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Brief Communication

Attention impairment in childhood absence epilepsy: An impulsivity problem?

Caterina Cerminara [a,*,1], Elisa D'Agati [a,1], Livia Casarelli [a], Ivo Kaunzinger [b], Klaus W. Lange [b], Mariabernarda Pitzianti [a], Pasquale Parisi [c], Oliver Tucha [d], Paolo Curatolo [a]

[a] Unit of Child Neurology and Psychiatry, Department of Neuroscience, University of Rome “Tor Vergata”, Italy
[b] Department of Experimental Psychology, University of Regensburg, Germany
[c] Paediatric Department, II Faculty of Medicine, University of Rome “La Sapienza”, Italy
[d] Department of Clinical and Developmental Neuropsychology, University of Groningen, The Netherlands

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ABSTRACT

Although attention problems have often been described in children with childhood absence epilepsy (CAE), the use of different methodological approaches, neuropsychological tests, and heterogeneous experimental groups has prevented identification of the selective areas of attention deficit in this population. In this study, we investigated several components of attention in children with CAE using a unique computerized test battery for attention performance. Participants included 24 patients with CAE and 24 controls matched for age and sex. They were tested with a computerized test battery, which included the following tasks: selective attention, impulsivity, focused attention, divided attention, alertness, and vigilance. Compared with healthy controls, patients with CAE made more commission errors in the Go/No-Go task and more omission errors in the divided attention task. Childhood absence epilepsy patients also showed decreased reaction times in measures of selective attention and a great variability of reaction times in alertness and Go/No-Go tasks.

Our findings suggest that patients with CAE were impaired in tonic and phasic alertness, divided attention, selective attention, and impulsivity.

1. Introduction

The association between childhood epilepsy and cognitive dysfunction has long been documented. In recent years, numerous studies have attempted to identify specific epilepsy-related factors that contribute to predicting cognitive dysfunction with largely conflicting results. Although neuropsychological studies of pediatric populations with epilepsy have not demonstrated a specific pattern of impairment, deficits in attention and memory have been documented [1,2]. Idiopathic generalized epilepsies that are not due to brain lesions could provide an interesting model for investigating the effects of underlying epileptic conditions on cognitive functions.

Childhood absence epilepsy (CAE) is a common form of pediatric epilepsy and accounts for approximately 15.3% of all cases [3]. Typical absence seizures are characterized by brief (<30 s), sudden, and unpredictable episodes of impaired consciousness associated with generalized-spike/polyspike-and-slow-wave discharges on electroencephalogram (EEG) and are often accompanied by motor automatisms [4]. Although CAE has been generally presumed to be relatively benign and occurs in children who show normal mental development, recent comparative studies suggest that patients with CAE show attentional problems even if their seizures are controlled [5–8]. The attention process can be viewed as the building block for other more complex forms of cognitive activity. Neuropsychological theories of attention include unitary concepts of attention in multidimensional models, with several distinct components of attentional functions. In their multicomponent model of attention, Van Zomeren and Brouwer include alertness, subdivided into tonic and phasic alertness, vigilance/sustained attention, selective attention, divided attention, and strategy/flexibility [9]. Selective attention and divided attention are regarded as aspects of selectivity, and alertness and vigilance/sustained attention represent expressions of intensity.

Attention problems are commonly reported in children with epilepsy, particularly CAE [5]. They can interfere with children's academic performances and daily lives [10]. Attention seems to be particularly vulnerable to epileptic activity [11], and evaluating the effects of epilepsy on the development of cognitive functions is complex because of the many variables that can affect cognitive abilities [i.e., antiepileptic drugs (AEDs), educational setting, interictal EEG abnormalities]. Recent studies have tried to systematically compare the neuropsychological performance of children with CAE with that of healthy control groups, but the findings are difficult to interpret.

* Corresponding author at: Department of Neuroscience, Pediatric Neurology Unit, “Tor Vergata” University of Rome, Italy, Via Montpellier 1, 00133, Rome, Italy. Fax: +39 06 20900018.

E-mail addresses: caterinacerminara@hotmail.com (C. Cerminara), elisadagati@gmail.com (E. D'Agati), liviacasarelli@hotmail.com (L. Casarelli), ivo.kaunzinger@psychologie.uni-regensburg.de (I. Kaunzinger), klaus.lange@psychologie.uni-regensburg.de (K.W. Lange), tempilunghi@libero.it (M. Pitzianti), pasquale.parisi@uniroma1.it (P. Parisi), O.M.Tucha@rug.nl (O. Tucha), pcuratolo@uniroma2.it (P. Curatolo).

[1] These authors contributed equally to the present work.

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Evidently, the substantial variations in methodological approaches and neuropsychological tests or the heterogeneity of the groups studied prevents the identification of the selective areas and degree of cognitive deficit in this population [12–14].

Theories on the mechanisms underlying epileptogenesis in absence seizures hold that they are not truly generalized but involve selective cortical networks [15–18], such as the prefrontal cortical circuits. The latter seem to play a role in attention and impulsivity [9,19]. Studies have looked mainly at attention deficit and a few at specific attentional measures [5,8,12,20] and impulsivity.

The present study aims to investigate several components of attention (as suggested by the multicomponent model) in a well-defined group of children with epilepsy using a computerized Tests of Attentional Performance (TAP) battery for attention performance (alertness, vigilance, divided attention, focused attention, and selective attention) that as well as a measure of impulsivity [21]. We hypothesized that the evaluation of both attentional functions and impulsivity could better define the underlying mechanism of attentional impairment documented in children with CAE.

2. Method

2.1. Participants

Twenty-four children with CAE (12 boys and 12 girls) and 24 controls (12 boys and 12 girls) matched for age and sex were included in the study. Children meeting criteria for CAE were recruited from the Department of Child and Adolescent Neuropsychiatry of “Tor Vergata University” and from the Pediatric Department of the II Faculty of Medicine of “La Sapienza University” in Rome.

The inclusion criteria for patients with CAE were the following: age between 8 and 14 years; IQ $\geq$ 80 measured using the Wechsler Intelligence Scale for Children, Third Edition [22]; a history of CAE diagnosis (characterized by the following: several absence seizures per day; EEG showing bilateral symmetrical and synchronous spike-and-wave discharges, occurring regularly at 3 Hz, with normal background activity; and absence seizures as the only identified seizure type); onset of seizures between 6 and 11 years; and normal neurological examination. Exclusion criteria for patients with CAE were the following: a comorbid diagnosis of psychiatric disorders, the presence of neurological impairments or learning disabilities, and not taking psychotropic drugs associated with antiepileptic treatment.

All patients were on antiepileptic medication treatment: 18 with valproic acid (VPA), 4 with levetiracetam, 1 with lamotrigine, 1 with VPA and levetiracetam, and 1 with VPA and lamotrigine. An awake EEG was done before the time of testing. None of the patients showed electroclinical seizures, and only 2 patients presented sporadic spike–wave in frontal regions. They were all seizure-free.

The healthy children, recruited in schools, were selected from a pool of subjects who voluntarily participated in the neuropsychological assessment. Inclusion criteria for healthy children were the following: age between 8 and 14 years; all children aged 10.5 years or younger had a full-scale IQ that fell above the 75th percentile on the Progressive Colored Matrices [23], and all children aged 11 years or older had an IQ greater than 80 on the Progressive Standard Matrices [24]; and no history or presence of CAE, psychiatric disorders, neurological impairments, or learning disabilities. At the time of the study, no healthy participant was taking medication known to affect the central nervous system.

In patients and healthy children, the long version of Conners' Parents Rating Scale—Revised [25] was used to exclude the diagnosis of attention deficit hyperactivity disorder according to the DSM-IV-TR criteria [26]. An interview was conducted by an expert child psychiatrist with the children and their parents using the Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS-PL) [27] to exclude other psychiatric comorbidities according to DSM-IV-TR in patients [26]. Prior to the start of this study, all parents were informed of the aims and nature of the study and gave written consent.

2.2. Methods and procedure

All participants were tested with a computerized test battery which consisted of a selective attention task, an impulsivity task, a task measuring focused attention, a measure of divided attention, two tests measuring arousal, and a vigilance task. While selective attention, impulsivity, focused attention, and divided attention are regarded as aspects of selectivity of attention, arousal and vigilance represent expressions of intensity of attention [9]. Test procedures were presented on a computer screen, and instructions were given orally. Participants were instructed to perform the computerized tasks as quickly as possible but to maintain a high level of accuracy. In each test, reaction times for correct responses, the number of omission errors (lack of response to target stimuli), and/or the number of commission errors (responses to nontarget stimuli) were calculated. To familiarize the participants with the tasks, a brief sequence of practice trials preceded each test. Participants were assessed individually in a quiet room, and the examiner was present during the entire assessment.

In the *alertness tasks*, participants were asked to respond by pressing a button when a visual stimulus (a cross of about 1.2 by 1.8 cm) appeared on a computer screen. A total of 40 trials were undertaken. In the first 20 trials, the stimulus appeared on the screen without prior warning (*tonic alertness task*), while during the second 20 trials, a warning tone preceded the appearance of the stimulus (*phasic alertness task*). The time span between the warning tone and the appearance of the stimulus was random (between 300 and 700 ms). Measures of tonic and phasic alertness were calculated on the basis of the reaction time of the participant [21]. In addition, the variability of reaction time and the number of omission errors were measured.

In the *vigilance task*, a structure consisting of two rectangles (each about 1 by 2 cm) was presented in the center of the screen. One rectangle was situated on top of the other. These rectangles were alternately filled with a pattern (stimulus) for 500 ms with an interstimulus interval of 1000 ms. The duration of the test was 15 min. A total of 600 stimuli (changes of pattern location) were presented. The participants were requested to press the response button when no change of the pattern location occurred. The target rate (i.e., no change of pattern location) was about one target stimulus per minute for a total of about 18 targets. The time intervals between target stimuli were irregular. Reaction time for correct responses, variability of reaction time, number of omission errors, and the number of commission errors were calculated [21]. The task measured vigilance by requiring the participant to remain alert and ready to react to infrequently occurring target stimuli over a relatively long and unbroken period of time.

The *divided attention task* required participants to concentrate simultaneously on a visual and an acoustic task presented by a computer. In the visual task, a series of matrices (about 9.5 by 11 cm) was presented in the center of the screen. Each matrix, consisting of a regular array of sixteen dots and crosses (4×4), was displayed for 2000 ms. The subjects were asked to press the response button whenever the crosses formed the corners of a square (visual target). In the acoustic task, the participants were requested to listen to a continuous sequence of alternating high (2000 Hz) and low (1000 Hz) sounds and to press the response button when irregularities of the sequence occurred (acoustic target). A total of 100 visual and 200 acoustic stimuli were presented including 17 visual and 16 acoustic targets. Reaction time for correct responses, variability of reaction time, the number of omission errors (lack of response to target stimuli), and the number of commission errors (responses to nontarget stimuli) were calculated as a measure of divided attention [21].