COGNITION AND ACHIEVEMENT IN CHILDREN WITH SEIZURE DISORDERS

Lydia Barza, PhD
Zayed University, United Arab Emirates

Abstract

School personnel can help to identify, monitor and accommodate students with seizure disorders. This article describes the general characteristics of seizure disorders and reviews research on implications for cognition and achievement among children. Despite methodological limitations of research in this area, a few trends are observed. Localization of seizure activity in the brain and age of onset have a major impact on cognition. A synthesis of major studies show that deficits often involve one or more of the following: verbal memory, visual memory, reaction time, and attention. Challenges in reading comprehension are well documented. Poor school performance, in general, may be due to frequent lapses of awareness. Recommendations are for school personnel to monitor and document symptoms at school.

Keywords: Chronic illness, epilepsy, seizure disorders, cognition, achievement

Introduction

School personnel, including teachers, school counselors, school nurses and special education needs coordinators (SENCos), play a vital role in informing educators and parents about chronic illnesses, such as seizure disorders. Epilepsy, the term used for recurrent seizures, is one of the most common neurological disorders of childhood. An understanding of the condition and its impact on cognition and achievement will afford the practitioner the knowledge to advocate for relevant services and provide appropriate social and academic support. The purpose of this article is to describe the prevalence and general characteristics of seizure disorders and then systematically review research on its implications for cognition and achievement among children.Finally, guiding principles for practice are discussed.

Effectively working with students with seizure disorders first involves a general understanding of the condition, particularly due to

commonly held misconceptions about individuals with such illnesses(Jacoby, Snape& Baker, 2005).School performance issues reviewed from the literature on students with seizure disorders provide some guidance as to how they may be placed in the least restrictive and most appropriate schooling environment, especially since some studies show higher rates of grade retention and placement in special education programs (Bailet & Turk, 2000; Berg et al., 2005).

Prevalence and characteristics of seizure disorders

A seizure is characterized by uncontrollable, excessive electrical activity in the central nervous system (CNS). It results from sudden electrical discharge of neurons in the brain (Black & Hynd, 1995). Rutecki explained that such "abnormal synchronization of cortical neurons results in a change in perception or behavior"(Rutecki, 1993, p. 275). It is thought that recurrent seizures are caused by an inherent brain abnormality. Nevertheless, no evidence is found for an underlying cause in 50-60% of cases. Recurrent seizures may subject the individual to transient and chronic brain electric and neurochemical disturbances (Jokeit & Ebner, 1999). Consequences of abnormal electrical activity in the brain most often include "loss of consciousness, an altered state of consciousness, cessation of motor activity, abnormal motor activity, abnormal sensory perceptions, and loss of bladder and bowel control"(Wiederholt, 1995, p. 211). Symptoms vary depending on seizure type.

Recurrent seizures in an otherwise healthy individual are a symptom of epilepsy. Peak ages of onset are the first two years of life and the onset of puberty (Black & Hynd, 1995).It is hypothesized that hormonal changes stress the CNS and may precipitate seizures in susceptible individuals (Wiederholt, 1995).

The incidence of epilepsy is about 1% of the population and 75% experience onset before age 20. Epilepsy is estimated to affect up to 50 million people globally and 2.5 million people in the United States with predominance among males. Approximately 145 diseases are associated with seizures. Seven to ten percent of the population will have a seizure at some point in their lives (CDC, 2011; WHO, 2001).

Types of Seizures

Seizures are categorized based on three factors: localization in the brain, loss of consciousness, and type of muscular activity. According to the International Classification of Epileptic Seizures (see Table 1), a distinction is made between partial and generalized seizure types. Partial seizures involve localized discharges in the brain. They begin focally, meaning onset is from one brain region or one cerebral hemisphere only. Generalized

seizures involve discharges from both cerebral hemispheres and subcortical connections and structures (Black & Hynd, 1995). Abnormal electrical activities begin in both hemispheres at the same time (Wiederholt, 1995). This distinction is of importance because some research findings on cognition and achievement are idiosyncratic based on this factor.

A seizure is described as complex if it is associated with a loss of consciousness. Conversely, a seizure is described as simple if it is not associated with a loss of consciousness. Muscular activity is characterized as tonic, clonic, or both. Tonic muscular activity refers to muscle contraction or tension. For example, the arms and legs may be extended rigidly for several seconds. Clonic muscle activity involves alternation between contraction and relaxation.

Tonic-clonic or grand mal types are most easily identified as a seizure because of their dramatic physical expression. This type of seizure is characterized by a sudden cry then unconsciousness, body rigidity, muscle jerking, clenched teeth, and possible suspended breathing. The seizure commonly lasts for about 2-3 minutes, while the entire seizure and recovery period may span about 10-20 minutes.

Nevertheless, typical absence or petit mal seizures are the most common type of seizure in children. They are characterized by losses of awareness without changes in muscle tone, vacant stare, rapid eyelid blinking at about 3 per second, and no recollection of the seizure. Typical absence seizures classically occur between the ages of 3 and 12 (Wiederholt, 1995). Such seizures last for less than 15 seconds per episode and can be difficult to diagnose because of their subtle physical manifestations. In the classroom, a seizure episode of this type is often mistaken for inattention, ignoring, or daydreaming. However, an awareness of the condition combined with keen observation by social workers and teachers may aid in the diagnosis and subsequent medical and educational intervention.

Method

This article synthesizes the results of studies on the cognitive implications of seizure disorders in children. The methods used to collect the literature for this paper included a comprehensive literature search of published literature since 1970 and a review and retrieval of references from relevant articles. The initial search was conducted using the following key search words: seizures or epilepsy, and cognition, achievement, education. These key word searches were conducted in several databases including PsycINFO and MEDLINE. Fifty papers were synthesized in a narrative format by topic: cognitive implications, academic implications, and pharmacological implications. Some papers were included in more than one section. An article met the relevance criteria if it was a primary study or

review and if it was published after 1970. A paper was excluded if it was a single subject case study. Fiftystudies passed the relevance test and data extraction was completed on those papers. Twenty-eight papers examined cognitive issues, fifteen examined achievement and seven studies described pharmacological issues. This paper provides a narrative synopsis of the relevant studies.

Cognitive issues

Several factors combined contribute towards cognitive dysfunction (Aldenkamp, 1997; Bourgeois, 1998). Studies on temporal lobe epilepsy suggest that seizures could produce progressive neuronal damage (Jokeit & Ebner, 1999; Koh, Storey, Santos, Mian& Cole, 1999; Tasch et al., 1999). Such damage may have an effect on long-term potentiation involved in learning(Giovagnoli & Avanzini, 1999). Nevertheless, reviews of the literatureconclude that children show mild, varied, transient cognitive difficulties during the course of their epilepsy (Dodrill, 2004; Hermann & Seidenberg, 2007; Vingerhoets, 2006).

Intelligence

Research studies are consistent in reporting that IQ scores of persons with seizure disorders are average with a tendency towards the lower end of the average range (Black &Hynd, 1995; Deonna et al., 2000; Liu, Zhang, Han, Guo& Wang, 2012; Selassie, Viggedal, Olsson, & Jennische, 2008). Nevertheless, discrepancy analyses may demonstrate significant deficits despite average IQ.

Localization in the brain

Localization of seizure focus in specific areas of the brain is sometimes related to the nature of cognitive impairment (Aldenkamp, 1997; Bulteau et al., 2000; Kwan & Brodie, 2001). Children with generalized seizures have greater problems in sustaining attention and poorer mental abilities compared to those with focal seizures (Dodrill, 1992; Nolan et al., 2003; Witt & Helmstaedter, 2012). Verbal memory deficits are associated with left temporal foci, while non-verbal, visual memory deficits are associated with right temporal foci. Furthermore, generalized absence seizures are associated with less cognitive dysfunction than tonic-clonic seizures (Dodrill, 1992).

In general, temporal lobe epilepsy is associated with greater memory deficit (Drane & Meador, 1996; Helmstaedter, 2002; Tuchscherer et al., 2010).Subclinical discharges have been associated with less accurate reading in children(Kasteleijn-Nolst Trenité, Bakker, Binnie, Buerman& Van Raaij,

1988) and impairment in verbal short-term memory (Siebelink, Bakker, Binnie& Kasteleijn-Nolst Trenité, 1988).

Correlations between seizure type and cognitive profile are, however, inconsistent (Fastenau et al., 2004; Kwan & Brodie, 2001; McCarthy, Richman & Yarbrough, 1995). Different pathologies can have differential effects on cognition even at the same anatomical site (Hermann, Seidenberg, Schoenfeld, & Davies, 1997). Williams, Sharp, Bates, and Griebel's (1996) study of children with complex partial or absence seizures found no influence of seizure type on achievement test scores or behavioral ratings. Yet, poorly controlled seizures correlated with lower reading scores, withdrawn behavior, and attention problems.

Nature of deficits

Specific deficits in reaction time and attention have been documented (Mitchell, Chavez, Lee & Guzman, 1991; Selassie et al.).Riva, Saletti, Nichelli and Bulgheroni(2002) found attention difficulties and impulsiveness in a study of 8 children between the ages of 6 and 13 with frontal epilepsy.

Nevertheless, several studies concur that the nature of deficits associated with seizure disorders are transitory, overall cognitive deficits. Significant weaknesses were found in various domains like verbal, visiospatial and memory abilities. In a study examining 57 children aged 7 to 10 years with complex partial seizures, Schoenfeld et al. (1999)found significant cognitive impairment suggesting a profile of diffuse, generalized cognitive dysfunction compared to sibling controls. No single cognitive profile was identified in a study of 22 children with typical benign partial epilepsy, although eight of the children had transient low scores on at least one cognitive domain and four had delayed language development (Deonna et al., 2000).

Age of onset

Young age of onset of the seizure disorder is associated with more severe cognitive impairment (Aldenkamp, Gutter& Beun, 1992; Berg, 2011; Bulteau et al., 2000; Dodrill, 1986, 1992; El Sabbagh, Soria, Escolano, Bulteau& Dellatolas, 2006; Farwell, Dodrill& Batzel, 1985; Nolan et al., 2003; Schoenfeld et al., 1999; Zelnik, Sa'adi, Silman-Stolar& Goikhman, 2001). Kwan and Brodie (2001) suggested this may be due to greater seizure induced damage and adverse antiepileptic drug reactions. Fastenau et al.(2009) observed that 27% of their 282 child participants between the ages of 6 and 14 showed neuropsychological deficits at or near onset of their first seizure, although no achievement difficulties were yet apparent.

Impact on Achievement

A synthesis of the research reveals several trends in the literature. Underachievement in reading skills among this populationis consistently documented (Kasteleijn-Nolst Trenite et al.; Seidenberg et al., 1986; Stores & Hart, 1976). There are particular deficits in reading comprehension, spelling, and arithmetic (Black & Hynd, 1995; Cull, 1988; Gourley, 1990; Jones, Siddarth, Gurbani, Shields& Caplan, 2010; Mitchell, Chavez, Lee& Guzman, 1991). Studies reported by Mahapatra(1990) and Rutter, Tizard and Whitmore(1970) both show that children with epilepsy performed significantly lower than matched controls on reading comprehension tasks. Impaired performance on arithmetic skills has also been acknowledged (Bagley, 1970; Bolter, 1986; Green & Hartlage, 1971; Jones et al.).On the other hand, one study of recent onset children found mean academic achievement to be in the average range (McNelis, Johnson, Huberty&Austin, 2005), while one review concluded that low academic achievement is common rather than general underachievement (Reilly & Neville, 2011).Poor school performance, in general, may be due to frequent lapses of awareness (Wiederholt, 1995). For example, students may miss important directions or information relayed by the teacher due to loss of consciousness for even a few seconds at a time as in absence seizures. Some suggest symptoms may mimic a learning disorder (Beghi, Cornaggia, Frigeni &Beghi, 2006; Breier et al., 2000). The prevalence of academic problems in this population is unknown.

Pharmacological issues

Over fifty percent of persons with seizure disorders can completely control their seizures with medication. Another thirty percent can improve management with medication. High dosages of medication and polypharmacyare associated with impaired intellectual functioning (Bulteau et al., 2000; Drane & Meador, 1996; El Sabbagh et al.; Selassie et al.) and reducing the number of medications has been linked to cognitive and behavioral improvement (Brodie, McPhail, Macphee, Larkin & Gray, 1987; Nolan et al., 2003).Fortunately, the majority of children on antiepileptic medications do not experience clinically relevant cognitive or behavioral adverse effects (Bourgeois, 1998). As an exception, a study of ten 6-12 year old children with benign rolandic epilepsy found that the children were quicker on a visual-search task and recalled stories better before treatment with carbamazepine (Seidel & Mitchell, 1999).

As with all medications, there is a need to investigate individual responses to treatment (Seidel & Mitchell, 1999). Side effects of the most common medications used to treat children with seizure disorders include but are not limited to drowsiness, sedation, ataxia (defective muscular

coordination), nausea, vomiting, weight gain, and hyperactivity (Rutecki, 1993; Wiederholt, 1995). School personnel may aid medical treatment in this respect through documentation of symptoms.

Limitations of Studies on Seizure Disorders

Methodological limitations of the research in this area have resulted in inconsistent and contradictory findings (Dodrill, 2004; Kwan & Brodie, 2001; Vermeulen & Aldenkamp, 1995; Vingerhoets, 2006). Hartlage andHartlage(1997)suggested that most studies on children are conducted in major medical centers which tend to house the most severe cases and may account for part of the inconsistency in findings and somewhat exaggerated intellectual deficits.

Studies clearly struggle to account for all the complexities and confounding variables associated with seizure disorders such as age of onset, type and frequency of seizures, treatment doses, gender, age, ethnicity and localization in the brain(Kwan & Brodie, 2001). Although most studies include children between the ages of 5 and 13, much developmental variability existswithin these age groups. The uniformity in the use and interpretation of neuropsychological tests is also worthy of scrutiny (Vermeulen & Aldenkamp, 1995). Further, comparison groups ranged and often seemed to be a matter of recruitment convenience, from sibling controls (Bailet & Turk, 2000) to subjects with other chronic illnesses (Williams et al.).

Guiding Principles for School Personnel

Given what is known about seizure disorders and children, several guiding principles may apply. Factors contributing to the poor academic performance of children with seizure disorders include deficits in verbal memory, visual memory, reaction time/motor speed, and inattention. Shortfalls in reading comprehension and arithmetic skills have been documented. In some cases, researchers describe a condition that looks similar to what you would find in a child with a learning disability. Students who show less transient deficits may warrant accommodations that would support their strengths.

There is not information in the seizure disorder literature to support any one model for school professionals to follow. However, the author suggests several guiding principles for school personnel to better support and encourage the child with seizure disorders, based on the literature for working with students with other chronic conditions. Celano and Geller (1993) provided recommendations for improving the school performance of children with asthma that may be applicable to any chronic illness with some modifications. They are (1) to help the child implement self-management

programs, (2) to monitor adverse effects of medical treatment, (3) to adopt a multidisciplinary psycho-educational evaluation, and (4) to promote educational programming that normalize psychosocial functioning.

Self-Management Programs

Self-management programs empower families and can be implemented in the school setting. Such a program for children with seizure disorders may include (a) recognizing when the child may have experienced a seizure (as in the petit mal type) or when one may be imminent (as in other types which may experience an "aura" sensation just prior to an episode), (b) taking medications correctly and managing side effects, (c) developing a contingency plan with school personnel should a seizure occur while at school, (d) normalizing the child's activities, and (e) communicating effectively with school and health care personnel. The regular or special education teacher's role is pivotal for empowering the student and aiding him or her to participate in the development of the contingency plan.

Monitoring and Documenting Symptoms

Characteristics of seizure disorders are often mistaken for other illnesses, behavioral problems, or inattention and daydreaming. School personnel may provide valuable information to the family in diagnosing a student based on their awareness and diligent record of two of the three factors that categorize seizures: loss of consciousness and type of muscular activity. Understanding how various types of the disorder manifest can also make school professionals more confident in sharing documented concerns with parents and others. Further, SENCosmay act as advocates for a student whose condition may be misunderstood and inspire fear among peers. For example, the student may be encouraged to educate the class, share thoughts and answer peer questions about seizures.

Rather than writing lengthy technical reports, short journal type entries or symptom logs may serve well as documentation. For example, one may notice that the student achieved lower scores than expected or is excessively sleepy and lacks energy. This information may be shared with the parents since it is an indication that the student may need an adjustment in medication. Paying special attention to the time of day and intensity of the sedationis also relevant.

Multidisciplinary Evaluation

As the research reviewed has shown, academic performance for a child with seizure disorders may be affected by many factors including, medical, psychological, pharmacological, and social issues. Such a multifaceted condition requires a comprehensive and multidisciplinary team

approach in order to adequately ensure that the child will perform to his or her highest potential. Those who may be involved on such a team include the classroom teachers, school social worker, neurologist, pediatrician, psychiatrist or psychologist and parents. Input from all parties will ensure that the student's individualized education plan is comprehensive and achievable. This will make it possible to promote educational programming in the least restrictive environment.

ImprovingCollaboration among the School, Parents, the Child, and Health Care Team

Facilitating communication among everyone involved with the child, and including the child, is no easy task. However, the responsibility to do so is shared by all. Of course, the SENCo plays a critical role in coordinating efforts to meet the needs of the student.It is important to identify day to day behavior, as well as details about developmental milestones.

Edwards (2004)provided a list of questions for teachers to ask parents in individual interviews about their child. Questioning strategies are used that show respect for the parent and take into account the fact that an emotionally charged topic will be discussed. The suggested questions for parentsshe outlines, originally intended to help teachers better connect with parents and understand how to help their children with regard to reading,may be modified for use with parents of children with medical illnesses. For example, one may ask 'How would you prefer I handle the situation should your son experience a seizure in the school?'

Conclusion

This article provided a brief overview of the characteristics of seizure disorders, cognitive and achievement issues associated with them, and guiding principles for school personnel to support children with epilepsy. Future studies may seek to use a standardized set of neuropsychological tests, control for more variables and choose more appropriate comparison groups. If sample size is of concern, a multi-site study may be an alternative. Research that combines both a quantitative and qualitative methodology is recommended. In addition, research on the most effective means for servicing children with seizure disorders in schools is lacking in the literature. School professionals play a key role in helping to identify, monitor and advocate for any needed accommodations for these students.

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