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Relationship between social competence and neurocognitive performance in children with epilepsy

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Abstract

Epilepsy may affect a child’s social skills and social cognition. The purpose of the study was to examine associations between sociocognitive skills and neurocognitive performance in children with epilepsy. Thirty-five children with epilepsy between the ages of 7 and 12 years (25 with partial and 10 with generalized epilepsy) and 30 controls participated. Theory of Mind (ToM) tasks, Social Cognition Questionnaire proposed by Saltzman-Benaiah and Lalonde (2007), and Social Skills Rating System were used to assess social competence and sociocognitive skills. Neurocognitive performance was assessed using the NEPSY battery. Children with epilepsy demonstrated more difficulties in understanding false belief (p < .001) and intentional lying (p < .05) and exhibited more behavioral problems (p < .05). Notably, their social skills were at the same level as typically developing peers. Children with epilepsy performed significantly worse in attention, executive, verbal, and fine motor tasks (p < .05). We found positive correlations between the understanding of false belief and executive (r = .58, p < .05), verbal (r = .45–.49, p < .05), and visuospatial skills (r = .34–.48, p < .01). Children with generalized epilepsy had more problems in memory tasks (p < .05) and understanding of sarcasm (p < .05) compared with children with partial epilepsy. An age of onset over 9.1 years was positively associated with ToM skills (r = .42, p < .05). In conclusion, better ToM in children with better executive functions, and language and visuospatial skills was revealed. The type of epilepsy and age of onset significantly affected ToM skills.

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1. Introduction

1.1. Epilepsy in children

Epilepsy, a chronic neurological condition characterized by recurrent seizures, is one of the diseases of the CNS most frequently accompanied by difficulties in academic work [1] as well as attention, behavioral, and social problems in children [2]. According to the ILAE, epileptic seizures can be classified either as generalized or partial [3]. Generalized epileptic seizures are conceptualized as originating at some point within and rapidly engaging bilaterally distributed networks. Such bilateral networks can include cortical and subcortical structures, but do not necessarily include the entire cortex. Partial epileptic seizures are conceptualized as originating within networks limited to one hemisphere. They may be discretely localized or more widely distributed [3].

The overall incidence rate for epilepsy in Estonia is 45:100,000 in children. However, the incidence rate is much higher for children from 1 month to 4 years of age (73:100,000) and declines remarkably after the age of 15 years [4]. Bearing this in mind, it is especially important to acknowledge that early injury to the developing brain may disrupt the acquisition of basic competencies, which provide the necessary foundations for later development. Furthermore, more devastating effects are thought to result if the seizure disorder starts at an early age, especially in patients with poor seizure control, in individuals who have had a long duration of disorder, and if the person exhibits multiple seizure types [5].

1.2. Social competence and sociocognitive functions in children with epilepsy

Childhood is a period of rapid development of social and cognitive skills. Most of the time, these skills develop naturally without any need for special attention. However, CNS diseases (such as epilepsy) can affect the development of age-appropriate social competences [6].

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and, therefore, have a negative influence on a child’s behavior and mental health.

There is no agreement on the definition of social competence; numerous and heterogeneous definitions and models have been proposed [7]. There is a great extent of content areas beneath the umbrella of “social competence”. According to Iarocci et al. [8], social competence involves the active and skillful coordination of multiple processes and resources available to the child to meet social demands and achieve social goals in a particular type of social interaction (e.g., parent–child, peer relations) and within a specific context (e.g., home, school). Social competence has many different aspects and subcomponents (e.g., social skills, also behavioral problems may be observable expressions of social competence deficits). Social skills include the abilities to (a) accurately select relevant and useful information from an interpersonal context, (b) use that information to determine appropriate goal-directed behavior, and (c) execute verbal and nonverbal behaviors that maximize the likelihood of goal attainment and the maintenance of good relations with others [9]. Cognitive aspects are important for successful social behavior. Social cognition is the ability to construct mental representations of social relations, thereby, helping to make sense of other people and interpersonal relationships and to properly use these representations to live flexibly in the social environment [10]. An important part of social cognitive skills is theory of mind (ToM) — the ability to understand other people's thoughts, intentions, and feelings [11]. Theory of mind assists in understanding what other people are thinking or feeling in a given social situation without it being said directly (examples are jokes, sarcasm, and irony). It is an important prerequisite to social behavior [12]. Previous research has indicated relations between false belief understanding and positive social skills in children, suggesting that ToM might be related to actual behavior [13]. Effective social interaction requires a complex combination of knowledge and interpretations to guide our actions. Ability to interpret social situations leads to effective peer interactions and is importantly associated with social competence. Therefore, misinterpretation is frequently the reason for inappropriate behavior [14]. These kinds of misinterpretations are fairly common in people with disrupted brain development. One of the reasons that people with epilepsy may have social dysfunction is the inability to understand other people’s thoughts, because of the dysfunction of underlying neural mechanisms. The main brain regions associated with ToM are the medial prefrontal cortex, temporal lobes, temporoparietal junction, and superior temporal sulcus [15, 16]. Adults with frontal lobe epilepsy have diminished ability to understand other’s thoughts, humor, emotions, and eye gaze expressions [17]; adults with temporal lobe epilepsy also have diminished ability to understand other’s thoughts and beliefs [18]. Children and adolescents with epilepsy are at risk of deficit in social cognition by having less ability to recognize facial expressions and to understand thoughts and motivations of others [19, 20]. Unfortunately, ToM studies in children with epilepsy are very limited. Most of the studies in this field rely only on parents’ and teachers’ questionnaires and usually show that epilepsy is a limiting factor for social competence of children and adolescents [21, 22].

Giovagnoli [23] emphasizes that there is a need to examine ToM in all patients with epilepsy. The study of ToM in epilepsy is important not only for advancing the understanding of its underlying neural network, but also in clinical care. The ToM tests are not homogeneous across studies. There are many different tests that measure ToM. A conventional neuropsychological test battery will not capture the concept of ToM, nor will conventional personality or psychopathological inventories [23]. Identifying ToM demands specially designed measures. First-order false belief is the easiest ToM test that evaluates a subject’s ability to guess another person’s mental state who is experiencing a situation that has changed unexpectedly, thus, revealing the capacity to focus on reality [23]. Second-order false beliefs use the same paradigm but are more complex and involve one character having a false belief about the belief of another character in a story [24]. The faux pas test requires distinguishing intentional and unintentional actions and related emotions in addition to the ability to recognize a person’s mental state [12]. Rantanen et al. [7] put together a conceptual framework of social competence, its subcomponents, and hypothetical connections in childhood epilepsy. According to their framework, social competence is affected by both pathophysiological (i.e., CNS dysfunction or lesions) and environmental factors. This effect may be direct or mediated through epilepsy-related or/and neurocognitive factors, which in turn may also have an independent effect on the development of social competence. Epilepsy-related factors (for example, age of onset and seizure type) as well as cognitive factors can have a direct impact on the development of social competence. Therefore, the associations between epilepsy and social competence are complex. Previous studies have found associations between social competence and epilepsy type [22], early onset of epilepsy [22], epilepsy etiology [25], seizure types [25], and seizure frequency [26], as well as antiepileptic treatment [26]. Behavioral problems are more associated with early onset of epilepsy [19], generalized epilepsy type, and seizure frequency [27]. Early onset refractory temporal lobe epilepsy can compromise the development of recognizing facial expressions in children and adolescents and is associated with comprehension of affects and intentions. In patients with frontal lobe refractory epilepsy, the comprehension of mental states was predicted by disease duration [12]. Research in this field is still limited, especially in children with well-controlled seizures and children with newly diagnosed epilepsy. Therefore, there is a need for more precise studies using reliable methods (tests, observations, etc.) in order to clarify the nature of impairment in cognitive and social function in children with epilepsy, in addition to the study of the impact of epilepsy-related factors.

Similarly, Saltzman-Benaih & Lalonde [14] have pointed out the need for more clinically suitable and appropriate assessment methods for children’s social competence. More so, they emphasize the importance of overcoming the gap between research oriented and clinically appropriate patient- and intervention-oriented tools. Thus, they have developed and provided several tasks to assess different aspects of children’s social competence. They have also provided normative data for their tasks. Therefore, some of the tasks and a questionnaire for parents developed by Saltzman-Benaih and Lalonde [14] were also used in the present research.

1.3. Neurocognitive performance in children with epilepsy

In addition to psychosocial complications, children with epilepsy may face neurocognitive problems. Berg et al. [28] found that 73.6% of children with epilepsy have cognitive abilities similar to the control group. This means that one-fourth of children demonstrate impaired cognition. The nature of neurocognitive impairment in children with epilepsy is not clear — there are a large number of concomitant studies and results. Many studies have found dysfunction in attention [29–31], memory [32,33], and executive functions [29]. There are also studies that have found dysfunction in visuospatial [34] and verbal skills [30].

The purpose of carrying out the present study was to explore the association between sociocognitive and neurocognitive functions in children with partial and generalized epilepsies. In the current study, social skills and behavioral problems were studied as subcomponents of social competence. In addition, cognitive aspects of social behavior (including theory of mind) were examined. While social competence and cognition are widely studied among healthy children, there are still very few good studies about sociocognitive skills in the pediatric epilepsy population. In addition, most studies rely on parents’ and teachers’ questionnaires. That is an important limitation because parents and teachers may not always be adequate observers and objective. They also are not always able to correctly interpret children’s mental states, thoughts, and intentions. In the present study, ToM tasks are used in addition to parent questionnaires to gain a broader knowledge of social competence in children with epilepsy.
The aims of the present study were:

1. Examine ToM, social skills, and neurocognitive performance in children with generalized and partial epilepsies and compare the results with a healthy control group.
2. Analyze relations between ToM, social skills, and neurocognitive performance in children with epilepsy.
3. Analyze the association of epilepsy-related factors with ToM, social skills, and neurocognitive performance.

2. Methods

The study was carried out between February 2009 and February 2013 in Tartu University Hospital’s Children’s Clinic, in the Department of Neurology and Neurorehabilitation. The study was approved by The Research Ethics Committee of the University of Tartu.

2.1. Participants

2.1.1. Patients

Thirty-five children between the ages of 7 to 12 years (mean age: 10.46, min: 7.0, max: 12.9) with active partial (25 children) or generalized (10 children) epilepsy participated in the study (more detailed data of the patients are presented in Table 1); 17/35 children had newly diagnosed (10 children) epilepsy participated in the study (more detailed data of the patients are presented in Table 1); 17/35 children had newly diagnosed epilepsy, and they were tested before the start of antiepileptic treatment. The mean age of onset was 9.09 years (min: 6.1, max: 12.9).

The mean duration of epilepsy was 1.37 years (min: 0, max: 6.03); epilepsy was well-controlled with antiepileptic drugs (AEDs). All the participants were from mainstream schools, attended grades from 1st to 6th, and studied according to the regular middle school curriculum.

Participants were selected according to the following inclusion criteria:

1. Previous epilepsy diagnosis confirmed by clinical and EEG studies according to the International League Against Epilepsy Classification [3].
2. Age between 7 and 12 years.

2.2. Assessment of sociocognitive skills

2.2.1. Theory of mind tasks

The children’s sociocognitive skills were evaluated using eight ToM tasks (four focusing on false belief, two on intentional lying, and two on sarcasm). The ToM tasks applied in the present study were the adaptations from the tasks developed by Saltzman-Benaiah and Lalonde [14].

Every task included 4–5 questions where children were asked to describe how he/she understood the story and what the characters in the story were saying and thinking. There was also a picture for each story describing the main characters and the scenario of the story. The aim of the picture was to help the children remember the characters and scenario. During the presentation of the task, the children were allowed to look at the picture. All stories, instructions, and questions were read to the children orally. The children had to understand a story character’s beliefs and thoughts and explain them logically. Answers were marked and scored. The maximum score from ToM tasks was 12 points — for each of the ToM task types (false belief stories, intentional lying stories, and sarcasm stories), scores ranged up to 4 points could be gained.

2.2.2. Social Cognition Questionnaire

The Social Cognition Questionnaire, which was an Estonian adaptation of Parent Questionnaire used by Saltzman-Benaiah and Lalonde [14], included questions about everyday behaviors and social interaction scenarios that would be commonly experienced by a school-aged child (e.g., making friends, being teased, understanding other mental states and jokes). The Social Cognition Questionnaire consisted of 57 statements that the parents rated on a 4-point scale (0 = never, 1 = sometimes, 2 = often, 3 = almost always) where higher scores indicated better social cognition. Scores ranged from 0 to 171 points. Reliability of Estonian adaptation of Social Cognition Questionnaire was checked and was rated as good (Cronbach’s α = .898).

2.3. Social skills evaluation

Social skills were evaluated using Social Skills Rating System [35], which includes two scales: Social Skills (four subcales: Cooperation, Responsibility, Self-control, and Assertion) and Problem Behaviors (three subcales: Externalizing Problems, Internalizing Problems, and Hyperactivity). Parents rated questions on a 3-point scale (0 = never, 1 = sometimes, 2 = very often). Higher scores on the social skills scale indicated more advanced social skills, and a higher score on the problem behavior scale meant more behavioral problems. Scores on the social skills scales ranged from 0 to 76 points. On the problem
behavior scale each subscale score ranged from 0 to 12 points. Reliability of the Estonian adaptation of Social Skills Rating System was checked and was good. (Internal reliability of the two subscales of rating scale were as follows: Total Skills scale: $\alpha = .736$, Problem Behaviors scale: $\alpha = .835$.)

2.4. Neurocognitive examination

The neurocognitive assessment was conducted by a licensed clinical neuropsychologist using the NEPSY test battery [36]. The NEPSY (A Developmental Neuropsychological Assessment) is a test battery developed to measure 3- to 12-year-old children's neurocognitive performances. The battery measures five domains: attention and executive functioning, verbal skills, fine motor skills, visuospatial skills, and memory and learning, using different subtests. The NEPSY is adapted into Estonian and previously used in research [30]. The NEPSY raw scores were transformed into standardized scores in accordance with Finnish norms [36] because there is a lack of valid normative Estonian data for this age group. The average age-appropriate score for the NEPSY subtests is 10 points while scores from 7 to 12 points fall into normal range. These standardized scores were used as estimates of neurocognitive performance; the NEPSY is thought to be a valid tool for neuropsychological evaluation in children with neurological and developmental disorders [37].

2.5. Statistics

Statistical data analysis was performed with the IBM SPSS Statistics 20. An independent sample t-test was used to compare the results of the patients and control group on the NEPSY subtests, ToM tasks, and parents’ questionnaires. A paired sample t-test was used to compare the results of ToM tasks within the group with epilepsy or control group. $p$ value of <.05 is considered statistically significant. Effect sizes were computed using means and standard deviations according to the formula and tables proposed by Cohen [38]. Effect sizes are small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$) [38]. Pearson correlation was used to address the associations between understanding other people's mental states and overall cognitive abilities.

3. Results

3.1. Sociocognitive skills

3.1.1. Theory of mind tasks

Compared with the control group, children with epilepsy demonstrated significantly more difficulties in understanding other people's mental states. They performed lower in false belief ($p < .001$) and intentional lying ($p < .05$), and a slight trend also suggested lower understanding in sarcasm tasks ($p = .06$) compared with the control group (for more details, see Table 2).

Children with epilepsy tended to understand false belief significantly better than intentional lying ($t(34) = 2.79, p = .009, d = 0.58$) and sarcasm ($t(34) = 2.32, p = .05, d = 0.5$), and understanding intentional lying was also better than understanding sarcasm ($t(34) = 5.68, p < .001, d = 1.37$). A similar trend was seen in the control group (children understood false belief better than intentional lying ($t(29) = 2.48, p = .05, d = 0.55$) and sarcasm ($t(29) = 8.1, p = .001, d = 1.82$) and understood intentional lying better than sarcasm ($t(29) = 3.73, p = .001, d = 1.06$)).

3.1.2. Social Cognition Questionnaire

According to the Social Cognition Questionnaire, a slight trend suggested that parents of children with epilepsy, compared with parents of control group children, thought their child's social cognition was lower (group with epilepsy: $M = 109.74, SD = 16.77$) (control group: $M = 118.11, SD = 18.42, t(57) = 1.83, p = .07, d = 0.48$).

3.2. Social skills

Results from Social Skills Rating System suggested that there were no significant differences in the mean scores of Social Skills scale between children with epilepsy ($M = 50.67, SD = 8.73$) and controls ($M = 48.2, SD = 5.77$). More thorough analysis revealed that children with epilepsy may have slightly higher mean scores in Cooperation subscale compared with control group children ($t = 2.8, df = 58, p = 0.07$) (group with epilepsy: $M = 11.6, SD = 3.15$; control group: $M = 9.5, SD = 2.64$). No significant differences in other subscales - Assertion (group with epilepsy: $M = 11.17, SD = 2.64$; control group: $M = 11.5, SD = 3.08$), Responsibility (group with epilepsy: $M = 12.45, SD = 2.65$; control group: $M = 12.17, SD = 2.23$), Self-control (group with epilepsy: $M = 12.43, SD = 3.88$; control group: $M = 12.03, SD = 1.92$) were found.

Problem Behaviors scale from Social Skills Rating System, however, suggested that children with epilepsy had significantly more behavioral problems compared with control group children ($t(28) = 1.95, p = .06$). We did not find any significant association between boys with epilepsy ($M = 20.3, SD = 2.4$) and conduct problems compared with control group children ($t(58) = 3.22, p < .05, d = 0.8$) (group with epilepsy: $M = 5.8, SD = 2.4$; control group: $M = 3.9, SD = 2.3$).

There were important gender differences in problem behaviors in children with epilepsy. Boys with epilepsy had more externalizing problems (such as fighting, bullying, arguing, disturbing others) ($t(28) = 2.89, p < .05$) and hyperactivity ($t(28) = 3.2, p < .001$) compared with girls. A slight trend suggested that girls with epilepsy exhibited more internalizing problems (such as loneliness, anxiety, low self-esteem, embarrassment) compared with boys with epilepsy ($t(28) = 1.95, p = .06$) (see Fig. 1).

3.3. Association between social skills and social cognition

Our results showed that children with better social skills also tended to have better social cognition ($r = .53, p < .05$) and children with better social cognition tended to have less behavioral problems ($r = -.66, p < .001$). According to the Social Skills Rating System, children with epilepsy who were evaluated by their parents as having better social skills also tended to have fewer behavioral problems ($r = -.42, p < .05$). We did not find any significant association between ToM tasks and the results of parents’ questionnaires (Social Skills Rating System and Social Cognition Questionnaire).

3.4. Neuropsychological profiles

The results from the neuropsychological assessment are presented in Table 3. Children with epilepsy had significantly lower executive functions and worse attention tasks compared with the control group. They scored significantly lower in the tower task, auditory attention, stature, and knock and tap task ($p < .05$).

Compared with the control group, children with epilepsy were doing significantly poorer in six language tests out of seven. They underperformed in receptive language — phonological processing,
comprehension of instructions, and understanding of sentences (p < 0.05). Their expressive language was also worse than that of the control group in speeded naming, repetition of nonsense words, and oromotor sequences (p < 0.05).

In fine motor skills, significant differences between the group with epilepsy and control group were evident in all subtests. Children with epilepsy did more poorly in sensorimotor abilities — imitating hand positions, visuomotor precision, and in manual motor sequences (p < 0.05). Finger discrimination was also lower in the group with epilepsy (p < 0.05).

In the visuospatial skills tests, children with epilepsy performed generally well, and thus, the control group performed significantly better in only two subtests: design copying and block construction (p < 0.5).

In three subtests of learning and memory, the control group performed significantly better than the children with epilepsy. Children with epilepsy performed more poorly in memory for names, narrative memory, and list learning (p < 0.5).

3.5. Relation between ToM and neurocognitive performance in children with epilepsy

The association between understanding other people’s mental states and overall neurocognitive performance are presented in Table 4. There was a significant positive correlation between false belief understanding and executive functions (r = 0.6, p < 0.001). False belief understanding was also positively correlated with auditory attention, receptive language, and visuospatial skills: block construction, route finding, and arrows. No significant associations between neurocognitive performance and intentional lying or sarcasm were revealed. Neurocognitive performance was not significantly associated with the results of parents’ questionnaires (Social Skills Rating System and Social Cognition Questionnaire).

3.6. Association between epilepsy-related factors, sociocognitive functions, and social skills

We found a moderate positive correlation between the age of a child and the understanding of ToM tasks (r = 0.37, p < 0.05) in children with epilepsy. In addition, a moderate positive correlation existed between age and the understanding of social lying (r = 0.41, p < 0.05). A more

### Table 3
Neurocognitive performance in children with epilepsy and control group.

<table>
<thead>
<tr>
<th>NEPSY subtests</th>
<th>Epilepsy (M, SD)</th>
<th>Control (M, SD)</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attention and executive functioning</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Tower</td>
<td>9.8 (3.67)</td>
<td>12.63 (1.96)</td>
<td>3.78</td>
<td>63</td>
<td>.001</td>
<td>0.96</td>
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<td>Auditory attention</td>
<td>8.77 (2.93)</td>
<td>11.97 (2.75)</td>
<td>4.51</td>
<td>63</td>
<td>.001</td>
<td>1.33</td>
</tr>
<tr>
<td>Visual attention</td>
<td>11.71 (4.35)</td>
<td>12.53 (2.93)</td>
<td>0.88</td>
<td>63</td>
<td>.39</td>
<td>0.22</td>
</tr>
<tr>
<td>Statue</td>
<td>7.97 (3.19)</td>
<td>9.63 (2.68)</td>
<td>2.24</td>
<td>62</td>
<td>.05</td>
<td>0.56</td>
</tr>
<tr>
<td>Design fluency</td>
<td>9.41 (3.29)</td>
<td>11.3 (3.26)</td>
<td>2.92</td>
<td>60</td>
<td>.05</td>
<td>0.74</td>
</tr>
<tr>
<td>Knock and tap</td>
<td>8.74 (3.1)</td>
<td>11.27 (1.93)</td>
<td>3.86</td>
<td>63</td>
<td>.001</td>
<td>0.98</td>
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<tr>
<td><strong>Language</strong></td>
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<tr>
<td>Phonological processing</td>
<td>7.74 (3.09)</td>
<td>9.63 (1.92)</td>
<td>2.93</td>
<td>63</td>
<td>.05</td>
<td>0.74</td>
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<tr>
<td>Comprehension of instructions</td>
<td>7.29 (4.08)</td>
<td>9.6 (2.88)</td>
<td>2.63</td>
<td>63</td>
<td>.05</td>
<td>0.65</td>
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<tr>
<td>Speeded naming</td>
<td>8.42 (2.88)</td>
<td>11.4 (2.25)</td>
<td>4.78</td>
<td>63</td>
<td>.001</td>
<td>1.15</td>
</tr>
<tr>
<td>Repetition of nonsense words</td>
<td>10.14 (3.15)</td>
<td>11.87 (1.76)</td>
<td>2.66</td>
<td>63</td>
<td>.05</td>
<td>0.68</td>
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<tr>
<td>Verbal fluency</td>
<td>8.87 (3.18)</td>
<td>10.17 (2.83)</td>
<td>1.68</td>
<td>59</td>
<td>.10</td>
<td>0.43</td>
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<td>Oromotor sequences</td>
<td>8.78 (2.66)</td>
<td>11.8 (2.41)</td>
<td>1.47</td>
<td>59</td>
<td>.10</td>
<td>0.43</td>
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<tr>
<td>Understanding of sentences</td>
<td>7.12 (2.69)</td>
<td>9.93 (2.59)</td>
<td>4.25</td>
<td>62</td>
<td>.001</td>
<td>1.06</td>
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<td><strong>Sensormotor abilities</strong></td>
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<tr>
<td>Fingertip tapping</td>
<td>9.83 (2.26)</td>
<td>11.5 (1.85)</td>
<td>2.33</td>
<td>63</td>
<td>.05</td>
<td>0.81</td>
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<tr>
<td>Imitating hand positions</td>
<td>6.57 (3.4)</td>
<td>9.37 (2.41)</td>
<td>3.76</td>
<td>63</td>
<td>.001</td>
<td>0.95</td>
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<td>Visuomotor precision</td>
<td>10.14 (4.31)</td>
<td>13.1 (3.9)</td>
<td>2.88</td>
<td>63</td>
<td>.05</td>
<td>0.72</td>
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<tr>
<td>Manual motor sequences</td>
<td>6.93 (2.65)</td>
<td>10.73 (2.03)</td>
<td>6.23</td>
<td>58</td>
<td>.001</td>
<td>1.61</td>
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<tr>
<td>Finger discrimination</td>
<td>9.32 (2.43)</td>
<td>11.0 (1.84)</td>
<td>3.04</td>
<td>59</td>
<td>.05</td>
<td>0.77</td>
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<td><strong>Visuospatial processing</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Design copying</td>
<td>8.14 (3.52)</td>
<td>12.2 (2.28)</td>
<td>5.42</td>
<td>63</td>
<td>.001</td>
<td>1.37</td>
</tr>
<tr>
<td>Arrows</td>
<td>8.51 (3.94)</td>
<td>10.17 (2.9)</td>
<td>1.9</td>
<td>63</td>
<td>.06</td>
<td>0.48</td>
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<tr>
<td>Block construction</td>
<td>9.63 (3.7)</td>
<td>12.23 (2.84)</td>
<td>3.14</td>
<td>63</td>
<td>.05</td>
<td>0.79</td>
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<tr>
<td>Route finding</td>
<td>8.63 (3.86)</td>
<td>10.4 (3.59)</td>
<td>1.87</td>
<td>60</td>
<td>.07</td>
<td>0.47</td>
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<tr>
<td>Picture finding</td>
<td>9.91 (3.24)</td>
<td>10.73 (2.24)</td>
<td>1.16</td>
<td>62</td>
<td>.25</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Memory and learning</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory for faces</td>
<td>7.66 (3.84)</td>
<td>9.23 (3.08)</td>
<td>1.8</td>
<td>63</td>
<td>.08</td>
<td>0.45</td>
</tr>
<tr>
<td>Memory for names</td>
<td>7.85 (2.58)</td>
<td>10.07 (3.01)</td>
<td>3.17</td>
<td>62</td>
<td>.05</td>
<td>0.79</td>
</tr>
<tr>
<td>Narrative memory</td>
<td>9.06 (2.59)</td>
<td>10.73 (2.41)</td>
<td>2.69</td>
<td>63</td>
<td>.05</td>
<td>0.67</td>
</tr>
<tr>
<td>Sentence repetition</td>
<td>8.62 (3.62)</td>
<td>10.0 (3.5)</td>
<td>1.55</td>
<td>62</td>
<td>.13</td>
<td>0.39</td>
</tr>
<tr>
<td>List memory</td>
<td>7.39 (3.67)</td>
<td>11.23 (2.47)</td>
<td>4.71</td>
<td>56</td>
<td>.001</td>
<td>1.23</td>
</tr>
<tr>
<td>Memory for pictures</td>
<td>8.27 (2.78)</td>
<td>9.13 (3.26)</td>
<td>1.15</td>
<td>62</td>
<td>.25</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Abbreviations: M, mean; SD, standard deviation; t, independence samples t-test; df, degrees of freedom; d, Cohen’s d.

In three subtests of learning and memory, the control group performed significantly better than children with epilepsy. Children with epilepsy performed more poorly in memory for names, narrative memory, and list learning (p < 0.5).
thorough analysis revealed that children with epilepsy aged 7–9 years performed significantly worse (t(32) = 2.93, p < .001) (7–9: M = 4.62, SD = 1.81; 10–12: M = 6.81, SD = 2.29) in understanding other people’s mental states than children aged 10–12, especially in understanding intentional lying (t(32) = 3.5, p < .05) (7–9: M = 0.92, SD = 1.19; 10–12: M = 2.57, SD = 1.36). The results showed that older children understood other peoples’ mental states better than younger children.

We also found that children with earlier onset of epilepsy were more impaired in understanding other peoples’ mental states (r = .42, p < .05). The mean age of epilepsy onset in the present study was 9.1 years. Children below the age of 9.1 years did more poorly in understanding other people’s mental states (t(32) = 2.34, p < .05) (younger: M = 5.17, SD = 2.36; older: M = 7.0, SD = 2.19) especially in understanding intentional lying (t(32) = 2.4, p < .05) (younger: M = 1.39, SD = 1.5; older: M = 2.56, SD = 1.32) than children older than 9.1 years of age. According to the Social Cognition Questionnaire, parents of children with earlier onset of epilepsy, compared with parents of children with later onset of epilepsy, thought their child’s social cognition was lower (t(28) = 2.81, p < .05) (younger: M = 102.13, SD = 15.22; older: M = 117.79, SD = 15.3).

Children with generalized epilepsy were worse in understanding sarcasm compared with children with partial epilepsy (t(33) = 2.0, p < .05, d = 0.77) (generalized: M = 0.8, SD = 0.92; partial: M = 1.56, SD = 1.04). Children with generalized epilepsy were also rated as having poorer social skills than children with partial epilepsy (t(28) = 2.0, p < .05, d = 0.83) (generalized: M = 45.63, SD = 8.3; partial: M = 52.5, SD = 8.3). Other epilepsy-related factors (duration, medication) did not have a significant correlation with children’s social skills, social cognition, and behaviors.

3.7. Association between epilepsy-related factors and cognitive performance

3.7.1. Generalized and partial epilepsies

Children with generalized epilepsy showed significantly more memory impairment. Compared with children with partial epilepsy, children with generalized epilepsy had lower scores in the task measuring memory for faces (see Fig. 2) (t(33) = 1.99, p < .05, d = 0.76) and in narrative memory (t(33) = 2.23, p < .05, d = 0.77).

3.7.2. Duration of epilepsy

The mean duration of epilepsy in the present study was 1.38 years. The duration of epilepsy was negatively correlated with different aspects of attention: impulse control (assessed by the statue task: r = −.63, p < .001), motor attention (assessed by knock and tap: r = −.42, p < .05), and design fluency (r = −.33, p < .06). The duration of epilepsy was also negatively correlated with visuospatial skills: design copying (r = −.48, p < .05), arrows (r = −.52, p < .05), route finding (r = −.37, p < .05), picture finding (r = −.37, p < .05), and memory domains: memory for faces (r = −.39, p < .05), memory for names (r = −.53, p < .05), list learning (r = −.38, p < .05), and memory for pictures (r = −.45, p < .05). Thus, a longer duration of epilepsy had a negative effect on attention, visuospatial skills, and memory. Other epilepsy-related factors (age of onset, medication) were not strongly associated with neurocognitive performance.

4. Discussion

This study examined factors related to social competence and neurocognitive performance in children with epilepsy. In the current study, social cognition (abilities allowing individuals to understand social cues and adequately interact) including ToM, social skills, and behaviors were studied as subcomponents of social competence. Theory of mind is a set of basic socio-cognitive skills that emerge in the preschool years that enable individuals to understand another person’s perspective and mental states, including desires, emotions, beliefs, and intentions, in order to predict behavior [39]. Examination of ToM was only introduced in the last decade [23].

We found that children with epilepsy performed significantly worse in ToM tasks (false belief, intentional lying, and sarcasm) compared with healthy peers. Understanding other people’s thoughts, intentions, and feelings is an important cognitive aspect of social behavior. People use different communication forms (lying, sarcasm, jokes) in everyday social interaction which rely on understanding intentions. Failure to understand others’ mental states will guide our behavioral responses and may lead to difficulties in social situations and peer interaction. Children with impaired ToM may make wrong decisions, hurt someone’s feelings, or be bullied, as has been demonstrated with previous studies: children with epilepsy face more problems in social situations [21,22].

We confirmed that the general developmental pattern of social–emotional competence was similar in children with epilepsy and controls. Previous studies have found that initially, children begin to understand false beliefs, after which they begin to understand intentional lying, and then finally develop the ability to understand sarcasm [14,40,41]. Our findings replicate the same developmental course, but children with epilepsy, presumably due to the vulnerability of the immature brain network, showed delayed progress and lower scores when compared with healthy peers.

Children with an earlier onset of epilepsy were especially vulnerable. We found a negative correlation between a younger age of epilepsy onset and ToM. In our study, children whose epilepsy started before the age of 9.1 years performed significantly worse in ToM than children with a later onset of epilepsy, especially in understanding intentional lying. Easier, first-order false belief development starts during the preschool years, whereas more complex ToM reasoning (second-order false beliefs) is not mastered until the age of 7–9 years [42,43]. Therefore, the crucial period for sociocognitive development is the first nine years of life. This helps to explain our findings — epileptic seizures or the underlying dysfunctional neuronal networks that start before nine years of life appear to have a serious, negative influence on the development of ToM. There are contradicting findings regarding ToM impairment and age of onset of epilepsy in previous literature. Schacher et al. [44] did not find any association between ToM and age of onset of epilepsy. On the contrary, other studies have associated age of seizure onset with a ToM deficit [12] as well as psychosocial problems [23,45]. Due to a lack of long-term studies, it is unclear whether delayed ToM development in children with epilepsy recover and mature with age, and children are, therefore, able to catch-up with healthy peers. If not, children with epilepsy may face permanent deficits in social cognitive development. The early onset of seizures can interfere with brain development by affecting myelination and reducing the number of synapses. This can have a negative impact on the maturation of neuronal networks involved in the acquisition of cognitive skills [46].
studies are necessary to determine the developmental course of ToM in children with epilepsy.

In our study, children with epilepsy demonstrated more problem behaviors compared with healthy peers, especially internalizing problems despite a relatively short duration of epilepsy (1.38 years). This indicates that children may have behavioral problems already before the first recognized seizure. Our results are in accordance with a previous study which indicated that children with unrecognized seizures were already at increased risk for behavior problems at the time of their first recognized seizure [47]. Children with epilepsy exhibit behavioral comorbidity [48] — 12.7% have internalizing behavioral problems and 11.4% have externalizing behavioral problems [49]. The recent data of Dafoulis and Kalyva showed that parents of children with idiopathic epilepsy report more emotional problems in addition to hyperactivity and conduct problems than parents of the healthy control group, as well as less prosocial behavior [27].

Our finding that children with epilepsy, even the children with newly diagnosed epilepsy, demonstrated behavioral deficit is important and also a critical point of concern because significantly more children with seizures experience consistent behavioral problems over time compared with siblings [50]. Also, children experiencing recurrent seizures have more behavioral problems compared with children not experiencing recurrent seizures [51].

Previous studies have indicated that boys with idiopathic epilepsy may encounter more behavioral symptoms [27]. Similarly, we found significant gender difference in problem behaviors — boys with epilepsy showed more externalizing problems and hyperactivity. Girls with epilepsy, on the other hand, have more internalizing problems. One risk factor that increases children's internalizing and externalizing behavioral problems is stressful life events [52]. Epilepsy, as a severe chronic illness, may be a considerably stressful factor and, therefore, increase the occurrence of behavioral problems. Sensitivity to interpersonal problems (worry about quality of relationships, loneliness, and helplessness, fear of abandonment) may also increase children's internalizing problems [52]. We found that children with epilepsy who had lower social skills and social cognition encountered more behavioral problems. Therefore, children with epilepsy may be more sensitive about the quality of relationships with friends and family and feel more rejected and lonely. This, in turn, can lead to more severe internalizing problems persisting into adolescence and adulthood.

Although children with epilepsy had an overall lower ability to understand others' mental states, we found that according to the Social Skills Rating System, the social skills of children with epilepsy (responsibility, self-control, and assertion) are intact and do not differ significantly from social skills of control group children. Furthermore, our data demonstrated that parents of children with epilepsy tended to rate their child's cooperation skills better than parents of typically developing peers. This is a relevant finding, and there may be many reasons for it. It is well known that parents of children with epilepsy are typically overprotective, and therefore, these children cannot be so independent and have to rely more on parents (have to follow orders, take medication etc.) [53]. They are used to turning to an adult or other similarly-aged children in case of problems and worries, thereby, training their cooperative skills. To sum up, similarly rated social skills in children with epilepsy and their healthy peers indicated that subcomponents measured with Social Skills Rating System (cooperation, assertiveness, responsibility, self-regulation) may not be affected by epilepsy. However, various aspects of social competence may be affected differently. Our results from the Social Cognition Questionnaire showed a slight trend suggesting that the parents of children with epilepsy, compared with parents of healthy children, evaluated their child's social cognition as lower. Appropriately age-developed social skills, detected problem behaviors, and worse ToM confirms the assumption that different aspects of social competence may be affected differently in children with epilepsy. Saltzman-Benaiah and Lalonde have shown that ToM abilities show steadily improving levels of performance between 6 and 12 years of age [14]. Therefore, the skills under rapid development may be more vulnerable to epilepsy (or other disruption in the CNS). Almane et al. have found that children with recent-onset epilepsy present with significant behavioral problems and lower social competence [54]. Coping in social situations may rely on underlying fundamental sociocognitive processes, and therefore, attention in the rehabilitation of these children should turn to more fundamental sociocognitive processes, not only teaching social skills.

Additionally, as suggested by Yeates et al., objective data about children's social skills cannot be compiled using only rating scales and questionnaires [55], especially since the questionnaires used in most studies are not specifically developed for children with epilepsy and, therefore, may not distinguish children with epilepsy from healthy peers. There is a need for special questionnaires to rate specific social skill problems in children with epilepsy and also combine questionnaires with ToM assessment in further studies.

Our study suggests that children with epilepsy have notable cognitive difficulties compared with healthy peers: the most impaired cognitive functions were attention, executive functioning, memory, and unexpectedly, fine motor skills. Lower performance in visuospatial and verbal skills was also found. Compared with controls, children with epilepsy performed lower in 21 subtests out of 29. Although the performances of the children with epilepsy were mostly within normal range (standard scores: 7 and above), their scores fell largely to the lower/borderline end of normal range. The pattern seems to be in line with previous studies indicating diffuse or global impairments in several neurocognitive functions [29,30]. Poorer fine motor skills in children with epilepsy is an interesting finding because the children with epilepsy did not have any known paresis or pyramidal syndrome. Hernandez et al. [56] found impairment in motor coordination in patients with frontal and temporal lobe epilepsy and, in addition, generalized epilepsy. In sum, very little attention has been paid to the assessment of fine motor skills in neuropsychological examination and rehabilitation in children with epilepsy. The results of our study broaden the knowledge of the nature of fine motor skills impairment: results confirm impaired motor attention and manual clumsiness. By supporting the development of fine motor skills it is also possible to improve attention and verbal skills. Brain regions that are in control of language and speech are activated when executing motor activities [57]. One reason for cognitive impairment in children with epilepsy may be that an immature CNS is vulnerable to epileptic charges, damages, and external conditions [58,59]. Therefore, any interruption (e.g., the presence of epileptic focus) may interfere with the expected developmental course and impair the normal maturation of the central nervous system and cognitive functions [58,59].

We found that in children with epilepsy, false belief understanding was correlated with neurocognitive performance (executive function and verbal and visuospatial skills), which infers that children who have a neurocognitive deficit have a poorer understanding of other's mental states. Neuropsychological status may contribute to the development and expression of aspects of social skills in children with congenital and acquired brain dysfunction [60]. These problems may cause a lack of appropriate responses in social situations, thereby, affecting children's social behavior. For the purpose of these data, the specific deficit in the language domain found in the present study may be one of the key factors affecting children's social reasoning. The wider linguistic deficit in children with childhood absence epilepsy was also reported by Caplan et al. [61]. Using the Child Behavioral Checklist, Byars et al. [62] also found that poor language function was associated with declining social competence in children with epilepsy. Several studies have linked cognitive functions (executive function, verbal ability) and ToM in typically developing children [63,64]. Studies with children with epilepsy are limited. Our finding suggests that a neurocognitive deficit may be the reason for impaired mechanisms regulating children's social development.

In the present study, we analyzed the differences in neurocognitive performance between children with generalized and partial epilepsies
and came to notable findings. Impairments in memory, ToM, and social skills were more evident in children with generalized epilepsy when compared with partial epilepsy. These findings dovetail with Jakovljevic and Martinovic’s [21] previously reported data. Using parents’ ratings, they found a lower level of social competence in children with generalized epilepsy. As generalized epilepsy involves epileptic activity in both brain hemispheres, it may cause a more severe impairment of cognitive and social skills than partial epilepsy, which usually involves one brain hemisphere. There are many studies that focus on cognitive abilities in partial epilepsy [17,18], but unfortunately, not enough attention to generalized epilepsy to date still. It is important to note that unfortunately, there were only 10 children with generalized epilepsy participating in our study; therefore, results regarding lower social and cognitive abilities in the group with generalized epilepsy need to be interpreted with caution. The results of our study raise the need to focus more on generalized epilepsy, taking sociocognitive function into consideration.

This study was limited by a small number of subjects — this prevents us from drawing firm conclusions, which affects the overall statistical power. We also did not compare the results of the group with newly diagnosed epilepsy (without AED) with that of children with longer duration of epilepsy. However, we used a large test battery and control group to provide complete assessment of neuropsychological profiles — this allows us to more precisely assess cognitive dysfunction relative to each participant’s ToM level. Further studies with more children would be helpful to obtain a more representative sample with regard to different types of epilepsy to determine whether deficit in social and cognitive skills are related to epilepsy-related factors. The second limitation was the use of the parents’ questionnaires that were not designed specially for children with epilepsy. Unfortunately, there are no known social competence questionnaires designed for children with epilepsy, which is an important direction for the future. The third limitation was the absence of social competence and academic-related information from school teachers. School is an environment in which children interact with others, and therefore, social difficulties should be more evident there. Information from peers and teachers would be very valuable in determining children’s social problems.

In conclusion, the present study brought forth several important findings. Firstly, we found that children with epilepsy encounter several sociocognitive and neurocognitive problems. Secondly, there is a positive correlation between higher cognitive abilities (executive, verbal, and visuospatial skills) and better ToM. Thirdly, children with generalized epilepsy and an earlier onset of epilepsy exhibit poorer sociocognitive performance. Our study raises the need to turn more attention to children with generalized epilepsy, as they might be an elevated risk group for developing social dysfunction and cognitive impairments.

Our findings have substantial implications for clinical management. We recommend using ToM assessment in all children with newly diagnosed epilepsy in addition to neurocognitive functioning, especially in children with generalized epilepsy, to prevent more extensive social problems in the longer term. Elucidation of the suspected causes and consequences of ToM impairments in the children with epilepsy will be helpful in guiding health practitioners in their intervention and follow-up of children exhibiting persistent sociocognitive difficulties.

In the rehabilitation of children with epilepsy, cognitive and social impairment should be handled together for better treatment outcomes. Learning and developing these skills is one of the important goals in childhood, as it is harder to acquire these skills later in life.

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Author contributions

Triin Raud had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Triin Raud and Anneli Kolk prepared the study concept and design. Triin Raud and Mari-Liis Kaldoja were in charge of the acquisition, analysis, and interpretation of data and statistical analysis. Triin Raud, Anneli Kolk, and Mari-Liis Kaldoja put together the manuscript draft. Anneli Kolk was responsible for the critical revision of the manuscript for important intellectual content and obtained funding for the study.

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Ethical approval

The study was approved by The Research Ethics Committee of the University of Tartu 1907–21.

Declaration of conflicting interests

None of the authors have any conflicts of interest to report.

References