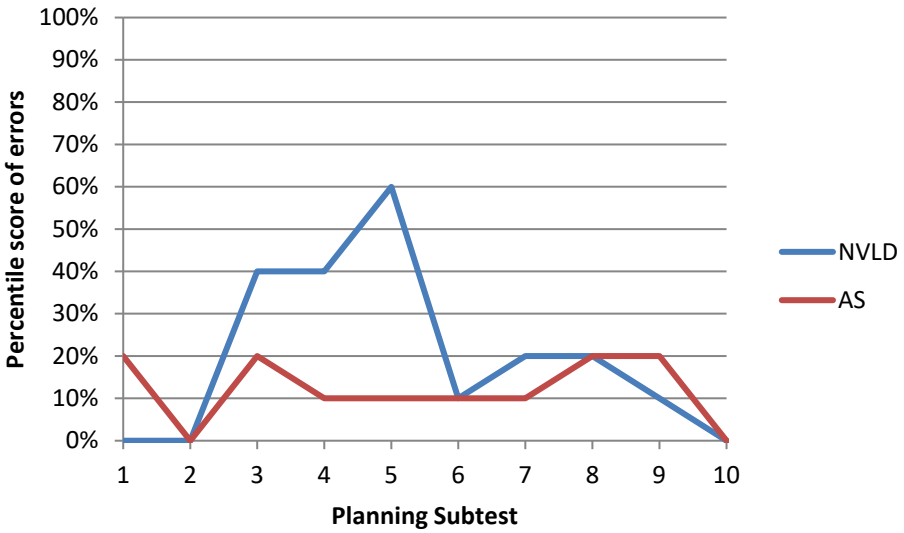

Figure 3: ***Percentile score of errors***

In figure 4 there are presented the subtests not tested, due to the stop test criterion. As it can be observed, for the NLD group half of the participants did not continue the test procedure after the 5th subtest, when only two participants were tested in all of the ten subtests. On the other hand, 40% of the ASD group did continue till the end of the test.

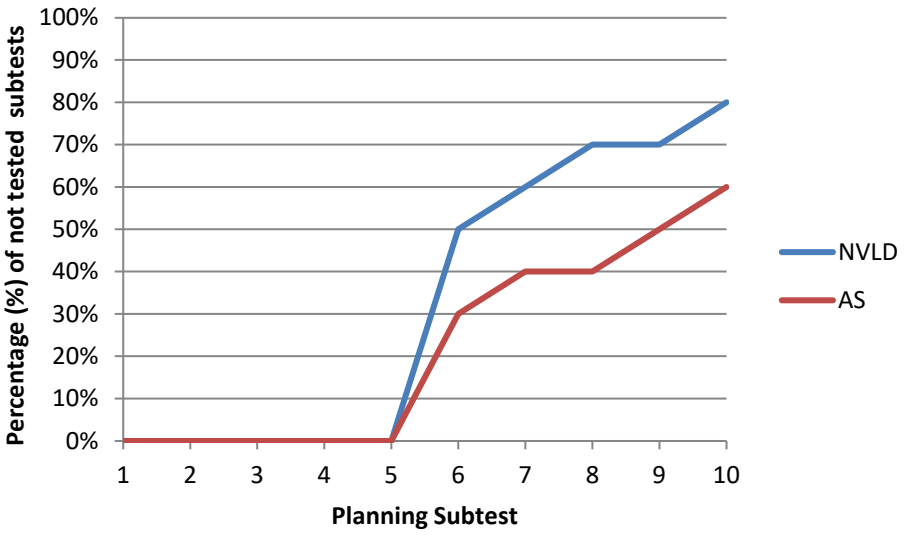

Figure 4. ***Percentage of not tested subtests per group***

Discussion

The goals of the current study were to explore whether there are differences between ASD and NLD individuals in EF and what is their nature; and whether there is any correlation between age and EF achievement. For the above reason, skills on measures of planning to children with NLD and ASD were assessed. The findings of this study will be discussed within the context of theoretical background and existed literature.

In summary, results propose that there were no significant differences between the groups on clinical measures of planning. ASD individuals slightly outperformed NLD individuals on planning measures. In addition, no participant did exceed the 60 seconds time given for the subtest completion.

Group profile analysis showed that in these groups there were no statistically significant interactions between achievement and age group on EF. Thus, in the said study there is no positive trajectory in development of EF for both groups based on diagnosis.

The two groups were relatively similar at their performance in the correct answers.

In accordance to their errors due to wrong use of movements, the ASD group is demonstrating different behavior from 5th subtest on. Specifically, they do achieve the desirable result but they do not use the proper number of movements asked/given. The above behavior may be due to decreased comprehension of the directions given, poor working memory, and/or impulsiveness. At the same time, the NLD group fails the desirable result.

In accordance to their errors performance, the two groups did differ from 3rd to 6th subtest, with the NVLD group performed more errors.

Regarding no tested items, it can be seen that the ASD group did continue till the last item (10 items) in a greater rate than the NLD group.

Generally, there is a scale difficulty across the test procedure for both groups, that is correlated to the planning of the test where the number of movements asked is gradually rising.

There was variability in the planning performance of individuals with ASD, ranging from well below average to well above average, as proved by the large standard deviation. The above finding underlines the importance of individual assessment and thus, individual educational and therapeutic program. Hence, it is very important to consider each case individually.

Hence, children with ASD and those with NLD were more different than similar in planning measure, even though they both performed low performance in planning and there were no significant statistical differences.

In the current study it seems that there is no interaction between age/class and achievement in both groups. Hence, there is no positive trajectory in development of EF for both groups based on age/class, with the NLD group performing more intense the above indication. This pattern does not provide support for the statement that ASD cognitive profile improves with age (Simonoff et al, 2020). The above could support, the role of working memory, the spatial abilities and/or motor skills in the successful completion of the tower task (Pennington & Ozonoff, 1996; Ozonoff et al., 2005).

These findings are consistent with studies indicating that ASD students do face difficulties with EF and specifically planning (Dubbelink & Geurts, 2017). In the field of EF in NVLD there is research showing that NLD individuals face difficulties with EF (Semrud-Clikeman, Fine, & Blesdoe, 2013; Ismirlidou, 2019); however, formal research is limited in investigating directly each of the EF (planning, cognitive flexibility, working memory, attention) in individuals with NVLD. It can be said that the right frontal lobe deficits that NLD individuals perform (Rourke, 1989), are responsible for poor EF performance (Jing et al., 2004). There is a need for future research in order more definite conclusions to be drawn in regard to EF in NLD.

In addition, there were no statistically interactions between diagnosis and age group.

It is difficult to relate these findings to the current literature as studies assessing planning in ASD and NLD are limited and vary in accordance to individuals' age and measures of EF used.

The current study offers proofs suggesting that both NLD and ASD perform poor achievement in planning. However, while the planning measure did not show differences between the two clinical groups, the differences were substantial. Specifically, these findings suggest that these two disorders may reflect different degrees of difficulty in planning rather than a quantitative difference.

Further analysis is difficult to be discussed due to the limited research in planning skills in NLD and ASD. Hence, further examination will light the field of EF in NLD and ASD.

Conclusion

Existing literature has proposed that ASD individuals face difficulties with planning (Brady et al., 2015). In addition, NLD individuals face EF difficulties too (Semrud-Clikeman et al., 2014). However, research on EF in NLD population is much less sufficient.

In summary, it appears that ASD group did not meet normative expectations on planning measures, although performing variability in their performance and NLD group as well.

The significant variability that ASD individuals performed in planning, highlights the importance of individual assessment both within the ASD group of individuals and within themselves. Hence, heterogeneity appears consistently in the EF skills of ASD individuals in this study.

In relation to developmental characteristics, research suggests that EF skills improve with age (Best & Miller, 2010). Given the difficulties with EF that both groups experience, it was expected that either a flat or decreased developmental trajectory would be observed, from both groups.

Clinicians should be particularly sensitive to the above tendencies and to provide additional resources and interventions.

Educational and therapeutic implications

Individual assessment and treatment

The results of the study suggest individual assessment and qualitative analysis of errors, for the planning profile of each student, as well as the stage of the planning process on which the student is struggling (unsuccessfully or successfully complete the task but in another way than

of that given) to be highlighted. In addition, there is a need from professionals and educators to explore/assess in depth the neuropsychological and academic profile of each student and increase their knowledge about NLD and ASD symptomatology.

The heterogeneity in performance of individuals with ASD has important educational and therapeutic implications. Specifically, the said heterogeneity proposes neuropsychological case series approach, utilizing individual assessment and treatment planning based on differences within individual rather than across individuals (Towgood et al., 2009).

Group and/or age level analysis risks missing cognitive characteristics that may be significant for a variety of individuals, and mislead through mean scores. Thus, neuropsychological case series approach targets on interindividual profiles of achievement. Particularly, individualized assessment and treatment encompasses the broad range of EF evident within ASD individuals.

Limitations

The current study aimed to extent existed findings on planning in ASD and light the EF profile of students with NLD. The study included individuals from two diagnostical groups that shares neuropsychological similarities and differences, offering unique and important findings that may assist in differential diagnosis and/or educational implications.

However, the are several limitations of the study which require cautious interpretation of the findings. One limitation was the low number of participants with a diagnosis of both NLD and ASD. Specifically for the NLD group, it is really hard to find sufficient number of participants who meet the criteria as the prevalence of the NLD population is said to be low worldwide. In addition, the sample was non-random and included individuals from the same geographical area; which means that the results of the current study may be not be generalizable to other developmental periods or clinical populations. In addition, representativity could be an issue, as selection process of the NLD group varies widely across researchers (Forrest, 2007).

In addition, the measure used to assess planning is a Greek standardized measure that has not widely been researched for its reliability.

Moreover, the current study relied only on direct laboratory performance measure of planning and did not include supplemental parental and/or teacher reports of planning. Hence, future research that combines laboratory and informant-based measures is required for a more in-depth investigation.

Finally, comorbidities in our sample such as psychosocial diagnoses, social cognition, social impairments and the way they might contribute to our research findings were not examined.

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