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Assessment of neuropsychological functioning related to attention, verbal learning and executive functions in adolescent girls and boys with a depressive episode.
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Assessment of neuropsychological functioning related to attention, verbal learning and executive functions in adolescent girls and boys with a depressive episode

Ocena funkcjonowania neuropsychologicznego w zakresie uwagi, uczenia się materiału werbalnego i funkcji wykonawczych u dziewcząt i chłopców z epizodem depresyjnym

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Abstract

Introduction and objective: The aim of this study was to assess cognitive functions in adolescents with a depressive episode, associated with attention, processing speed, verbal learning, and executive function. Additionally, it focused on potential gender differences in the pattern and severity of the deficits. **Materials and methods:** The study involved 63 adolescents with a depressive episode (56% girls) and 43 healthy controls (48% girls), aged 16.92 ± 1.3 and 17.24 ± 1.16 years, respectively. The Polish versions of the Children's Depression Inventory-2 and the Beck Depression Inventory-II were used as the measures of mood. Attention was assessed with the use of the d2 test. Processing speed and divided attention were measured with the Color Trails Test. Verbal learning was evaluated with the California Verbal Learning Test. Executive function was assessed with the use of the Ruff Figural Fluency Test, the Tower of London and the Brixton Spatial Anticipation Test. **Results:** The results show significant cognitive deficits in adolescents with a depressive episode, affecting attention, processing speed, divided attention, verbal learning and executive function, which is consistent with the evidence reported in the existing literature. Notably, planning deficits, measured with the tower task, were more prominent in girls. Verbal learning efficiency was related to the severity of depressive symptoms in depressive episode group. In verbal learning, regardless of gender, adolescents with depression used the semantic clustering strategy less often than their healthy peers. **Conclusions:** The study highlights the need for tailored therapeutic interventions and treatments for depressive disorders which may ultimately be important for improved academic performance of adolescents with depressive episodes, with particular attention to gender-specific cognitive profiles and approaches.

Keywords: children, depression, education, memory, executive function

Streszczenie

Wprowadzenie i cel: Badanie miało na celu ocenę funkcji poznawczych u młodzieży ze zdiagnozowanym zaburzeniem depresyjnym w zakresie uwagi, szybkości przetwarzania informacji, uczenia się werbalnego i funkcji wykonawczych. Ponadto skupiono się na potencjalnych różnicach między płciami pod względem wzorca i nasilenia deficytów. **Materiał i metody:** W badaniu wzięło udział 63 nastolatków z zaburzeniami depresyjnymi (56% dziewcząt) i 43 zdrowych osób w grupie kontrolnej (48% dziewcząt) w wieku 16,92 ± 1,3 i 17,24 ± 1,16 roku. Do pomiaru nastroju wykorzystano polską wersję Zestawu Kwestionariuszy do Diagnozy Depresji u Dzieci i Młodzieży-2 i Inwentarza Depresji Becka-II. Do oceny uwagi

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wykorzystano test d2. Szybkość przetwarzania i podzielność uwagi mierzono za pomocą Kolorowego Testu Połączeń. Uczenie się werbalne zostało przetestowane za pomocą Kalifornijskiego Testu Uczenia się Werbalnego. Do oceny funkcji wykonawczych wykorzystano Test Fluencji Figuralnej Ruffa, Tower of London oraz Test Przewidywania Przestrzennego Brixton. **Wyniki:** Wyniki wykazały istotne deficyty poznawcze wśród młodzieży z zaburzeniami depresyjnymi, wpływające na koncentrację, szybkość przetwarzania informacji, uczenie się werbalne i funkcje wykonawcze, co jest zgodne z istniejącą literaturą. Warto zauważyć, że deficyty w zakresie planowania, mierzone za pomocą zadania z Tower of London, były bardziej widoczne u dziewcząt. Efektywność uczenia się werbalnego była powiązana z nasileniem objawów depresyjnych w grupie młodzieży z zaburzeniami depresyjnymi. W uczeniu się werbalnym, niezależnie od płci, młodzież z depresją rzadziej niż ich zdrowi rówieśnicy stosowała strategię grupowania semantycznego. **Wnioski:** Badanie podkreśla potrzebę dostosowanych interwencji terapeutycznych i leczenia zaburzeń depresyjnych, co w efekcie może mieć znaczenie dla poprawy wyników w nauce młodzieży z zaburzeniami depresyjnymi, ze szczególnym uwzględnieniem profili poznawczych i podejść dostosowanych do płci.

Słowa kluczowe: dzieci, depresja, edukacja, pamięć, funkcje wykonawcze

INTRODUCTION

The prevalence of depressive symptoms in adolescents increased from 24% in 2001–2010 to 37% in 2011–2020 (Shorey et al., 2022). Depressive disorders remain the most common psychiatric diagnosis in children and adolescents, accounting for 44.1% of all mental health admissions within the US paediatric population aged 3–20 years (Bardach et al., 2014). A study focusing on Polish adolescents showed that depression occurs in 4.1% of students (Pakalska-Korcala et al., 2021). Depression-related cognitive impairment has been far less thoroughly investigated in adolescents than in the adult population (Vilgis et al., 2015). In a recent meta-analysis (Schumacher et al., 2024) that included data of 13,567 depressed children aged 10–17 years, lower performance was shown in such domains as attention, working memory, long-term memory, executive function and language. No performance differences were observed in tests assessing short-term memory or processing speed.

Adolescent depression shares multiple features with adult depression (Thapar et al., 2012), in which deficits related to task initiation are a predominant feature of executive dysfunction. However, a meta-analytic study focusing

Variables	Descriptive statistics	CG ($n = 63$)	HC ($n = 46$)	Test statistics	*p*	Effect size[a]
Age	Mean (*SD*)	16.92 (1.30)	17.24 (1.16)	BM(104.94) = 1.31	0.191	0.57 [0.46; 0.68]
	Range (min÷max)	15÷19	15÷19			
	Me (IQR)	17 (2)	17 (2)			
Gender	Female	35 (56%)	22 (48%)	$\chi^2(1) = 0.64$	0.424	0.08
	Male	28 (44%)	24 (52%)			
General intellectual functioning: TRS-Z	*Me* (IQR)	8 (6)	9 (4.75)	BM(103.96) = 0.16	0.871	0.51 [0.40; 0.62]
	Range (min÷max)	2÷19	3÷23			
BDI-II	*Me* (IQR)	37 (8)	8 (9)	BM(95.87) = −430.83	**<0.001**	0.001 [−0.001; 0.004]
	Range (min÷max)	20÷53	0÷23			
CDI-2	*Me* (IQR)	32 (8)	7 (11)	BM(88.50) = −84.30	**<0.001**	0.001 [−0.003; 0.021]
	Range (min÷max)	13÷43	0÷20			
Psychiatric hospitalisations	No	17 (27%)	46 (100%)	-	-	-
	Yes	46 (73%)	0 (0.0%)	-	-	-
Taking antidepressants	No	2 (3.2%)	45 (97.8%)	-	-	-
	Yes	61 (96.8%)	1 (2.2%)	-	-	-
Individual psychotherapy	No	1 (1.6%)	40 (87%)	-	-	-
	Yes	62 (98.4%)	6 (13%)	-	-	-
Family therapy	No	11 (17.5%)	45 (97.8%)	-	-	-
	Yes	52 (82.5%)	1 (2.2%)	-	-	-

χ^2 – Pearson's chi-square test; **BDI-II** – Beck Depression Inventory; **BM** – Brunner–Munzel test statistics; **CDI-2** – Children's Depression Inventory-2; **CG** – clinical group – adolescents with depressive episode; **HC** – healthy controls; ***Me* (IQR)** – median (interquartile range); ***SD*** – standard deviation; **TRS-Z** – Word Comprehension Test – advanced version.

[a] The effect strength for the chi-square test is the phi coefficient (φ), and for the Brunner–Munzel test, the relative effect was treated as the effect strength, taking into account the 95% confidence interval.

Tab. 1. Basic demographic and clinical characteristics

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Variables	Descriptive statistics	CG ($n = 63$)	HC ($n = 46$)	Test statistics	p	Effect size[a]
Attention						
d2 CP Concentration	Mean (*SD*)	187.81 (24.62)	207.74 (17.53)	$t(106.95) = -4.94$	**<0.001**	0.93
	Range (min÷max)	149 (120÷269)	86 (160÷246)			
Processing speed and divided attention						
CTT-1	Mean (*SD*)	40.71 (9.61)	30.98 (6.38)	$t(106.15) = 6.35$	**<0.001**	1.19
	Range (min÷max)	54 (16÷70)	28 (18÷46)			
CTT-2	*Me* (IQR)	98 (36)	72 (17.75)	BM(81.64) = −6.36	**<0.001**	0.22 [0.13; 0.30]
	Range (min÷max)	86 (44÷130)	66 (33÷99)			
Cognitive flexibility (EF)						
The Brixton Spatial Anticipation Test	*Me* (IQR)	21 (7.50)	12 (6.00)	BM(106.18) = −9.05	**<0.001**	0.16 [0.09; 0.23]
	Range (min÷max)	43 (6÷49)	15 (7÷22)			
Planning (EF)						
RFFT total number of unique designs	Mean (*SD*)	76.52 (20.52)	101.00 (15.44)	$t(107) = -6.80$	**<0.001**	1.32
	Range (min÷max)	125 (14÷139)	71 (69÷140)			
RFFT error rate	*Me* (IQR)	0.00 (0.04)	0.00 (0.03)	BM(106.14) = −1.08	0.282	0.45 [0.35; 0.55]
	Range (min÷max)	6.00 (0÷6)	0.13 (0÷0.13)			
TOLDX2 Total moves	Mean (*SD*)	38.21 (11.27)	27.89 (7.56)	$t(107) = 5.38$	**<0.001**	0.62
	Range (min÷max)	56 (12÷68)	35 (11÷46)			
TOLDX2 Total correct score	*Me* (IQR)	3 (2)	5 (2)	BM(104.86) = 10.56	**<0.001**	0.86 [0.80; 0.93]
	Range (min÷max)	9 (0÷9)	5 (2÷7)			
Inhibitory control (EF)						
TOLDX2 Total rule violations	*Me* (IQR)	0 (0.50)	0 [the variable does not take different values]	-	-	-
	Range (min÷max)	3 (0÷3)				

BM – Brunner–Munzel test statistics; **CTT** – Color Trails Test; **CVLT** – California Verbal Learning Test; ***Me* (IQR)** – median (interquartile range); **RFFT** – Ruff Figural Fluency Test; ***SD*** – standard deviation; **TOLDX2** – Tower of London – Drexel University 2nd edition.

[a] For the Student's *t*-test for independent samples, Cohen's *d* was calculated, and for the Brunner–Munzel test, a relative effect was computed. In the case of d2 CP Concentration and CTT-1, Welch's correction was used for the Student's *t*-test due to the failure to eet the assumption of homogeneity of variances. For RFFT total number of unique designs and for TOLDX2 Total moves this assumption was met, so the test was reported without correction. For TOLDX2 Total rule violations, constant values were recorded in the HC group, therefore comparisons were abandoned.

Tab. 2. Comparison of the selected aspects of cognitive performance (attention, processing speed and divided attention, executive function – EF) in adolescents with a depressive episode (clinical group, CG) and healthy controls (HC)

on paediatric population showed prominent deficits not only in phonemic verbal fluency, sustained attention, verbal memory and planning but also in inhibition capacity (Wagner et al., 2015). Thus, it seems that adolescent depression is associated with a combination of deficits in task initiation and inhibition.

As regards gender differences, a meta-analysis by Shorey et al. (2022) revealed that female adolescents exhibit a slightly greater prevalence of elevated depressive symptoms (32%) than their male counterparts (24%). This pattern transcends cultural boundaries, highlighting a predisposition of female adolescents to develop depression. This vulnerability stems from a complex interplay of biological factors, such as genetic predispositions and hormonal variations, alongside psychological and cultural influences, including gender roles (Chentsova-Dutton et al., 2014; Liu et al., 2015; Piccinelli and Wilkinson, 2000). Also, neurobiological mechanisms of reward processing may function differently in young men and women diagnosed with depressive disorder (Han et al., 2012).

AIM OF THE STUDY

The study aimed to assess verbal learning in relation to attention, processing speed, divided attention, and executive functions (planning and cognitive flexibility in particular) in adolescents with a depressive episode. Also, we aimed to identify possible gender differences in the pattern and severity of cognitive impairment. It was hypothesised that adolescents with a depressive episode would exhibit poorer performance in tasks assessing attention, processing speed, working memory and executive function, and would acquire lower scores in verbal learning tasks that are more dependent on executive functions (free recall).

PROCEDURE

All adolescents with a depressive episode attended either the Psychiatric Daycare Ward for Children and Adolescents or Children Outpatient Mental Health Clinic of the Gdańsk Health Centre in Gdańsk. The diagnosis of depression

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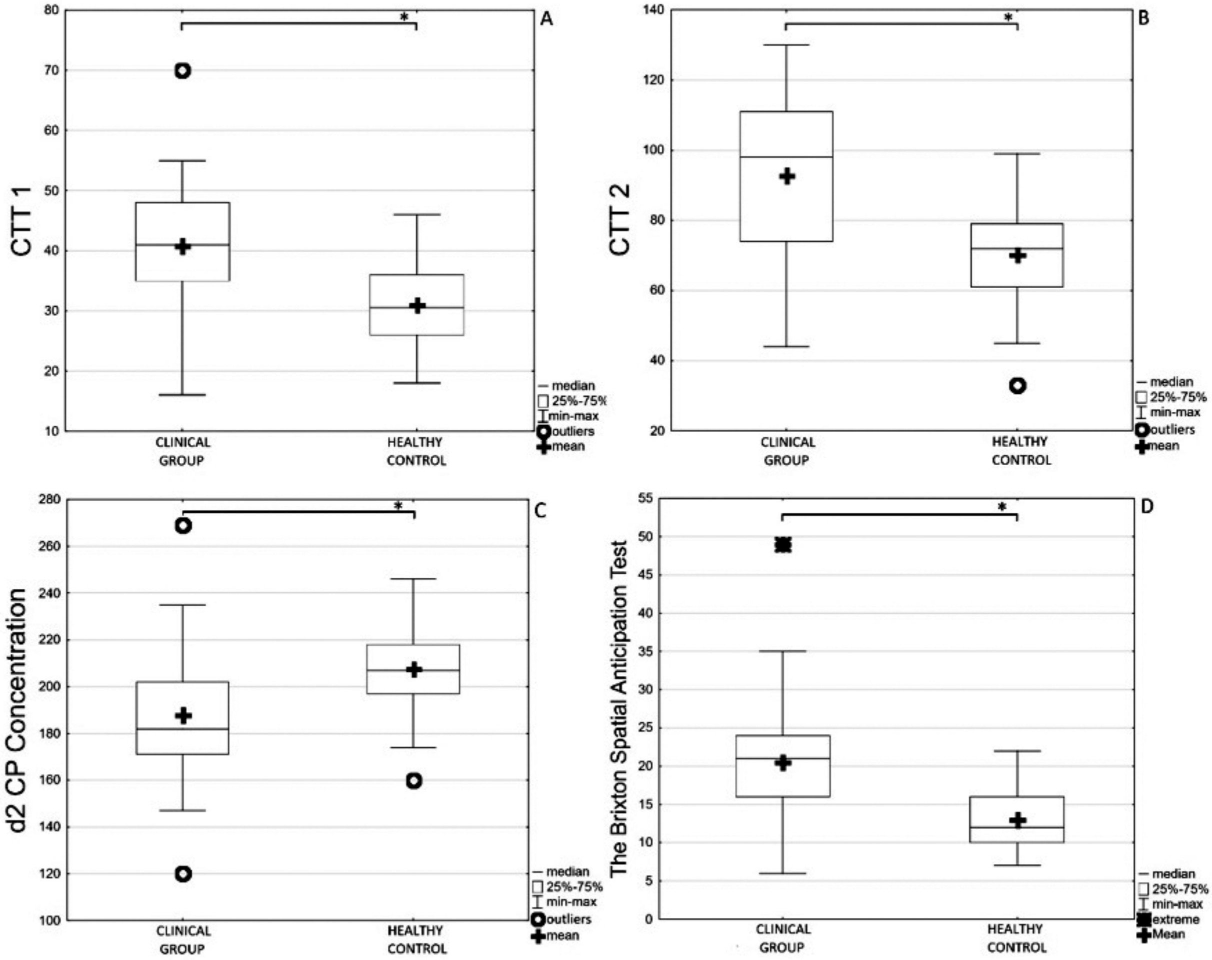

CTT – Color Trails Test.
* $p < 0.05$.

Fig. 1. Comparison of the selected aspects of cognitive performance. **A.** *CTT 1 (raw score – seconds).* **B.** *CTT 2 (raw score – seconds).* **C.** *d2 CP Concentration (raw score).* **D.** *The Brixton Spatial Anticipation Test (raw score)*

was established by a psychiatrist prior to the study procedures. The control group comprised students of the Maritime School Complex in Gdańsk. Informed consent was obtained from both the adolescent and his/her mother. The study was approved by the Bioethics Committee of the Medical University of Gdańsk (NKBBN/478/2018-2019).

PARTICIPANTS

The study sample consisted of 63 teenagers diagnosed with a depressive episode (56% girls), aged 16.92 ± 1.3 years, and 43 healthy adolescents (48% girls), aged 17.24 ± 1.16 years, matched for gender, age, and overall intellectual performance (Tab. 1). The inclusion criteria were defined as follows: existing depressive episode (F32) according to the ICD-10 classification (World Health Organization, 2016), and age 14–19 years. The exclusion criteria were specified as follows: existing significant somatic diseases in the child (cancer, diabetes, cystic fibrosis, etc.), history of traumatic brain injury or other neurological conditions (e.g. epilepsy, encephalitis, cerebral palsy) and other mental health disorders (such as schizophrenia, eating disorders, etc.), as well as specific learning difficulties.

Importantly, differences in the severity of depressive symptoms between the groups were consistent with the medical diagnosis (Tab. 1).

METHODS

Adolescents completed questionnaires for mood and cognitive assessments, including the Polish version of the Children's Depression Inventory-2 (CDI-2) (Kovacs et al., 2017), and the Beck Depression Inventory-II (BDI-II) (Beck et al., 2019) and they took part in a structured interview. General intellectual ability was assessed using the Word Comprehension Test – advanced version (TRS-Z) (Matczak et al., 2012).

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Variables: CVLT	Descriptive statistics	CG ($n = 63$)	HC ($n = 46$)	Test statistics	*p*	Relative effect [95% CI]
Total Learning Trials 1–5 Correct	*Me* (IQR)	47 (9)	52 (11.25)	BM(90.90) = 6.65	**<0.001**	0.79 [0.70; 0.87]
	Range (min÷max)	34 (32÷66)	19 (47÷66)			
Trial 1 Correct	*Me* (IQR)	6 (3)	8 (2)	BM(105.12) = 3.87	**<0.001**	0.69 [0.59; 0.79]
	Range (min÷max)	5 (5÷10)	4 (6÷10)			
Trial 5 Correct	*Me* (IQR)	12 (2)	13 (2)	BM(100.61) = 6.20	**<0.001**	0.77 [0.68; 0.85]
	Range (min÷max)	8 (8÷16)	6 (10÷16)			
List B Correct	*Me* (IQR)	5 (1.5)	6 (2)	BM(96.00) = 5.45	**<0.001**	0.74 [0.65; 0.83]
	Range (min÷max)	8 (3÷11)	8 (3÷11)			
Short-Delay Free-Recall Correct	*Me* (IQR)	11 (2)	13 (1.75)	BM(91.89) = 4.89	**<0.001**	0.74 [0.64; 0.84]
	Range (min÷max)	15 (1÷16)	15 (1÷16)			
Long-Delay Free-Recall Correct	*Me* (IQR)	11 (2)	12 (1)	BM(99.30) = 5.25	**<0.001**	0.74 [0,65; 0.83]
	Range (min÷max)	8 (8÷16)	7 (9÷16)			
Short-Delay Cued-Recall Correct	*Me* (IQR)	11 (2)	12 (1.75)	BM(105.34) = 5.37	**<0.001**	0.74 [0.65; 0.83]
	Range (min÷max)	8 (7÷15)	4 (11÷15)			
Long-Delay Cued-Recall Correct	*Me* (IQR)	11 (2)	12 (2)	BM(106.90) = 3.83	**<0.001**	0.68 [0.59; 0.78]
	Range (min÷max)	8 (8÷16)	6 (10÷16)			
Semantic Cluster Ratio	*Me* (IQR)	0.88 (1.20)	1.60 (0.67)	BM(97.66) = 5.12	**<0.001**	0.74 [0.65; 0.83]
	Range (min÷max)	2.83 (0÷2.83)	2.27 (0.39÷2.66)			
Serial Cluster Ratio	*Me* (IQR)	4.29 (3.90)	3.6 (2.69)	BM(105.61) = −3.14	**0.002**	0.34 [0.23; 0.44]
	Range (min÷max)	8.69 (0.85÷9.54)	8.58 (0.96÷9.54)			
Long Delay Yes/No Recognition: Hits	*Me* (IQR)	14 (2)	16 (2)	BM(68.27) = 4.38	**<0.001**	0.73 [0.62; 0.83]
	Range (min÷max)	7 (9÷16)	7 (9÷16)			
Long Delay Recognition Discriminability	*Me* (IQR)	95 (5)	100 (5)	BM(67.71) = 4.38	**<0.001**	0.73 [0.62; 0.83]
	Range (min÷max)	16 (84÷100)	16 (84÷100)			
Long Felay Yes/No Recognition: False Positives	*Me* (IQR)	0 (0)	0 (0)	BM(106.68) = −1.31	0.194	0.47 [0.42; 0.52]
	Range (min÷max)	2 (0÷2)	2 (0÷2)			
Total Free-Recall Intrusions in Immediate Recall	*Me* (IQR)	−0.33 (0.5)	0 (0.30)	BM(98.19) = 2.95	**0.004**	0.64 [0.55; 0.74]
	Range (min÷max)	0.75 (−0.75÷0)	0.75 (−0.75÷0)			

BM – Brunner–Munzel test statistics; **CG** – clinical group; **CVLT** – California Verbal Learning Test; **HC** – healthy controls; ***Me* (IQR)** – median (interquartile range); ***SD*** – standard deviation.

Tab. 3. Comparison of verbal learning performance (CVLT – California Verbal Learning Test) in adolescents with a depressive episode (clinical group, CG) and healthy controls (HC)

Attention was assessed using the d2 test (Brickenkamp et al., 2020) and the Color Trails Test (CTT) (Łojek and Stańczak, 2012) was applied as a measure of processing speed and divided attention. Verbal learning was assessed with the California Verbal Learning Test (CVLT) (Łojek and Stańczak, 2010). In addition to immediate and delayed recall measures, two aspects of learning strategies were assessed: semantic clustering (semantic cluster ratio) and serial clustering (serial cluster ratio). Planning was assessed with the use of the Ruff Figural Fluency Test (RFFT) (Łojek and Stańczak, 2005) and the Tower of London test – Drexel University 2nd edition (TOLDX-2) (Culbertson and Zillmer, 2005), while the Brixton Spatial Anticipation Test was used as a measure of cognitive flexibility (Burgess and Shallice, 1997; Scherman et al., 2023).

STATISTICAL ANALYSIS

The statistical analysis was conducted using the STATISTICA 13.3 and Jamovi 2.3.28 software, with the level of significance set at $\alpha = 0.05$. The Shapiro–Wilk test was used to verify the normality of variable distribution. Intergroup comparisons were performed with the use of the χ^2 test for categorical variables, and either the Student's *t*-test or the Brunner–Munzel test for independent groups, relative to the data distribution. The rho Spearman rank correlation coefficient was used in the correlation analysis. Two-factor comparison: gender and study group (clinical group, CG vs. healthy controls, HC), was performed separately for inter-gender comparisons within the study group and separately for inter-group comparisons within gender due to the lack of a satisfactory equivalent of non-parametric two-way analysis of variance (ANOVA). Additionally, the FDR correction was applied using the Benjamini–Hochberg procedure for multiple comparisons within the compared variables.

RESULTS

In the first step, the characteristics of the adolescents in the control group and in the clinical group were compared in

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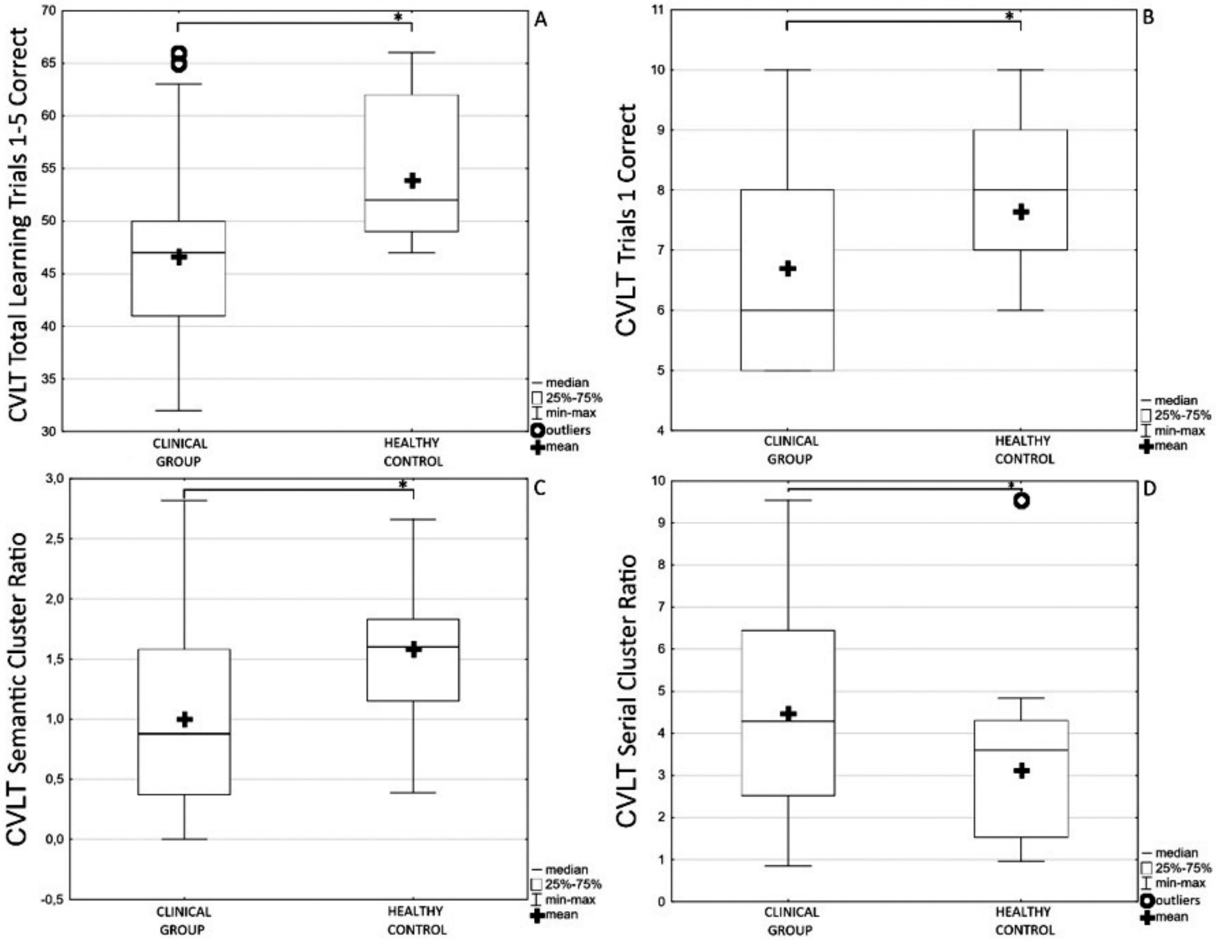

CVLT – California Verbal Learning Test.
* $p < 0.05$.

Fig. 2. Comparison of verbal learning performance. **A.** *CVLT Total Learning Trials 1–5 Correct (raw score).* **B.** *CVLT Trials 1 Correct (raw score).* **C.** *CVLT Semantic Cluster Ratio (raw score).* **D.** *CVLT Serial Cluster Ratio (raw score)*

terms of age and gender. In this case, no significant differences were noted. Additionally, the groups were compared in terms of general intelligence (TRS-Z), and depressive symptoms (BDI-II, CDI-2). Statistically significant differences were observed only in depressive symptoms. Considering that the relative effect is close to 0, these effects are very strong. CG subjects had higher levels of depression and emotional problems than HC subjects (Tab. 1).

Group differences in the cognitive functioning between adolescents with a depressive episode and their healthy peers

In order to identify the differences between the CG and HC groups, comparisons were performed taking into account attention, memory, cognitive flexibility, planning and inhibitory control. In the case of inhibition, comparison could not be performed due to the constant value of the variable in the HC group. Adolescents with a depressive episode presented significantly poorer performance than their healthy peers in all measured aspects of cognitive functioning (Tab. 2, Fig. 1). The observed effects based on Cohen's d indicate strong differences, while based on the relative effect they differed from the target value (50%) by 15–36%, which suggests effects of moderate strength (Tab. 2).

As regards verbal learning (CVLT) only false positive recognitions did not differentiate the groups. The strongest effects in these comparisons were recorded for Total Learning Trials 1–5 Correct, and the weakest for Total Free-Recall Intrusions in Immediate Recall (Tab. 3, Fig. 2).

Analysis of the cognitive performance pattern in the group with a depressive episode

In order to identify relationships between the severity of depressive symptoms in CG and cognitive functioning, a correlation analysis was performed. Non-parametric analysis

Variables	Spearman's ρ (Rank Correlation)	*p*
d2 CP Concentration	−0.31	**0.013**
CTT-1	0.07	0.601
CTT-2	0.20	0.114
The Brixton Spatial Anticipation Test	0.17	0.176
RFFT total number of unique designs	−0.13	0.300
RFFT error rate	−0.20	0.119
TOLDX2 Total moves	0.02	0.875
TOLDX2 Total correct score	0.04	0.740
TOLDX2 Total rule violations	−0.14	0.270
CVLT – Total Learning Trials 1–5 Correct	−0.29	**0.022**
CVLT Trial 1 Correct	−0.17	0.176
CVLT Trial 5 Correct	−0.29	**0.020**
CVLT List B Correct	0.01	0.958
CVLT Short-Delay Free-Recall Correct	−0.32	**0.011**
CVLT Long-Delay Free-Recall Correct	−0.34	**0.007**
CVLT Short-Delay Cued-Recall Correct	−0.17	0.176
CVLT Long-Delay Cued-Recall Correct	−0.08	0.542
CVLT Semantic Cluster Ratio	−0.17	0.176
CVLT Serial Cluster Ratio	0.19	0.129
CVLT Long Delay Yes/No Recognition: Hits	−0.16	0.206
CVLT Long Delay Recognition Discriminability	−0.17	0.174
CVLT Long Delay Yes/No Recognition: False Positives	0.07	0.612
CVLT Total Free-Recall Intrusions in Immediate Recall	−0.12	0.340
CDI-2 – Children Depression Inventory-2; **CTT** – Color Trails Test; **CVLT** – California Verbal Learning Test; **RFFT** – Ruff Figural Fluency Test; **TOLDX2** – Tower of London – Drexel University 2nd edition.		

*Tab. 4. Results of the correlation analysis between mood (CDI-2) and cognitive functioning in adolescents with a depressive episode (*n *= 63)*

(Spearman's rho) was performed because the normality assumption was violated and outliers were visible in the scatterplots. However, no relationship was classified as curvilinear. The results of the analysis are presented in Tab. 4. The results showed significant relationships between the severity of depressive symptoms and attention (moderate relationship) and verbal learning: CVLT – Total Learning Trials 1–5 Correct, CVLT Trials 5 Correct (weak relationship), and CVLT Short-Delay Free-Recall Correct, CVLT Long-Delay Free-Recall Correct (moderate relationship). Greater severity of depressive symptoms is associated with poorer attention and verbal learning.

Gender differences in cognitive function

For intergroup comparisons: depressive episode vs. HC and intergender comparisons: girls vs. boys, a series of comparisons was performed. In the group of adolescents with depression, boys performed better than girls in tasks assessing attention (d2), and planning (TOLDX2, RFFT). However, girls scored higher in CVLT immediate recall (trial 1) (Tab. 5, Fig. 3).

In the group of healthy adolescents, a similar pattern of results was found in TOLDX2. However, in CVLT the pattern of results showed a slightly better performance of male participants in overall immediate recall and long-delay cued recall. Notably, healthy girls used serial clustering strategy more often than boys (Tab. 6).

Subsequently, further comparisons between CG and HC were performed for each gender separately. Overall pattern of results is similar in both genders. However, while immediate memory (CVLT Trial 1) differentiated between CG and HC boys, it was comparable in girls in both groups. Additionally, boys with depression used serial clustering strategy in verbal learning more often than their healthy peers, while this difference was not present in girls (Tabs. 7 and 8).

In the next step, analyses were carried out to check whether the differences would persist after applying the correction for multiple comparisons (FDR, Benjamini–Hochberg procedure). The results did not change significantly. The corrected *p*-values are greater than the 0.05 threshold for all d2 %B comparisons, raw score and d2 score range limits. Moreover, in the group of healthy adolescents, no differences were observed between boys and girls in terms

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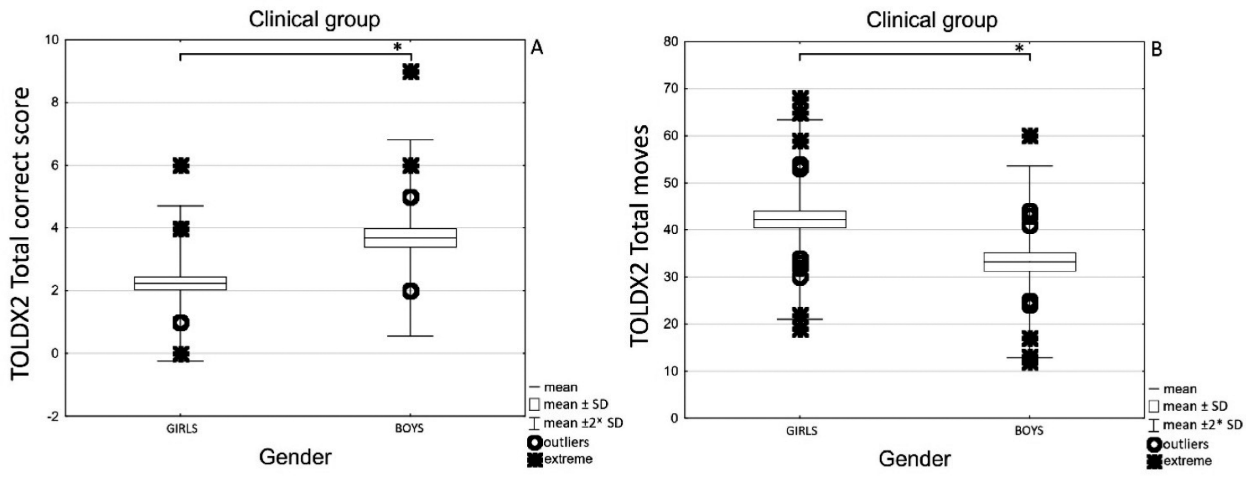
Variables	CG		Test statistics	*p*	Effect size
	Girls (*n* = 35)	Boys (*n* = 28)			
	M/Me **(*SD*/IQR)**	***M/Me*** **(*SD*/IQR)**			
Age	17 (2)	17 (2)	BM(59.27) = −0.08	0.938	0.49 [0.35; 0.64]
d2 CP Concentration	175 (33)	190.5 (22.25)	BM(59.19) = 2.34	**0.023**	0.66 [0.52; 0.80]
CTT-1[a]	41.23 (22.29)	40.07 (9.65)	*t*(61) = 0.47	0.639	0.12
CTT-2	96 (35)	100 (35.25)	BM(55.64) = −0.19	0.850	0.49 [0.34; 0.64]
The Brixton Spatial Anticipation Test	20 (6.5)	21.5 (9)	BM(60.80) = 0.14	0.891	0.51 [0.36; 0.82]
RFFT total number of unique designs	71 (20)	85.5 (29.75)	BM(48.13) = 2.49	**0.016**	0.69 [0.53; 0,82]
RFFT error rate	0.03 (0.05)	0 (0.02)	BM(60.76) = −3.06	**0.003**	0.31 [0.19; 0.43]
TOLDX2 Total moves[a]	42.2 (10.6)	33.21 (10.19)	*t*(61) = 3.40	**0.001**	0.86
TOLDX2 Total correct score	2 (2)	3 (2)	BM(60.80) = 4.97	**<0.001**	0.78 [0.67; 0.89]
TOLDX2 Total rule violations	0 (1)	0 (0)	BM(58.77) = −2.57	**0.013**	0.37 [0.27; 0.47]
CVLT – Total Learning Trials 1–5 Correct[a]	48.34 (7.64)	44.61 (7.61)	*t*(61) = 1.93	0.058	0.49
CVLT Trial 1 Correct	7 (2)	6 (2)	BM(58.14) = −2.73	**0.008**	0.32 [0.18; 0.45]
CVLT Trial 5 Correct	12 (2)	11 (2)	BM(60.89) = −1.62	0.111	0.39 [0.25; 0.53]
CVLT List B Correct	5 (2)	5 (1)	BM(60.82) = 0.23	0.820	0.52 [0.38; 0.65]
CVLT Short-Delay Free-Recall Correct	11 (2.5)	11 (2.5)	BM(60.62) = 0.44	0.664	0.53 [0.39; 0.68]
CVLT Long-Delay Free-Recall Correct	11 (2.5)	11.5 (2)	BM(56.75) = 1.00	0.321	0.57 [0.43; 0.72]
CVLT Short-Delay Cued-Recall Correct[a]	10.91 (1.54)	11.11 (1.77)	*t*(61) = −0.46	0.646	0.12
CVLT Long-Delay Cued-Recall Correct	11 (2)	11 (2)	BM(60.87) = −0.16	0.876	0.49 [0.35; 0.63]
CVLT Semantic Cluster Ratio	0.88 (1.05)	0.85 (1.26)	BM(41.70) = −0.63	0.532	0.45 [0.29; 0.61]
CVLT Serial Cluster Ratio	3.68 (3.63)	4.41 (3.27)	BM(60.64) = 1.88	0.065	0.64 [0.49; 0.78]
CVLT Long Delay Yes/No Recognition: Hits	14 (2)	14 (1)	BM(60.71) = 0.81	0.424	0.56 [0.41; 0.70]
CVLT Long Delay Recognition Discriminability	95 (5)	95 (5)	BM(60.72) = 0.74	0.463	0.55 [0.41; 0.70]
CVLT Long delay Yes/No Recognition: False Positives	0 (0)	0 (0)	BM(59.72) = −0.13	0.900	0.50 [0.41; 0.58]
CVLT Total Free-Recall Intrusions in Immediate Recall	−0.33 (0.5)	−0.33 (0.33)	BM(58.76) = 0.36	0.722	0.53 [0.39; 0.67]

BM – Brunner–Munzel test statistics; **CG** – clinical group; **CTT** – Color Trails Test; **CVLT** – California Verbal Learning Test; **IQR** – interquartile range; ***M*** – mean; ***Me*** – median; **RFFT** – Ruff Figural Fluency Test; ***SD*** – standard deviation; **TOLDX2** – Tower of London – Drexel University 2nd edition.
[a] Since all assumptions were fulfilled, a parametric test was used: Student's *t*-test for independent samples and adequate descriptive statistics (*M* and *SD*). For other comparisons, the Brunner–Munzel test was performed and the median and interquartile range were reported. For the *t*-test, Cohen's d was reported as the effect size, and for the Brunner–Munzel test, the absolute effect with a 95% confidence interval was reported.

Tab. 5. Gender comparisons performed in adolescents with a depressive episode (CG – clinical group)



TOLDX2 – Tower of London – Drexel University 2nd edition.
* $p < 0.05$.

Fig. 3. Gender differences in planning in adolescents with a depressive episode. **A.** *TOLDX2 Total correct score (raw score).* **B.** *TOLDX2 Total moves (raw score)*

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Variables	HC		Test statistics	*p*	Effect size
	Girls (*n* = 22)	Boys (*n* = 24)			
	M/Me (*SD*/IQR)	*M/Me* (*SD*/IQR)			
Age	17 (2)	17 (2)	BM(41.68) = 0.35	0.731	0.53 [0.36; 0.70]
d2 CP Concentration	211 (25.5)	205 (8.75)	BM(36.92) = −1.39	0.173	0.38 [0.20; 0.56]
CTT-1[a]	32.77 (6.60)	29.33 (5.82)	*t*(44) = 1.87	0.067	0.55
CTT-2[a]	71.41 (14.94)	69.13 (13.89)	*t*(44) = 0.54	0.594	0.16
The Brixton Spatial Anticipation Test[a]	13.82 (4.5)	12.25 (3.33)	*t*(44) = 1.35	0.183	0.40
RFFT total number of unique designs[a]	101.36 (17.78)	100.67 (13.31)	*t*(44) = 0.15	0.880	0.05
RFFT error rate	0 (0.01)	0.01 (0.03)	BM(42.82) = 1.63	0.110	0.63 [0.47; 0.78]
TOLDX2 Total moves[a]	29.82 (6.12)	26.13 (8.43)	*t*(44) = 1.69	0.099	0.50
TOLDX2 Total correct score	5 (1)	6 (1)	BM(43.99) = 4.36	**<0.001**	0.78 [0.65; 0.91]
TOLDX2 Total rule violations	-	-	-	-	-
CVLT – Total Learning Trials 1–5 Correct	51.5 (4.75)	53.5 (14)	BM(38.13) = 2.21	**0.033**	0.68 [0.52; 0.84]
CVLT Trial 1 Correct	7 (1)	8 (2.25)	BM(36.63) = 1.38	0.177	0.62 [0.45; 0.79]
CVLT Trial 5 Correct	12 (1)	13 (2)	BM(35.70) = 2.09	**0.044**	0.66 [0.51; 0.82]
CVLT List B Correct	6 (1)	6 (2.25)	BM(41.44) = −0.70	0.486	0.44 [0.27; 0.61]
CVLT Short-Delay Free-Recall Correct	12 (2)	13 (1)	BM(40.57) = 0.98	0.334	0.58 [0.41; 0.75]
CVLT Long-Delay Free-Recall Correct	12 (1)	12 (1.25)	BM(40.11) = −0.08	0.937	0.49 [0.32; 0.66]
CVLT Short-Delay Cued-Recall Correct	12 (1.75)	12.5 (1)	BM(43.45) = 1.88	0.067	0.65 [0.49; 0.81]
CVLT Long-Delay Cued-Recall Correct	11 (1)	12 (1)	BM(40.68) = 2.53	**0.015**	0.70 [0.54; 0.86]
CVLT Semantic Cluster Ratio[a]	1.39 (0.58)	1.78 (0.45)	*t*(44) = −2.55	**0.014**	−0.75
CVLT Serial Cluster Ratio	3.99 (0.99)	1.95 (2.29)	BM(40.98) = −3.93	**<0.001**	0.22 [0.07; 0.36]
CVLT Long Delay Yes/No Recognition: Hits	16 (0)	16 (2.25)	BM(35.75) = −2.19	**0.035**	0.35 [0.21; 0.49]
CVLT Long Delay Recognition Discriminability	100 (0)	100 (5.5)	BM(34.86) = −2.22	**0.033**	0.35 [0.21; 0.49]
CVLT Long Delay Yes/No Recognition: False Positives	0 (0)	0 (0)	-	-	-
CVLT Total Free-Recall Intrusions in Immediate Recall	0 (0)	0 (0.33)	BM(37.03) = −3.03	**0.004**	0.32 [0.19; 0.44]

BM – Brunner–Munzel test statistics; **CTT** – Color Trails Test; **CVLT** – California Verbal Learning Test; **HC** – healthy controls; **IQR** – interquartile range; ***M*** – mean; ***Me*** – median; **RFFT** – Ruff Figural Fluency Test; ***SD*** – standard deviation; **TOLDX2** – Tower of London –Drexel University 2nd edition.
[a] Since all assumptions were fulfilled, a parametric test was used: Student's *t*-test for independent samples and adequate descriptive statistics (*M* and *SD*). For other comparisons, the Brunner–Munzel test was performed and the median and interquartile range were reported. For the *t*-test, Cohen's *d* was reported as the effect size, and for the Brunner–Munzel test, the absolute effect with a 95% confidence interval was reported.

Tab. 6. Gender comparisons performed in healthy controls (HC)

of learning abilities (CVLT Trials 5 Correction, CVLT Long Delay Yes/No Recognition: Hits, CVLT Long Delay Recognition Discriminability) after the correction was applied.

DISCUSSION

Adolescents diagnosed with a depressive episode in our study presented with notable cognitive deficits, manifesting as impaired attention, processing speed, divided attention and executive function. To the best of our knowledge, this is the first study documenting such deficits in an outpatient adolescent cohort with a depressive episode in Poland. The identified deficits in attention are consistent with the findings reported in the literature (Schumacher et al., 2024). However, our study also demonstrated deficits in processing speed and short-term memory, which have not been consistently reported in prior paediatric research (Schumacher et al., 2024). This disparity in the results may be attributed to the limited inclusion of the studies investigating processing speed and short-term memory in the meta-analysis by Schumacher et al.

The pattern of verbal learning deficits in adolescents diagnosed with a depressive episode corresponds to that demonstrated in adult depression (Hammar et al., 2022). Our study highlights substantial differences between individuals with a depressive episode and healthy controls across all recall measures in CVLT, i.e. in immediate and delayed recall (both short and long-delay). Notably, adolescents with a depressive episode relied more on serial clustering than on semantic clustering. As both groups were matched in terms of intellectual functioning with the use of a verbal semantic task, this pattern of performance is likely to stem from executive deficits. Furthermore, participants' performance in CVLT free recall tasks was found to be significantly associated with mood states. It is possible that the intensity of depressive mood, particularly intrusive negative thoughts, to a greater extent impacts performance in complex verbal tasks which are more prone to interfere with depressive thoughts than the visuospatial tasks. Overall verbal learning has been much more frequently assessed in individuals with a depressive episode in the context of clinical trials (Bakkour et al., 2014). It would be worthwhile to compare the effect

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Variables	Girls		Test statistics	*p*	Effect size
	CG (*n* = 35)	HC (*n* = 22)			
	M/Me (*SD*/IQR)	*M/Me* (*SD*/IQR)			
Age	17 (2)	17 (2)	BM(53.48) = 0.67	0.505	0.55 [0.40; 0.70]
d2 CP Concentration[a]	181.74 (24.14)	210.86 (18.29)	*t*(55) = –4.85	**<0.001**	1.32
CTT-1[a]	41.23 (22.29)	32.77 (6.60)	*t*(55) = 3.56	**<0.001**	0.98
CTT-2[a]	93.71 (22.29)	71.41 (14.94)	*t*(55) = 4.14	**<0.001**	1.13
The Brixton Spatial Anticipation Test	20 (6.5)	12.5 (6)	BM(52.03) = –5.01	**<0.001**	0.20 [0.08; 0.32]
RFFT total number of unique designs	70.80 (18.22)	101.36 (17.78)	*t*(55) = –6.22	**<0.001**	1.69
RFFT error rate	0.03 (0.05)	0 (0.01)	BM(49,74) = –2.94	**0.005**	0.31 [0.17; 0.44]
TOLDX2 Total moves[ab]	42.2 (10.6)	29.82 (6.12)	*t*(54.70) = 5.58	**<0.001**	1.43
TOLDX2 Total correct score	2 (2)	5 (1)	BM(52.24) = 9.53	**<0.001**	0.90 [0.81; 0.98]
TOLDX2 Total rule violations	0 (1)	-	-	**-**	-
CVLT – Total Learning Trials 1–5 Correct	47 (8.5)	51.5 (4.75)	BM(42.74) = 2.68	**0.010**	0.69 [0.55; 0.83]
CVLT Trial 1 Correct	7 (2)	7 (1)	BM(54.55) = 0.90	0.371	0.57 [0.42; 0.72]
CVLT Trial 5 Correct	12 (2)	12 (1)	BM(49.69) = 2.58	**0.013**	0.67 [0.54; 0.81]
CVLT List B Correct	5 (2)	6 (1)	BM(45.55) = 4.18	**<0.001**	0.77 [0.64; 0.90]
CVLT Short-Delay Free-Recall Correct	11 (2.5)	12 (2)	BM(54.08) = 3.97	**<0.001**	0.75 [0.63; 0.88]
CVLT Long-Delay Free-Recall Correct	11 (2.5)	12 (1)	BM(55.00) = 5.66	**<0.001**	0.80 [0.70; 0.91]
CVLT Short-Delay Cued-Recall Correct	11 (2)	12 (1.75)	BM(54.88) = 3.30	**0.002**	0.71 [0.58; 0.84]
CVLT Long-Delay Cued-Recall Correct	11 (2)	11 (1)	BM(55.00) = 1.23	0.225	0.59 [0.44; 0.73]
CVLT Semantic Cluster Ratio	0.88 (1.05)	1.39 (0.58)	BM(54.99) = 2.31	**0.025**	0.67 [0.52; 0.81]
CVLT Serial Cluster Ratio	3.68 (3.63)	3.99 (0.99)	BM(53.77) = 0.27	0.787	0.52 [0.36; 0.68]
CVLT Long Delay Yes/No Recognition: Hits	14 (2)	16 (0)	BM(44.73) = 7.19	**<0.001**	0.86 [0.76; 0.96]
CVLT Long Delay Recognition Discriminability	95 (5)	100 (0)	BM(46.56) = 7.41	**<0.001**	0.86 [0.76; 0.96]
CVLT Long Delay Yes/No Recognition: False Positives	0 (0)	0 (0)	-	-	-
CVLT Total Free-Recall Intrusions in Immediate Recall	–0.33 (0.5)	0 (0)	BM (53.11) = 4.46	**<0.001**	0.73 [0.63; 0.84]

BM – Brunner–Munzel test statistics; **CG** – clinical group; **CTT** – Color Trails Test; **CVLT** – California Verbal Learning Test; **HC** – healthy controls; **IQR** – interquartile range; ***M*** – mean; ***Me*** – median; **RFFT** – Ruff Figural Fluency Test; ***SD*** – standard deviation; **TOLDX2** – Tower of London – Drexel University 2nd edition.
[a] Since all assumptions were fulfilled, a parametric test was used: Student's *t*-test for independent samples and adequate descriptive statistics (*M* and *SD*). For other comparisons, the Brunner–Munzel test was performed and the median and interquartile range were reported. For the *t*-test, Cohen's *d* was reported as the effect size, and for the Brunner–Munzel test, the absolute effect with a 95% confidence interval was reported.
[b] The test was reported with Welch's correction due to the violation of the assumption of homogeneity of variances.

Tab. 7. Gender comparisons performed in females (CG – clinical group vs. HC – healthy controls)

of depressed mood on verbal and visuospatial learning in future research, as most studies to date focused on verbal or visual memory, and did not compare the process of learning and recall (free vs. cued) of verbal and visuospatial material. Since adolescents with depression find it difficult to spontaneously use learning strategies, such as semantic clustering, and at the same time they present with impaired set-shifting, they are unlikely to promptly modify the strategy that turns out to be inefficient. This problem is highly relevant during adolescence when educational requirements for self-study increase considerably in comparison with earlier periods. Usually, structured material is recalled better than unstructured (Polyn et al., 2009). However, in many educational contexts, when the students are faced with large portions of material to read, it is up to the learner to identify the core of the material to be grasped, and to determine the links between different concepts that may facilitate learning. Possibly, if useful strategies were demonstrated to adolescents with a depressive episode, they could at least try to benefit from them when learning on their own.

In the adult population, semantic clustering is positively associated with employment (Williams et al., 2021). However, research exploring the educational implications of depression in adolescence remains limited (Urbańska-Grosz et al., 2023). The adoption of new learning strategies by adolescents with depression may indeed present challenges, particularly related to motivation. Nevertheless, it would be worthwhile to investigate whether strategies that are initially taught by and practiced under the guidance of a tutor can be effectively implemented during self-study sessions, especially in preparation for exams. Such research could explore the potential efficacy of structured learning interventions for adolescents with a depressive episode, providing insights into ways to support their academic success despite the cognitive challenges associated with their condition.

Our findings show that adolescents with a depressive episode present with impaired set-shifting abilities measured by the Brixton Spatial Anticipation Test. This result is consistent with findings reported by the majority of earlier studies using either the Wisconsin Card Sorting Test

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Variables	Boys		Test statistics	p	Effect size
	CG ($n = 28$)	HC ($n = 24$)			
	M/Me (*SD*/IQR)	*M/Me* (*SD*/IQR)			
Age	17 (2)	17 (2)	BM(48.33) = 1.27	0.210	0.60 [0.44; 0.75]
d2 CP Concentration	190.5 (22.25)	205 (8.75)	BM(43.40) = 2.36	**0.023**	0.69 [0.53; 0.84]
CTT-1[ab]	40.07 (9.65)	29.33 (5.82)	$t(45.22) = 4.93$	**<0.001**	1.35
CTT-2	100 (35.25)	70 (15.5)	BM(30.75) = −3.79	**<0.001**	0.23 [0.08; 0.37]
The Brixton Spatial Anticipation Test[ab]	20.04 (5.43)	12.25 (12)	$t(45.55) = 6.33$	**<0.001**	1.73
RFFT total number of unique designs[a]	83.68 (21.29)	100.67 (13.31)	$t(50) = -3.38$	**0.001**	0.94
RFFT error rate	0 (0.02)	0.01 (0.03)	BM(48.16) = 1.82	0.074	0.63 [0.49; 0.77]
TOLDX2 Total moves[a]	33.21 (10.19)	26.13 (8.43)	$t(50) = 2.71$	**0.009**	0.75
TOLDX2 Total correct score	3 (2)	6 (1)	BM(40.61) = 7.18	**<0.001**	0.86 [0.76; 0.96]
TOLDX2 Total rule violations	0 (0)	-	-	-	-
CVLT – Total Learning Trials 1–5 Correct	45 (10.5)	53.5 (14)	BM(46.17) = 7.51	**<0.001**	0.87 [0.77; 0.96]
CVLT Trial 1 Correct	6 (2)	8 (2.25)	BM(48.82) = 5.60	**<0.001**	0.81 [0.70; 0.93]
CVLT Trial 5 Correct[a]	11.04 (1.58)	13.17 (1.34)	$t(50) = -5.21$	**<0.001**	1.45
CVLT List B Correct	5 (1)	6 (2.25)	BM(47.41) = 3.29	**0.002**	0.71 [0.58; 0.84]
CVLT Short-Delay Free-Recall Correct	11 (2.5)	13 (1)	BM(39.59) = 2.93	**0.006**	0.73 [0.57; 0.88]
CVLT Long-Delay Free-Recall Correct	11.5 (2)	12 (1.25)	BM(44.68) = 2.44	**0.019**	0.68 [0.53; 0.83]
CVLT Short-Delay Cued-Recall Correct	11 (2)	12.5 (1)	BM(46.14) = 4.07	**<0.001**	0.76 [0.63; 0.89]
CVLT Long-Delay Cued-Recall Correct	11 (2)	12 (1)	BM(49.74) = 4.59	**<0.001**	0.78 [0.66; 0.90]
CVLT Semantic Cluster Ratio	0.85 (1.26)	1.68 (0.5)	BM(33.10) = 4.12	**<0.001**	0.78 [0.64; 0.92]
CVLT Serial Cluster Ratio	4.41 (3.27)	1.95 (2.29)	wBM(49.98) = −5.37	**<0.001**	0.17 [0.05; 0.30]
CVLT Long Delay Yes/No Recognition: Hits	14 (1)	16 (2.25)	BM(31.65) = 1.07	0.295	0.59 [0.42; 0.76]
CVLT Long Delay Recognition Discriminability	95 (5)	100 (5.5)	BM(31.35) = 1.12	0.272	0.59 [0.42; 0.77]
CVLT Long Delay Yes/No Recognition: False Positives	0 (0)	0 (0)	BM(48.98) = −0.23	0.817	0.49 [0.41; 0.57]
Total Free-Recall Intrusions in Immediate Recall	−0.33 (0.33)	0 (0.33)	BM(42.57) = 0.67	0.508	0.55 [0.40; 0.71]

BM – Brunner–Munzel test statistics; **CG** – clinical group; **CTT** – Color Trails Test; **CVLT** – California Verbal Learning Test; **HC** – healthy controls; **IQR** – interquartile range; ***M*** – mean; ***Me*** – median; **RFFT** – Ruff Figural Fluency Test; ***SD*** – standard deviation; **TOLDX2** – Tower of London – Drexel University 2nd edition.
[a] Since all assumptions were fulfilled, a parametric test was used: Student's *t*-test for independent samples and adequate descriptive statistics (*M* and *SD*). For other comparisons, the Brunner–Munzel test was performed and the median and interquartile range were reported. For the t test, Cohen's *d* was reported as the effect size, and for the Brunner–Munzel test, the absolute effect with a 95% confidence interval was reported.
[b] The test was reported with Welch's correction due to the violation of the assumption of homogeneity of variances.

Tab. 8. Gender comparisons performed in males (CG – clinical group vs. HC – healthy controls)

(de Lima and Ciasca, 2010) or the CANTAB Intra-Extra Dimensional Set Shift Test (Bloch et al., 2013; Matthews et al., 2008). Demonstrating sufficient sensitivity of the Brixton Spatial Anticipation Test in depressed adolescents is of practical significance as the test is less perceptually complicated and less dependent on working memory than the more complex assessments.

Our study contributes evidence to the growing body of literature related to planning deficits in adolescent depression. In two different assessments, performed using RFFT and TOLDX2, deficient planning has been documented in adolescents with a depressive episode. In previous studies on adolescent depression, planning was not commonly assessed. The most frequently used planning test was CANTAB Stockings of Cambridge. Its results were usually reported in relation to working memory. In two studies, adolescents with depression performed less effectively than healthy controls (Bloch et al., 2013; Maalouf et al., 2011), while in one study focusing on girls only, the differences were insignificant (Matthews et al., 2008). Also, in another study, the Tower of Hanoi test did not differentiate between depressed and non-depressed girls (McClure et al., 1997). Composite planning scores in another study did not show impaired performance in depressed adolescents (Holler et al., 2014). Notably, the traditional Tower of London test was used in only one study, in which groups were not matched in terms of education (Baune et al., 2012), so the comparability of its findings to our results is limited.

As regards the gender-related differences, our findings show poorer planning performance in girls than boys with a depressive episode. This is consistent with previous findings that highlighted similar differences in visual memory (Matthews et al., 2008) and verbal learning tasks (Horan et al., 1997), while pointing out that planning did not differentiate between depressed and non-depressed girls (Matthews et al., 2008). In our study, we found relatively comparable levels of performance in verbal learning tasks in both gender groups. However, the observed differences in performance

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in the TOLDX2 accompanied with no differences in processing speed suggest that the performance patterns may be attributed to the strategies used by individuals in their approach to the tasks. The TOLDX2 assesses visual planning skills applied in handling visuospatial material. It is widely acknowledged that males typically exhibit better performance than females when confronted with complex visuospatial tasks (Halpern, 2004). It has also been demonstrated that males rely more on visuospatial abilities, while females tend to employ executive functions when performing the tower task (Boghi et al., 2006). Given the fact that the parietal cortex, underlying visuospatial functions, matures earlier than the prefrontal cortex in adolescence (Blakemore and Choudhury, 2006), it is likely that boys with a depressive episode compensate for executive impairments using better visuospatial processing.

LIMITATIONS

Our study has several methodological limitations. Firstly, the sample of adolescents diagnosed with a depressive episode encompassed individuals with varying severity of depressive symptoms. Due to the constraints resulting from the sample size, we were unable to conduct subgroup analyses comparing individuals with different levels of depressed mood.

Secondly, the cognitive assessment was not exhaustive. It was conducted as a part of a larger project that also investigated non-cognitive factors (Urbańska-Grosz et al., 2024). Specifically, the tasks assessing executive function were based solely on visuospatial material processing (such as the RFFT, TOLDX2 and the Brixton Spatial Anticipation Test), however assessment of visuospatial learning was not included. The study sample comprised adolescents aged 15–19 years, but for some of the tests normative data were only available for individuals aged 16 or more (CVLT, TOLDX) or 18 (CTT). Thus, raw scores were included in the analyses. Also, we did not assess hot executive functions, as the cognitive tests administered where not the only tools used in the project, and we could not address all aspects of the executive functions. We decided to focus on these aspects of executive functions that are crucial for learning (e.g. planning and set-shifting). Most of the neuropsychological tests applied, with the exception of CVLT, have rather limited ecological validity.

CONCLUSION

Our study identified prominent cognitive deficits in adolescents with a depressive episode, including impaired attention, processing speed and executive function in a Polish outpatient setting. Boys with a depressive episode performed better than girls in terms of planning. Overall, depressed adolescents used semantic clustering strategy less often than their healthy peers. Verbal learning impairment was associated with the severity of depressed mood in depressive episode group. Adolescents with depressive episode may use inefficient learning strategies, which has particular relevance for self-study.

Comprehensive cognitive assessment in adolescents with a depressive episode should address learning abilities in the context of executive functioning. Gender differences in verbal and visual material processing may be prominent during adolescence. Therapeutic interventions which target learning abilities should take into account gender differences in planning. Qualitative analysis of verbal learning performance, concerning semantic processing and planning, could lead to personalized interventions improving learning outcomes through the use of relevant strategies and potentially leading to better educational achievement.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organisations which might negatively affect the content of this publication and/or claim authorship rights to this publication.

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Author contribution

Original concept of study: JUG, EJS, MW. Collection, recording and/or compilation of data: JUG, AP, BPK, KS. Analysis and interpretation of data: JUG, RS, EJS, DW, MW. Writing of manuscript: JUG, RS, EJS, MW. Critical review of manuscript: EJS, DW, AP, BPK, KS, MW. Final approval of manuscript: JUG, RS, EJS, DW, AP, BPK, KS, MW.

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