University of Groningen

Cognitive control deficits in pediatric frontal lobe epilepsy

van den Berg, Lydia; de Weerd, Al; Reuvekamp, Marieke; van der Meere, Jaap

Published in:
Epilepsy & Behavior

DOI:
[10.1016/j.yebeh.2019.106645](https://doi.org/10.1016/j.yebeh.2019.106645)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2020

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

van den Berg, L., de Weerd, A., Reuvekamp, M., & van der Meere, J. (2020). Cognitive control deficits in pediatric frontal lobe epilepsy. *Epilepsy & Behavior*, 102, [106645].
<https://doi.org/10.1016/j.yebeh.2019.106645>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Cognitive control deficits in pediatric frontal lobe epilepsy

Lydia van den Berg^{a,b,*}, Al de Weerd^a, Marieke Reuvekamp^a, Jaap van der Meere^b

^a Stichting Epilepsie Instellingen Nederland, Postbus 563, 8000 AN Zwolle, Netherlands

^b RijksUniversiteit Groningen, Faculteit Gedrags- & Maatschappijwetenschappen, Klinische & Ontwikkelingsneuropsychologie, Grote Kruisstraat 2/1, 9712 TS Groningen, Netherlands

ARTICLE INFO

Article history:

Received 19 July 2019

Revised 25 September 2019

Accepted 9 October 2019

Available online 21 November 2019

Keywords:

Epilepsy

Mental flexibility

Shifting

Impulsiveness

Inhibition

Behavioral problems

ABSTRACT

Executive dysfunction and behavioral problems are common in children with epilepsy. Inhibition and shifting, both aspects of cognitive control, seem related to behavior problems and are thought to be driven mainly by the frontal lobes. We investigated if inhibition and shifting deficits are present in children with frontal lobe epilepsy (FLE). Secondly, we studied the relationship between these deficits and behavior problems. Thirty-one children were administered the Stroop Color Word Test and a digital version of the Wisconsin Card Sorting Test (WCST). Parents completed the Behavioral Rating Inventory for Executive Function (BRIEF) and the Achenbach scale (Child Behavior Checklist (CBCL)). About 20% of the children displayed significant low results on the Stroop Effect. About 60% showed shifting problems on the WCST. Parents reported cognitive control and behavioral deficits in about a third of the children. Also, behavioral problems and deficits in inhibition and shifting in daily life (BRIEF) seem to be related. There were no correlations between questionnaires and the Stroop and the WCST. Only in the group of children with many perseverative errors there were especially high correlations between Inhibit of the BRIEF.

© 2019 Elsevier Inc. All rights reserved.

1. Introduction

Executive function (EF) deficits in children with epilepsy have been frequently reported by parents on, for example, the Behavioral Rating Inventory for Executive Function (BRIEF) [1–4]. These deficits have also been demonstrated using validated neuropsychological tasks [5–8]. Although these studies strengthen the EF hypothesis, the EF domain remains very broadly defined comprising various functions. This makes effective assessment of EF difficult. As executive dysfunction seems to be a major contributor to poor quality of life in children with epilepsy [9], proper identification of this is critical to provide appropriate support and interventions [1,10,11]. Therefore, the aim of the present study was to pinpoint more precisely the assumed EF deficit by investigating an important element of EF: cognitive control.

Cognitive control refers to the higher-level processes that regulate lower-level processes needed to remain goal-directed, especially in the face of distraction [12]. The cognitive control model comprises three well-established subcomponent processes: shifting, updating, and inhibition [13,14]. Updating is defined as the ability to maintain and actively manipulate the contents of working memory. We do not investigate ‘updating’ in this study because this has already been investigated in a separate study on the same sample [15]. Results of this study imply that updating seems relatively intact in children with frontal lobe

epilepsy (FLE). Also, updating is suggested to have a distinct role in the ‘cognitive control’ model [16]. Furthermore, ‘Inhibit’ and ‘Shift’ are both parts of the Behavioral Regulation Index (BRI) of the BRIEF [17–19], whereas ‘Working memory’ is a subscale of the Metacognition Index of the BRIEF, suggesting different cognitive control functions. The present study, therefore, focuses on the other elements of cognitive control: shifting and inhibiting.

The first component, shifting, involves moving between multiple tasks, operations, and mental sets and is positively correlated with intelligence [20]. It is closely related to cognitive flexibility [21], broadly defined as the ability to flexibly adjust behavior to the demands of a changing environment [22]. The second component, inhibiting, is the ability to deliberately lower the interference of unwanted stimuli or responses.

In general, deficits of these cognitive control processes may lead to weak attentional switching [21,23], poor sustained attention [23], impulsive behavior [24], and behavioral problems [11]. From a neurological perspective, a complex circuit is involved in the number of different processes necessary for successful response inhibition and shifting, both in real life and in the laboratory. The neuroanatomical basis has been suggested to be in different cortical and subcortical regions, specifically in the prefrontal cortex [21,22,24]. Consequently, frontal lobe dysfunction and thus children with FLE, could be at risk of developing cognitive control deficits. Therefore, the present study aimed firstly to investigate whether these deficits are associated with pediatric FLE and hoped to elaborate on a number of recent studies on this subject [5,15,25].

* Corresponding author at: SEIN, Postbus 563, 8000 AN Zwolle, Netherlands.
E-mail address: lvdenberg@sein.nl (L. van den Berg).

We used two common EF tests to assess cognitive control in a clinical setting: the Wisconsin Card Sorting Test (WCST) assessing shifting and cognitive flexibility and the Stroop Color Word Test (Stroop Test) assessing the inhibition of cognitive interference expressed as the ‘Stroop Effect’ [26]. Only few reports on the use of these tests in pediatric FLE are available. With regard to the WCST, results are inconclusive [27]: Some prior studies show reduced WCST performance, also in comparison with children with temporal lobe epilepsy [28]. In contrast, there are also investigations concluding that the WCST is relatively insensitive to EF in children with epilepsy [27,29] or that WCST performance is reduced on a specific item [30]. For the Stroop Test, prior research in pediatric epilepsy shows that epileptic activity negatively affects performance on the Stroop Test [31,32].

Because cognitive control deficits are linked to externalizing and internalizing behavioral problems [1,11,15], the second aim of the study was to link scores of EF tests with questionnaires measuring problem behavior with the Achenbach Scales [33–35] and EF in daily life as displayed by the BRIEF.

Based on the existing literature on patients with frontal lobe dysfunction, we hypothesize that children with FLE will display deficits in inhibition and shifting as assessed with the WCST and the Stroop Test and reported by parents on the BRIEF. Secondly, we hypothesize that cognitive control dysfunction will be related to behavioral problems in our sample.

2. Design

2.1. Sample

Children with FLE were referred for a broad neuropsychological assessment by the pediatric neurologist at a tertiary center. All parents were asked to complete questionnaires about perceived behavioral problems and executive functioning while their children were being tested. Assessment of EF with validated and normative tests is possible from the age of eight. Cognitive flexibility skills begin to develop in early childhood, with a sharp increase in abilities between 7 and 9 years of age. Cognitive flexibility and inhibition skills are largely mature around the age of 10 [21,36]. Previous work [37] has also shown significantly poorer performance in children with FLE aged 8–12 years compared with children with other epileptic syndromes. Therefore, inclusion criteria were age between 8 and 12 years and Intelligence quotient (IQ) > 70 or school achievement scores above C level (Dutch CITO) in math and language. Children who would become 8 years old in the next two months were also invited to participate. Exclusion criteria were health and/or psychiatric problems, which could influence the neuropsychological assessment, except for attention-deficit and hyperactivity disorder (ADHD), which is common in children with epilepsy [38]. Thirty-one children met the inclusion criteria. All parents completed both questionnaires. Epilepsy diagnoses was based on the International League Against Epilepsy criteria and confirmed by an Electroencephalogram (EEG) recording. The study was approved by the Ethical Committee of MST Enschede, and parents gave their informed consent.

2.2. Measures

2.2.1. Wisconsin Card Sorting Test

The WCST (classification) of the computerized test battery FePsy [39] was used to assess set shifting and cognitive flexibility. It consists of 128 digital cards to categorize on the color of its symbols, the shape of the symbols, or the number of the shapes on each card. The only feedback is whether the classification is correct or not. Outcome is the quantity of categories (with a maximum of 6), total errors, and perseverative errors. Unfortunately, no clinical cutoffs are available for the number of categories and amount of errors. More than 16 perseverative errors are considered as significantly elevated.

2.2.2. The Stroop Color Word Test

The Stroop Color Word Test, Dutch version [40], was used to assess inhibition. Subjects are required to read three different cards as fast as possible. Two of them represent the “congruous condition” in which subjects are required to read names of colors printed in black and name different color patches. In the third table, color-words are printed in an inconsistent color ink (for instance the word “green” is printed in red ink). Thus, in this “incongruent condition”, patients are required to name the color of the ink instead of reading the word. In other words, the patient is required to perform a less automated task (naming ink color) while inhibiting the interference arising from a more automated task (reading the word). This difficulty in inhibiting the more automated process is called the ‘Stroop Effect’ [41]. Working pace is measured in seconds and then computed into a normative score. A score of decil 1 (low) and 10 (high) is considered statistically significant for all cards.

2.2.3. The BRIEF and CBCL

Parents completed the Child Behavior Checklist (CBCL) and the BRIEF. This analysis focuses on the externalizing and internalizing scale of the CBCL and the two subscales Shift and Inhibit and the BRI of the BRIEF to assess more daily life behavior. The BRIEF has good psychometric properties that include appropriate construct validity. Internal consistency is strong, and the test–retest reliability is also high [42]. A score 1.5 Standard deviation (SD) ($\geq$ percentile 93) above average is considered statistically significant for the indices.

The CBCL is a well-established behavioral questionnaire with good psychometric properties [35], also for children with epilepsy [34]. A score 1.33 SD ($\geq$ percentile 90) above average is considered statistically significant for the main scales.

2.3. Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (IBM SPSS Statistics 23.0). The data, corrected for age, were compared with normative data of the Dutch population. For the digital WCST, we did not use normative data because those were not available. In the analysis, we compared scores according to age. To explore group differences based on perseverative errors and the Stroop Effect, we categorized into few (<16 errors) vs many ($\geq$ 16 errors) perseverative errors and Stroop effect (< decil 1) vs no Stroop effect ($\geq$ decil 2).

Differences in normally distributed scores between the cohort with FLE and the reference values were tested with one-sample *t*-tests or, in not normally distributed data, with nonparametric tests. The association between the tests and the questionnaires was investigated. As sample sizes are relatively small, effect sizes are shown when appropriate using Cohen's *d*.

3. Results

Patients' demographic characteristics are presented in Table 1.

Fig. 1 shows the results of the Stroop Test. Working pace on card 1 (reading words) is significantly low (decil 1) in a third (*n* = 10) of the sample and slowest of all three cards. Sixteen percent (*n* = 5) scored

Table 1
Demographic and epilepsy variables.

Characteristics	Value
<i>N</i>	31
Participants	
– Gender (male:female)	18:13
– Mean age ($\pm$ SD) in years at assessment	9.2 $\pm$ 1.6
Age at seizure onset	
– Mean age ($\pm$ SD)	4.6 $\pm$ 2.8 years
Duration of epilepsy	
– Mean duration ($\pm$ SD)	4.6 $\pm$ 2.7 years

Fig. 1. Frequencies scores Stroop Test.

significantly lower on the 'Stroop effect' compared with the normative sample.

In Fig. 2, the results of WCST are displayed controlling for age. It shows that task performance was not related to age: mean errors, mean perseverative errors, and the number of categories remained stable with age. More than 60% of the children scored in the clinical range (≥ 16 errors) for perseverative errors.

About a third of the parents reported behavioral and cognitive control (inhibit and shift) problems on the CBCL and the BRIEF (Fig. 3).

Except for one scale, correlations between the CBCL and the BRIEF questionnaires were moderate (Table 2), indicating that cognitive control (shifting and inhibiting) in daily life is associated with behavior as reported by parents. In contrast, the parent proxy reports did not correlate with the neuropsychological performance (the Stroop Test and the WCST) (Table 3) in the total group. However, especially in the

group with many perseverative errors (on the WCST), these correlations were moderate between the Inhibit of the BRIEF and the Stroop Test.

The mean scores between age groups on the CBCL appeared to show huge variations, and we, therefore, conducted post hoc comparisons. This indicated that the mean score for internalizing problems of children aged 10 to 12 years ($M = 82.00$, $SD = 18.59$) was significantly different ($p = .02$) than the mean score of children aged 8 to 10 years ($M = 58.94$, $SD = 31.80$). There was no significant difference on externalizing problems between the 'older' children ($M = 70.43$, $SD = 30.68$) and 'younger' children ($M = 65.71$, $SD = 26.03$).

4. Discussion

This study focused on two aspects of cognitive control, namely inhibiting and shifting in children with FLE. Impaired response inhibition, as measured by the Stroop Test, was found in about 20% of the participants when the conservative cutoff level was used ($-2SD$). Performance on the Stroop Test (or the almost similar Color-Word Interference Test of the D-Kefs) has hardly been investigated in children with (frontal lobe) epilepsy. Nevertheless, our data seem to replicate the findings of a limited number of studies [43–45]. Furthermore, our data are consistent with several studies suggesting that people with frontal lobe dysfunction are impaired to some extent on different tasks of inhibition [45–47].

Furthermore, children displayed slowness on the Stroop Test, which was most pronounced on card 1 of the Stroop Test, but was also present on card 2. Psychomotor speed problems and general slowness are often reported in children with epilepsy [48,49]. It could therefore be argued that poor performance on the Stroop Test in our sample might be related to an attention problem and/or a problem in (processing) speed rather than a specific impairment in response inhibition [43,44].

For the WCST, the large amount of perseverative errors in 60% of the participants indicates weak shifting, which concurs with other studies [28,37,44]. Age factor was not associated with shifting abilities, which is in contrast with many developmental studies, showing that EF skills normally improve with age and brain maturation [21,50]. An explanation for this could be that in our group with frontal disturbances, the development of shifting skills levels off with age, whereby executive dysfunction emerges over time [50,51], resulting in long-term developmental "lagging behind".

In concordance with the results on test assessment, parents' reports on the BRIEF show inhibit and shifting deficits in about a third of the

Fig. 2. Scores WCST. Scores displayed per age.

Fig. 3. Frequencies scores questionnaires.

sample. Parents also reported behavioral problems to the same extent. These reported cognitive control deficits on the BRIEF seem to be related to the reported behavioral problems on the CBCL. This concurs with other studies [1,11,25,37], suggesting that having cognitive control deficits places a child at risk for developing behavioral problems. However, significant connections between our neuropsychological measurements and the questionnaires including the BRIEF are low. This finding replicates the results in this sample on working memory [15] and previous findings [27,52,53]. When considering children with shifting problems only, we did find associations between Inhibit of the BRIEF and the Stroop Test. The sample size is small, but this might indicate that children with poor shifting skills also show other executive dysfunction.

Post hoc analysis yielded that parents of the children aged 10 to 12 years reported far more internalizing problems compared with children age 8 to 10 years. As longer duration of epilepsy is considered to be a risk factor for psychopathology [54–57], this could be expected. We could, however, not confirm this same finding for externalizing problems; these problems were reported to the same extent in both age groups. The perceptibility of mood and anxiety problems (so called internalizing problems) is low in young children [58], which might indicate that these problems are underreported. Therefore, it might be worthwhile to take unreliable proxy report into consideration when interpreting results [59,60].

The study has several limitations. Firstly, it is not controlled. Comparison with normative data gives information for clinical use, but a larger group (clinical and nonclinical) enables further comparisons, for example, based upon subgroups with epilepsy. Epilepsy variables can be taken into account in identifying people who are particularly at risk for developing cognitive deficits and behavioral problems. Secondly, because of setting, there is a selection bias as children were referred by a pediatric neurologist. The results can therefore not be fully generalized to a broader sample with epilepsy. Thirdly, inhibiting and shifting components of cognitive control are separable but also correlated [14]. Thus, indexing these abilities solely with experimental tasks and manipulations is unlikely [16]. Reported everyday behavioral and tested measures do appear to tap different elements of executive

Table 2
Correlation between the questionnaires.

	Internalizing	Externalizing
Inhibit	.34	.62***
Shift	.65***	.41*
BRI	.60***	.64***

Correlations are shown using Spearman's r_s .

* $p \leq .05$.

*** $p < .00$.

functioning, confirming that the BRIEF reflects more daily “real-life” behavior, while performance on neuropsychological primarily predicts behavior in a controlled assessment setting [7,42,53]. Lastly, the sensitivity of the WCST has been questioned in pediatric epilepsy [27,29], and we even used a different digital version, which is not investigated much in children with epilepsy. Unfortunately, there are not many validated alternatives to investigate these specific functions.

The WCST might not be fully reliable, and we failed to find many deficits on the Stroop Test. However, there is also evidence for inconsistencies in parental reports for several reasons [60], which make it for future research necessary to rely on both informant- and performance-based measures.

5. Conclusions

Inhibition and shifting deficits are found with performance-based measures in children with FLE. These are also frequently reported by parents on daily life level, to the same extent as behavioral problems.

Table 3
Correlating questionnaires and Stroop/WCST.

	Inhibit	Shift	BRI	Int	Ext
Total group (n = 30)					
Interference	.26	.13	.15	.06	.10
Card 1	.40*	.25	.30	.04	.14
Card 2	.35	.27	.31	.01	.09
Card 3	.34	.29	.26	.02	.17
Total categories	.21	.17	.19	.03	.07
Total perseverative errors	.31	.04	.20	.03	.23
Total errors	.08	.06	.00	.21	.22
Few perseverative errors (n = 11)					
Interference	.02	.19	.23	.04	.11
Card 1	.11	.36	.27	.40	.05
Card 2	.44	.63*	.52	.52	.28
Card 3	.25	.66*	.48	.29	.05
Total categories	.60	.51	.62*	.36	.46
Total perseverative errors	.02	.06	.16	.40	.46
Total errors	.36	.36	.65*	.47	.36
Many perseverative errors (n = 19)					
Interference	.54*	.21	.29	.06	.08
Card 1	.56*	.17	.33	.15	.04
Card 2	.47*	.12	.32	.13	.18
Card 3	.54*	.20	.31	.04	.14
Total categories	.12	.11	.12	.11	.14
Total perseverative errors	.19	.04	.08	.24	.22
Total errors	.12	.02	.10	.19	.09

Correlations are shown using Spearman's r_s .

* $p \leq .05$.

Cognitive control in daily life and behavior seems related, whereas performance-based measures of cognitive control and behavior seem less related. Shifting problems might indicate the presence of other executive dysfunction.

Declaration of competing interest

The author(s) declare(s) that there is no conflict of interest.

References

- [1] van den Berg L, de Weerd A, Reuvekamp HF, Hagebeuk EEO, van derMeere JJ. Executive and behavioral functioning in pediatric frontal lobe epilepsy. *Epilepsy Behav* 2018;87:117–22.
- [2] Kavanaugh BC, Scarborough VR, Salorio CF. Parent-rated emotional-behavioral and executive functioning in childhood epilepsy. *Epilepsy Behav* 2015;42:22–8.
- [3] Parrish J, Geary E, Jones J, Seth R, Hermann B, Seidenberg M. Executive functioning in childhood epilepsy: parent-report and cognitive assessment. *Dev Med Child Neurol* 2007;49:412–6.
- [4] Sarco DP, Boyer K, Lundy-Krigbaum SM, Takeoka M, Jensen F, Gregas M, et al. Benign rolandic epileptiform discharges are associated with mood and behavior problems. *Epilepsy Behav* 2011;22(2):298–303.
- [5] Conant LL, Wilfon A, Inglese C, Schwarte A. Dysfunction of executive and related processes in childhood absence epilepsy. *Epilepsy Behav* 2010;18:414–23.
- [6] Hoie B, Sommerfelt K, Waaler PE, Alsaker H, Skeidsvoll H, Mykletun A. The combined burden of cognitive, executive function and psychosocial problems in children with epilepsy: a population-based study. *Dev Med Child Neurol* 2008;50(7):530–6.
- [7] MacAllister WS, Bender HA, Whitman L, Welsh A, Keller S, Granader Y, et al. Assessment of executive functioning in childhood epilepsy: the Tower of London and BRIEF. *Child Neuropsychol* 2012;18:404–15.
- [8] Raud T, Kaldoja M, Kolk A. Relationship between social competence and neurocognitive performance in children with epilepsy. *Epilepsy Behav* 2015;52:93–101.
- [9] Sherman EM, Slick DJ, Eyrl KL. Executive dysfunction is a significant predictor of poor quality of life in children with epilepsy. *Epilepsia* 2006;47(11):1936–42.
- [10] Isquith PK, Roth RM, Kenworthy L, Gioia G. Contribution of rating scales to intervention for executive dysfunction. *Appl Neuropsychol Child* 2014;3:197–204.
- [11] Modi AC, Gutierrez-Colina AM, Wagner JL, Smith G, Junger K, Huszti H, et al. Executive functioning phenotypes in youth with epilepsy. *Epilepsy Behav* 2019;90:112–8.
- [12] Miller EK, Cohen JD. An integrative theory of prefrontal cortex function. *Annu Rev Neurosci* 2001;24:167–202.
- [13] Botvinick M, Braver T. Motivation and cognitive control: from behavior to neural mechanism. *Annu Rev Psychol* 2015;66:83–113.
- [14] Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A, Wager TD. The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: a latent variable analysis. *Cogn Psychol* 2000;41(1):49–100.
- [15] van den Berg L, Reuvekamp M, Hagebeuk EEO, de Weerd A, van der Meere JJ. Working memory in pediatric frontal lobe epilepsy. *Appl Neuropsychol Child* 2019;15:1–10.
- [16] Rietbergen M, Roelofs A, den Ouden H, Cools R. Disentangling cognitive from motor control: influence of response modality on updating, inhibiting, and shifting. *Acta Psychol (Amst)* 2018;191:124–30.
- [17] Gioia GA, Isquith PK, Guy SC, Kenworthy L. Behavior Rating Inventory of Executive Function. *Child Neuropsychol* 2000;6:235–8.
- [18] Slick DJ, Lautzenhiser A, Sherman EMS, Eyrl K. Frequency of scale elevations and factor structure of the behavior rating inventory of executive function (BRIEF) in children and adolescents with intractable epilepsy. *Child Neuropsychol* 2006;12:181–9.
- [19] Smidts D, Huizinga M. BRIEF: Executive Functies Gedragvragenlijst. Amsterdam (NL): Hogrefe Uitgevers B.V.; 2009.
- [20] Biesmans KE, van Aken L, Frunt EMJ, Wingbermuhle PAM, Egger JIM. Inhibition, shifting and updating in relation to psychometric intelligence across ability groups in the psychiatric population. *J Intellect Disabil Res* 2019;63(2):149–60.
- [21] Dajani DR, Uddin LQ. Demystifying cognitive flexibility: implications for clinical and developmental neuroscience. *Trends Neurosci* 2015;38(9):571–8.
- [22] Armbruster DJ, Ueltzhoffer K, Basten U, Fiebach CJ. Prefrontal cortical mechanisms underlying individual differences in cognitive flexibility and stability. *J Cogn Neurosci* 2012;24(12):2385–99.
- [23] Kertz SJ, Belden AC, Tillman R, Luby J. Cognitive control deficits in shifting and inhibition in preschool age children are associated with increased depression and anxiety over 7.5 years of development. *J Abnorm Child Psychol* 2016;44(6):1185–96.
- [24] Bari A, Robbins TW. Inhibition and impulsivity: behavioral and neural basis of response control. *Prog Neurobiol* 2013;108:44–79.
- [25] Baum KT, Byars AW, deGrauw TJ, Dunn DW, Bates JE, Howe SR, et al. The effect of temperament and neuropsychological functioning on behavior problems in children with new-onset seizures. *Epilepsy Behav* 2010;17(4):467–73.
- [26] Scarpina F, Tagini S. The Stroop color and word test. *Front Psychol* 2017;8:557s.
- [27] MacAllister WS, Maiman M, Whitman L, Vasserman M, Cohen RJ, Salinas CM. Sensitivity of the Wisconsin Card Sorting Test (64-card version) versus the Tower of London (Drexel version) for detecting executive dysfunction in children with epilepsy. *Child Neuropsychol* 2018;24(3):354–69.
- [28] Longo CA, Kerr EN, Smith ML. Executive functioning in children with intractable frontal lobe or temporal lobe epilepsy. *Epilepsy Behav* 2013;26(1):102–8.
- [29] Hernandez MT, Sauerwein HC, Jambaque I, De Guise E, Lussier F, Lortie A, et al. Deficits in executive functions and motor coordination in children with frontal lobe epilepsy. *Neuropsychologia* 2002;40:384–400.
- [30] Riva D, Saletti V, Nichelli F, Bulgheroni S. Neuropsychologic effects of frontal lobe epilepsy in children. *J Child Neurol* 2002;17(9):661–7.
- [31] Ayaz M, Karakaya I, Ayaz AB, Kutlu M. Psychiatric and neurocognitive evaluation focused on frontal lobe functions in Rolandic epilepsy. *Noro Psikiyatr Ars* 2013;50(3):209–15.
- [32] Holtmann M, Matei A, Hellman U, Becker K, Poustka F, Schmidt MH. Rolandic spikes increase impulsivity in ADHD — a neuropsychological pilot study. *Brain Dev* 2006;28(10):633–40.
- [33] Achenbach TM, Rescorla LA. Multicultural supplement to the manual for the ASEBA school-age forms and profiles. Burlington, VT: University of Vermont, Research Center for Children, Youth & Families; 2007.
- [34] Gleissner U, Fritz NE, Von Lehe M, Sassen R, Elger CE, Helmstaedter C. The validity of the Child Behavior Checklist for children with epilepsy. *Epilepsy Behav* 2008;12(2):276–80.
- [35] Verhulst FC, van der Ende J, Koot HM. Handleiding voor de CBCL/4-18. Rotterdam: Afdeling kinder- en jeugdpsychiatrie, Sophia kindziekenhuis/Academisch ziekenhuis Rotterdam/Erasmus Universiteit Rotterdam; 1996.
- [36] Anderson V, Anderson P, Northam E, Jacobs R, Catroppa C. Development of executive functions through late childhood and adolescence: an Australian sample. *Dev Neuropsychol* 2001;20:385–406.
- [37] Hernandez MT, Sauerwein HC, Jambaque I, deGuise E, Lussier F, Lortie A, et al. Attention, memory, and behavioral adjustment in children with frontal lobe epilepsy. *Epilepsy Behav* 2003;4(5):522–36.
- [38] Williams AE, Giust JM, Kronenberger WG, Dunn DW. Epilepsy and attention-deficit hyperactivity disorder: links, risks, and challenges. *Neuropsychiatr Dis Treat* 2016;12:287–96.
- [39] Alpherts WCJ, Aldenkamp AP. FePsy, the iron psyche manual. Heemstede: Instituut voor epilepsiebestrijding; 1995.
- [40] Hammes JGW. De Stroop Kleur-Woord Test. Handleiding. Lisse: Swets and Zeitlinger; 1971.
- [41] Stroop JR. Studies of interference in serial verbal reactions. *J Exp Psychol* 1935;18:643–62.
- [42] Huizinga M, Smidts DP. Age-related changes in executive function: a normative study with the Dutch version of the Behavior Rating Inventory of Executive Function (BRIEF). *Child Neuropsychol* 2011;17(1):51–66.
- [43] Helmstaedter C, Kemper B, Elger CE. Neuropsychological aspects of frontal lobe epilepsy. *Neuropsychologia* 1996;34(5):399–406.
- [44] McDonald CR, Delis DC, Norman MA, Wetter SR, Tecoma ES, Iragui VJ. Response inhibition and set shifting in patients with frontal lobe epilepsy or temporal lobe epilepsy. *Epilepsy Behav* 2005;7(3):438–46.
- [45] Rai VK, Shukla G, Afsar M, Poornima S, Pandey RM, Rai N, et al. Memory, executive function and language function are similarly impaired in both temporal and extra temporal refractory epilepsy—a prospective study. *Epilepsy Res* 2015;109:72–80.
- [46] Demakis GJ. Frontal lobe damage and tests of executive processing: a meta-analysis of the Category Test, Stroop test, and Trail-Making Test. *J Clin Exp Neuropsychol* 2004;26:441–50.
- [47] Stuss DT, Floden D, Alexander MP, Levine B, Katz D. Stroop performance in focal lesion patients: dissociation of processes and frontal lobe lesion location. *Neuropsychologia* 2001;39:771–86.
- [48] Piccinelli P, Beghi E, Borgatti R, Ferri M, Giordano L, Romea A, et al. Neuropsychological and behavioural aspects in children and adolescents with idiopathic epilepsy at diagnosis and after 12 months of treatment. *Seizure* 2010;19:540–6.
- [49] vanMill SG, delaParra NM, Reijs RP, vanHall MH, Aldenkamp AP. Psychomotor and motor functioning in children with cryptogenic localization-related epilepsy. *Neurorehabilitation* 2010;26(4):291–3.
- [50] Anderson PJ. Assessment and development of executive functioning (EF) in childhood. *Child Neuropsychol* 2002;8(2):71–82.
- [51] Braakman HM, Vaessen MJ, Hofman PA, Debeij-van Hall MH, Backes WH, Vles JS, et al. Cognitive and behavioral complications of frontal lobe epilepsy in children: a review of the literature. *Epilepsia* 2011;52:849–56.
- [52] Gross AC, Deling LA, Wozniak JR, Boys CJ. Objective measures of executive functioning are highly discrepant with parent-report in fetal alcohol spectrum disorders. *Child Neuropsychol* 2015;21:531–8.
- [53] Hessen E, Alfstad KA, Torgersen H, Lossius MI. Tested and reported executive problems in children and youth epilepsy. *Brain Behav* 2018;8:1–10.
- [54] Dinkelacker V, Dupont S, Samson S. The new approach to classification of focal epilepsies: epileptic discharge and disconnection in relation to cognition. *Epilepsy Behav* 2016;64(Pt B):322–8.
- [55] Brand JG, Mindt MR, Schaffer SG, Alper KR, Devinsky O, Barr WB. Emotion processing bias and age of seizure onset among epilepsy patients with depressive symptoms. *Epilepsy Behav* 2012;25(4):552–7.
- [56] Lordo DN, Van Patten R, Sudikoff EL, Harker L. Seizure-related variables are predictive of attention and memory in children with epilepsy. *Epilepsy Behav* 2017;73:36–41.
- [57] Ma Y, Chen G, Wang Y, Xu K. Language dysfunction is associated with age of onset of benign epilepsy with centrotemporal spikes in children. *Eur Neurol* 2015;73(3–4):179–83.
- [58] Kanner AM, Dunn DW. Diagnosis and management of depression and psychosis in children and adolescents with epilepsy. *J Child Neurol* 2004;19(s1):s65–72.
- [59] Rodenburg R, Meijer AM, Dekovic M, Aldenkamp AP. Family factors and psychopathology in children with epilepsy: a literature review. *Epilepsy Behav* 2005;6(4):488–503.
- [60] van den Berg L, Reuvekamp M, de Weerd A, van der Meere JJ. The burden of parenting children with frontal lobe epilepsy. *Epilepsy Behav* 2019;97:269–74.