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Impaired performance on advanced Theory of Mind tasks in children with epilepsy is related to poor communication and increased attention problems☆

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ABSTRACT

Children with epilepsy (CWE) have social difficulties that can persist into adulthood, and this could be related to problems with understanding others' thoughts, feelings, and intentions. This study assessed children's ability to interpret and reason on mental and emotional states (Theory of Mind) and examined the relationships between task scores and reports of communication and behavior. Performance of 56 CWE (8–16 years of age) with below average IQ (n = 17) or an average IQ (n = 39) was compared with that of 62 healthy controls with an average IQ (6–16 years of age) on cognition, language, and two advanced Theory of Mind (ToM) tasks that required children to attribute mental or emotional states to eye regions and to reason on internal mental states in order to explain behavior. The CWE-below average group were significantly poorer in both ToM tasks compared with controls. The CWE — average group showed a significantly poorer ability to reason on mental states in order to explain behavior, a difference that remained after accounting for lower IQ and language deficits. Poor ToM skills were related to increased communication and attention problems in both CWE groups. There is a risk for atypical social understanding in CWE, even for children with average cognitive function.

1. Introduction

Poor social outcomes are frequently reported in long-term follow-up studies of childhood-onset epilepsies, and these are not limited to individuals with structural brain abnormalities or intellectual disabilities [1,2]. Even for adults with good cognitive development and no comorbidity, forming and maintaining social relationships can remain problematic [3]. Children with epilepsy (CWE) with normal global cognitive function also have difficulties in making friends and with peer relationships [4,5]. Studies have found that parents report poorer social skills [6] and lower social competence in CWE compared with typically developing children [7,8] and unaffected siblings [9]. Children with epilepsy with normal intelligence are often found to have cognitive and language deficits, and it remains unclear if social difficulties reflect neuropsychological impairment [10]. There is an increasing research focus on social development in CWE with recognition that deficits in social information processing and poor sociocognitive skills could help explain the worse-than-expected outcomes in terms of education, social adjustment, and mental health [11]. We use the term Theory of Mind (ToM) here to refer to a set of social cognitive skills involved in the ability to interpret and reason about others' mental and emotional states and use them to explain and predict behavior also known as 'mentalizing'. Theory of Mind development relies on social perceptual skills in order to recognize and attribute mental or emotional states as well as more complex social conceptual reasoning that involves inference on how these internal states are causally related to overt behavior [12]. Theory of Mind develops in tandem with other cognitive and linguistic skills [13], and poor performance on ToM tasks is often found in children with disorders of communication and behavior [14]. Assessment of ToM may provide additional explanation for the communication and behavioral problems in children with epilepsy beyond measures of more general nonsocial cognitive or language functions.

Prior investigations of different facets of social cognition in CWE have mainly assessed patients with refractory epilepsy with normal intelligence and epileptogenic foci in regions associated with processing social–emotional content. Impairments in face processing [15,16], emotion recognition [15], and emotional memory [17] have been observed, with one study reporting that poor recognition of fear predicted increased behavioral problems [15]. Poor affective ToM (inferring internal states from emotional cues) was also recently demonstrated in children with epilepsy with centrotemporal spikes [18], indicating that ToM deficits may be present even in the most benign forms of the disease. These studies have provided evidence of specific impairments in particular epilepsy types, often with all groups showing poorer performance when compared

☆ This article reports findings on an extended sample from a previous smaller study (Lew et al., 2014, http://dx.doi.org/10.1111/dmcn.12613).

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with unaffected controls. We have recently found, in a small group of CWE, that ToM skills did not differ between generalized and focal seizure types and that no reliable relationships between task performance, communication, and behavior could be established [19]. Cognitive, psychiatric, and social adjustment problems are neurobehavioral comorbidities in CWE with normal intelligence, irrespective of syndrome [20,21]. In the wider CWE population, impairments in sociocognitive skills (that would include ToM) are theorized to contribute to the poor development of social competence that includes poorer social skills, social adjustment problems, and lower social performance [8]. Similarly, the higher rate of reported social problems (i.e., peer isolation or rejection) observed in CWE [22] could be related to a poor ability to interpret and reason about others' mental and emotional states. There remains, however, a dearth of studies that have assessed such sociocognitive skills in children.

The substantial evidence of cognitive, linguistic, and behavioral problems in CWE suggests that school-aged children will likely perform less well on advanced ToM tasks compared with healthy controls. Studies often report that the mean IQ of groups with epilepsy is at the lower end of the normal range [23,24], and the ability to reason about belief states and to understand the causes and consequences of emotions is impaired in children with global developmental delay [25,26]. Children with epilepsy with normal global cognition are also at higher risk for disorders of language and communication [27–29]. Preschool CWE have been found to have lower verbal IQ and deficits in basic language functions [30–32], whereas school-aged CWE cohorts have displayed additional problems with more complex skills that include pragmatic language [33,34] and conversational discourse functions [28,35]. There is also a higher risk of thought disorder that is characterized by an impaired ability to use coherent casual reasoning and to monitor higher-order topic maintenance in communication [36]. Advanced ToM tasks require children to reason causally about others' internal states and to use language to explain social behavior. Furthermore, poor mentalizing skills have been found to predict increased peer problems in adolescents with a history of early language impairment [37]. Therefore, the cognitive and language dysfunction observed in CWE increases the risk of developing poor ToM that might be an additional marker of communication and social problems in school-aged children.

Poor cognition, language, and communication also overlap with behavioral problems that all contribute to social difficulties in CWE [4,8,38]. Comorbid inattention and affective disorders are frequently reported in children with average intelligence [11,39], and externalizing problems are an additional concern associated with lower IQ [40,41]. Children with attention deficits are less able to process fully and integrate perceptual information from social cues that include signals from eye gaze and emotions [42] and also show impaired higher-order social cognitive reasoning [43]. Atypical mentalizing about others' intentions and misattributions of emotional cues are also implicated in child psychopathology [44,45].

In school-aged CWE cohorts, poorer cognition and language have been linked to an early age at epilepsy onset [46,47], illness duration [28], persistent seizures [48], and multiple AEDs [47]. These factors can be correlated in small samples of chronic epilepsies that can make it difficult to distinguish between separate effects and can be confounded with low IQ. Relationships between illness-related variables and neurocognitive outcomes are also known to vary depending on the child's global cognitive function [49]. Studies also report different associations between neurocognitive functions and communication and behavior in CWE with below average intelligence and average intelligence [41,49] and emphasize the need to address the groups separately [11]. The present study included CWE with presumed genetic or unknown etiologies in mainstream education. It distinguished between CWE with a below average Full Scale IQ from those with a Full Scale IQ in the average range to test if perceptual and conceptual ToM deficits are present in CWE beyond global cognition and language skills. It assessed if IQ, language, or ToM skills predict parental reported problems in functional domains known to be at risk (communication, attention, social problems, internalizing and externalizing) and examined if epilepsy-related variables predict children's task performance.

2. Material and methods

2.1. Participants

The study involved 56 children with epilepsy (CWE) and a control group of 62 typically developing children. Inclusion criteria were CWE between 8 and 16 years of age with presumed genetic or unknown etiology and who attend a mainstream school. Exclusion criteria were cases of epilepsy with an identifiable structural or metabolic etiology. Recruitment involved identification of candidate children from a tertiary care pediatric neurology department and a community-based pediatrician's caseload in two urban areas. Patient medical information was accessed after written parental consent, child assent, and study participation. A consultant pediatric neurologist responsible for care at both sites reviewed clinical, EEG, and imaging information where available and categorized children in accordance with the revised terminology and concepts for epilepsies and seizures proposed by the International League Against Epilepsy (ILAE) Commission on Classification and Terminology 2005–2009 [50]. Nine (16%) children met the criteria for an epilepsy syndrome (2 CAE, 7 BECTS). The remaining participants were grouped on mode of seizure onset (generalized, focal, or features of both). Full details of the classifications are reported in Table S1 (Supplementary online materials). Information on epilepsy developmental variables (age at onset and duration), the presence of a seizure in the prior six months to study participation, and number of current medications was derived from clinical records. Seventeen (30%) children with epilepsy had a FSIQ < 80 (6 were in the range of 60 to 69). None of the included children were undergoing assessment for a psychiatric or neurodevelopmental disorder at the time of participation. A further six children participated but were excluded from the analyses. Four were attending or awaiting special school placement (IQ ranged from 46 to 59), one had incomplete study data, and one had a diagnosis of Asperger syndrome (IQ of 72).

A control group of typically developing children was recruited from local mainstream schools. Children were between 6 and 16 years of age without a diagnosis of a neurological or developmental disorder. As CWE were likely to perform less well than same-age peers, younger control children (n = 10) were included to improve the reliability of estimates used to standardize the experimental ToM measures [51]. None of the control children was in receipt of additional educational support. An estimate of socioeconomic status (SES) was derived from the National Statistics Indices of Total Deprivation 2010 rankings for postal codes that rank all neighborhoods in England from 1 (most deprived) to 32,482 (least deprived); the ranks were further grouped to represent the lowest, middle, and highest terciles. Table 1 displays the participant information for the three groups. These were CWE with below average IQ (FSIQ range = 60 to 79: 'CWE — below average'), CWE with average IQ (FSIQ range = 81 to 121: 'CWE — average'), and controls with an average IQ (FSIQ range = 83 to 121: 'Control — average'). Comparisons on demographic information found that, as a consequence of the recruitment strategy, the CWE — average group was significantly older than the Control — average group but did not differ on mental age. As might be expected, the CWE — average group was also less likely to be receiving educational support than the CWE — below average group. As in previous studies [49], the highest third SES tercile contained a much smaller proportion of the CWE — below average group than of the Control — average group (Table 1). National Health Service and University Departmental Research Ethics Committees reviewed and approved the study before commencement.

2.2. Measures

2.2.1. IQ and language

Full Scale IQ (FSIQ) was estimated from four subtests of the Wechsler Intelligence Scale for Children IV — UK [52]. Each subtest