Is Language Impairments a Symptom of Nocturnal Epileptiform Activity?

Studies exploring the relationship between nocturnal epileptiform activity and language impairments

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*Studies exploring the relationship between nocturnal epileptiform activity and language impairments*

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Silje Systad
Abstract

Evidence and experience indicate that children with isolated epileptiform activity during sleep (nocturnal epileptiform activity [NEA]) often have language impairments. However, this relationship is not fully understood. Therefore, the overall aim of this PhD project was to explore the relationship between NEA and language impairments. Increased knowledge about language impairment in children with NEA could, among others, strengthen pedagogical interventions for these children.

For some children, the language impairments would be the only or the first symptom of NEA because epileptic seizures are absent or follow the language impairments. However, there is no consensus related to which language impairments should be regarded as symptom of NEA. Therefore, the project’s prolonged goal was to gain such knowledge to support the early identification of children with NEA. Early identification of NEA is crucial because it could indicate course of treatment.

Based on the overall aim and the prolonged goal, three hypotheses were developed: The main hypothesis was that NEA plays a role in children’s language development. The second hypothesis was that specifically NEA is a contributing factor in the development of language impairments in particular. The last hypothesis was that NEA affects certain aspects of language.

Two studies are comprised in the PhD project: one focusing on the NEA dimension and one focusing on the language impairments dimension. First, by conducting a systematic review, the prevalence of NEA in children with language impairments was explored. 55 studies (eight studies with control groups) were included in a meta-analysis and showed that isolated epileptiform activity (IEA) were more common in the language-impaired children than it was in the control group children. The overall pooled prevalence of IEA in children with language impairments was 27.3 %. However, the prevalence varied widely between the studies. The results implied that IEA during sleep (in other words NEA) are more common than IEA during wakefulness, and that children with language regression and language impairments are more likely to have IEA than children with speech impairments.

Second, by conducting an empirical study with a cross-sectional design, the presence of language impairments in children with NEA was explored by comparing them with several
comparison groups (typically developing children matched on age, typically developing children matched on language ability and language-impaired children without NEA). Also, the aims were explored both thorough prospective data (language and linguistic-cognitive tests and electroencephalograms [EEGs]) and retrospective data (parental questionnaires and medical records). The results indicate that children with NEA have delayed language abilities and that these impairments seem to be confined to the language domain. Moreover, it seems like children with NEA have specifically poor skills in phonology and naming speed. Last, the results indicate that an early indicator of NEA would be alterations in language development. Also, the results showed that symptoms other than language impairments could be indicators of NEA. Together with epileptic seizures, cognitive impairments (such as difficulties with executive functioning, particularly if alterations in functioning is involved), sleep problems and sound sensitivity could be early indicators of NEA.

As a whole, the results confirm the three hypotheses articulated in the projects: NEA plays a role in children’s language development; specifically NEA is a contributing factor in the development of language impairments in particular; NEA affects certain aspects of language. The results could have several implications. Results showing that children with NEA have overall delayed language abilities and particularly difficulties with verbal processing could guide pedagogical practice. Results showing that a considerable prevalence of children with language regression and language impairments have NEA, and that cognitive impairments, sleep problems and sound sensitivity could be indicators of NEA, could guide us in identifying which children to refer to EEGs.
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Abbreviations

AED = antiepileptic drug
AEA = acquired epileptic aphasia
ADHD = attention-deficit hyperactivity disorder
BECTS = benign epilepsy with centrotemporal spikes
CSWS = continuous spike and waves during sleep
EEG = electroencephalogram
ICD = International Classification of Diseases
IEA = isolated epileptiform activity
ILAE = international league against epilepsy
NEA = nocturnal epileptiform activity
PhD = Philosophiae Doctor (doctoral degree)
REK = Regional Committee for Medical and Health Research Ethics
REM = rapid-eye-movement
SLI = specific language impairments
SWA = slow wave activity
WHO = world health organization
WISC = Wechsler Intelligence Scale for Children
WPPSI = Wechsler Preschool and Primary Scale of Intelligence
1 Prologue

A boy is born. He develops as expected, and around his first birthday, he says his first word. The parents are delighted and enjoy life with their first born. The boy is doing well, and just after his second birthday, he begins to put words together into sentences. Half a year later, a baby sister is born. About the same time, the parents begin to wonder about their son’s behaviour. It seems like he no longer cares about what they say to him. Why is he behaving like this? Is it because he has become a big brother, or is something wrong with his hearing? They see their family doctor, but the boy’s hearing is normal. The situation becomes worse. It seems as if the boy no longer understands words he used to know. When they call his name, he does not react. After some time, the parents notice that he also does not react when the doorbell rings. Time goes by, and the situation becomes more and more challenging. The boy is examined for a variety of diagnoses. At last, the boy experiences an epileptic seizure. He is registered with a whole-night electroencephalogram (EEG), and the registration shows epileptiform activity during sleep. The boy is finally diagnosed with acquired epileptic aphasia (AEA).

Acquired epileptic aphasia (AEA) is an epilepsy syndrome characterised by language regression following normal early development. All children with AEA experience epileptiform activity during sleep (hereafter called nocturnal epileptiform activity [NEA]). This NEA is hypothesised to be the cause of the children’s language regression (Stefanatos, 2011).

Most children with AEA have epileptic seizures, but some never do. For some children, the language regression precedes the seizure onset. When epileptic seizures are absent or have a late onset, the language regression is the first or only clinical sign of the syndrome. However, when seizures are absent, it is not obvious to consider an electroencephalogram (EEG), and AEA can remain unrecognised. Furthermore, in some children, language regression is a rather vague symptom, which could contribute to AEA remaining unrecognised. For instance, if the regression onsets in early language development, it may be difficult to notice and could be identified simply as late language development (Deonna, 1991; Echenne et al., 1992). Moreover, if the regression is brief and/or minimal, it could be difficult to distinguish from naturally occurring stages of language development.
Despite much discussion in the medical world, descriptions of AEA are often lacking in the field of speech and language pathology (Fandino, Connolly, Usher, Palm, & Kozak, 2011). Since many children with language impairments are referred to speech and language pathologists and not to medical professionals (Baird, 2008), Fandino et al. (2011) concludes that children with AEA are often referred to professionals who lack knowledge of this syndrome. Bishop (1997), likewise, notes that studies of children with specific language impairments might unknowingly include cases with AEA. The lack of awareness of language symptoms within this field could contribute to AEA being an underdiagnosed condition.

AEA is argued to belong to a spectrum of conditions for which NEA and language impairments are prominent characteristics (Overvliet et al., 2010). Epileptic seizures are not always the most prominent feature in this spectrum; thus, language impairments could be the first, most salient or only symptoms of NEA. Naturally, the non-epileptic nature of such symptoms makes it difficult to identify children within the spectrum, and one could argue that there are children with unidentified NEA among, for instance, the group of children with language impairments. Uncovering NEA in children is important because such discoveries may indicate which types of treatment should be initiated. In some children, this treatment may include medication.

Despite evidence indicating that NEA specifically affects language in children, the relationship between NEA and language impairments is not fully understood. A better understanding of this relationship could guide teachers in developing adequate and targeted pedagogical interventions to prevent increased impairment (Verrotti, Filippini, Matricardi, Agostinelli, & Gobbi, 2014).

### 1.1 Overview of the PhD project

The overall objective of the current doctoral degree (Philosophiae Doctor [PhD]) project was to explore the relationship between NEA and language impairments. An additional objective of the project was to identify the language symptoms of NEA so that professionals working with language-impaired children could more accurately identify which children to refer to EEGs.

As proposed by Buchhalter (2012), we chose to explore the relationship between NEA and language impairments across two dimensions: namely, the NEA dimension and the language
impairments dimension. Thus, the project is divided into two studies. Study 1 focuses on children with language impairments and explores the presence of NEA in these children, and study 2 focuses on children with NEA and explores the presence of language impairments in these children. Study 1 is presented in one article (article I), and study 2 is presented in two articles (articles II and III).

1.2 Overview of the thesis

The thesis consists of an extended abstract followed by the three articles.

The extended abstract comprises three main parts: a general introduction, a section addressing methodological reflections and a general discussion. In addition, an overview of the results is presented. Specific introductions, detailed descriptions of methodological issues and results and distinct discussions are presented in the three articles.

The focus of the current project was to explore the relationship between the two dimensions of NEA and language impairments. Therefore, in the general introduction, these two dimensions are initially described separately. Specifically, whereas language impairments are described in the context of language, NEA is described in the context of epilepsy. Thereafter, the relationships between NEA and language impairments are elaborated. In order to provide relevant background knowledge, the introduction also describes basic issues related to the brain. Last, the general introduction describes the aims and hypotheses that underlie the PhD project.

The section on methodological reflection presents an overview of the studies and articles comprised in the project. This section does not represent a thorough presentation of the studies. Rather, it discusses the methodological choices made when designing and planning the studies. For detailed information about the studies, see the respective articles.

Finally, following a brief presentation of the study results, the extended abstract provides a general discussion of the relationship between NEA and language impairments.
2 General introduction

This general introduction will first provide background knowledge on the brain and its neurological processes. Considering the focus of the project (i.e. language impairments in children and epileptiform activity during sleep), neurological processes that take place during development and during sleep will be elaborated on. Thereafter, NEA and language impairments will be introduced separately and in the contexts of epilepsy and language, respectively. Last, the general introduction will address the relationship between NEA and language impairments.

2.1 The brain

The brain is the most complex organ in the human body. We still lack full knowledge on how it is structured, how it works and how it develops. However, as increasingly advanced techniques to monitor the brain are invented and implemented, this understanding is steadily growing.

The brain is composed of two hemispheres, right and left, each commonly divided into four lobes: the occipital, the parietal, the frontal and the temporal (Purves et al., 2008). The brain also comprises two types of cells: glial cells and neurons (Kandel, Schwartz, & Jessell, 1991). Although the role of the glial cells in epilepsy is increasingly acknowledged, the role of the neurons has to date been the most important for understanding epilepsy. The neurons are in charge of all human operations, both physiological and cognitive. To manage these operations, the neurons communicate through electrical activity passed from one neuron to another through a wire called an axon (Purves et al., 2008). The axon is surrounded by myelin, a type of fat, and appears white (Kandel et al., 1991). The neuron body, on the other hand, appears grey. Hence, the brain is often described as containing white and grey matter. While the neurons are located primarily on the brain’s surface, the axons are located in its centre. Neurons are not directly attached to other neurons. Instead, the gaps between neurons are filled with transmitter substances (neurotransmitters) that mediate the electrical activity (Purves et al., 2008). Some neurotransmitters exhibit activity and others inhibit it. The cooperation between these exhibiting and inhibiting processes is finely tuned.

There has long been an interest in determining which brain areas are responsible for which specific operations (Zola-Morgan, 1995). Evidence on this topic comes from, among others,
studies of persons with brain lesions (Stevens, 2009). For instance, if a defined lesion disrupts a person’s ability to perform a specific operation, this could suggest that the location of the lesion is responsible for that particular operation. More recent evidence has come from neurological imaging technology. This field of research has mapped specific brain areas to specific operations. For example, studies have shown that the occipital lobes are in charge of vision, the parietal lobes are in charge of somatic sensory information, the frontal lobes are in charge of movement and the temporal lobes are in charge of auditory information (Kandel et al., 1991).

Rather than simply revealing specialised brain areas, recent work has also sought to achieve an increased awareness of how different brain areas cooperate to form intricate networks (Bassett & Gazzaniga, 2011). Evidence in this field has come from studies that monitor the brain during different operations (e.g. during reading or resting). Some studies monitor how certain operations simultaneously activate several neurons (i.e. grey matter) (Stevens, 2009). Other studies monitor the corresponding activation of axons (i.e. white matter) (van Diessen, Diederen, Braun, Jansen, & Stam, 2013). If a defined network shows increased activity during a specific operation, this could suggest that the activated network is responsible for that particular operation. For instance, when a person is resting, studies have shown links between areas within the temporal lobe, called the default mode network (Greicius, Krasnow, Reiss, & Menon, 2003). More and more networks are continuously being discovered and discussed.

Traditionally, it has been believed that the left hemisphere is in charge of language (Specht, 2014). Furthermore, several specific parts of the brain are believed to manage different components of language. Commonly mentioned areas are Brocha’s and Wernicke’s areas (Purves et al., 2008). While Brocha’s area (within the frontal lobe) is said to be responsible for producing language, Wernicke’s area (within the temporal lobe) is responsible for understanding it (Tropper & Schwartz, 2009). Other brain areas are also active when we perform language-related operations (Amunts, 2008). For instance, the movement centre is engaged when we speak, and the vision centre is engaged when we read. Evidence from newer research has modified this traditional way of understanding language neurobiology (Tremblay & Dick, 2016). First, instead of a left hemispheric dominance, current research speaks of a cerebral asymmetry (Specht, 2014). Second, the definitions of Brocha’s and Wernicke’s areas are both inaccurate and incomplete with respect to encompassing all brain areas involved in language operations (Tremblay & Dick, 2016). Last, within the field of language, there has been a growing body of research trying to discover a language network.
However, the idea of a unified network of language is perhaps not applicable because language in itself is not one simple operation, but rather several different, partially related operations. Specht (2014) states that several study results support a dual-stream model. On one hand, the ventral stream is in charge of language perception and comprehension, while on the other hand, the dorsal stream is in charge of production. Fedorenko and Thompson-Schill (2014) proposed that the language network involves both specialised and generalised areas of the brain. While the specialised areas are responsible for language operation in particular, the generalised areas are also responsible for other cognitive operations. Whichever theory is correct, it is clear that the neurobiology of language is complex and that language can be affected in complex ways, such as through brain disorders like epilepsy.

2.1.1 The developing brain

Because of its plasticity, the brain constantly develops. This brain maturation is influenced not only by genetic factors, but also by environmental factors, such as usage, experiences, schooling and training. These factors influence each other through complex interactions; for instance, the environment could affect genes (Gottlieb, 1998). Furthermore, this maturation takes place not only during childhood, but also throughout a person’s life.

The development of the brain involves both the production of neurons and the links between them. Links that are used will persist, while links that are not used will be pruned (Goswami, 2008; Johnston, 2004). As a consequence of this development, both grey and white matters alter in thickness. Grey matter grows during early childhood because of an overproduction of neurons before it decreases due to pruning (Walhovd, Tamnes, & Fjell, 2014). White matter grows as links between neurons grow. This enhancement partially depends on an increase in myelination, which makes the axons more efficient (Lebel & Beaulieu, 2011). The development of neurons and the links between them form a complexity of networks.

The capacity for plasticity varies with development and decrease during adulthood and late life (Johnston, 2004). A much-sited theory hypothesises that because the degree of plasticity varies with development, the brain has critical periods for learning specific skills (Hulme & Snowling, 2009; Knudsen, 2004). For instance, it has been shown that lower-order functions, such as movement, develop before higher-order functions, such as executive functioning and language (Gogtay et al., 2004).
Like any other neurological function, the language domain is also constantly developing. In typical language acquisition, some developmental patterns are expected. For instance, it is expected that a child will reach specific milestones, such as saying his or her first word, within certain age ranges. As mentioned, this development depends on both genes and environment. One could argue that language development comprises critical periods for learning specific language-related operations. For instance, it has been argued that the critical period for learning phonology is earlier than the critical period for learning syntax (Hulme & Snowling, 2009). This has been demonstrated by studies on second language learning, which show that children can learn languages fluently, while adults learn the syntax but not the phonology. For example, Goto (1971) found that adults from Japan had difficulties distinguishing between the phonemes /r/ and /l/. In Japanese, there is a phoneme sounding as a mixture of /r/ and /l/, while the phonemes /r/ and /l/ are absent. Therefore, people growing up in Japan are not exposed to /r/ and /l/ and this lack of early exposure is hypothesised to reduce the ability to learn these phonemes in adulthood.

2.1.2 The sleeping brain

Sleep is not as trivial as it may seem. In addition to supporting the recovery of energy, sleep facilitates complex tasks necessary for brain development (Grønli & Ursin, 2009; Stickgold, 2015). The many functions of sleep are being increasingly recognised and are widely debated. It could be argued that one of the most important roles of sleep is consolidation. Sleep consolidation is the process through which what we learn and experience during the day stabilises and becomes memories (Diekelmann & Born, 2010). More specifically, the links that are used during the day are re-activated and therefore preserved during sleep. The theory of sleep consolidation has been verified by, among others, results showing that sleep enhances performance (Stickgold, Whidbee, Schirmer, Patel, & Hobson, 2000). Sleep consolidates all sorts of memories, such as declarative memories (e.g. memories of facts and events) and procedural memories (e.g. memories of skills needed for activities, like riding a bicycle) (Wilhelm et al, 2012).

Sleep comprises several stages, the composition of which is often referred to as the sleep architecture. The sleep architecture is commonly divided into two main stages: rapid-eye-movement (REM) sleep and non-REM sleep. Each of these stages is characterised by different types of brain activity (Rasch & Born, 2013). For instance, non-REM sleep involves
slow wave activity (SWA). An individual’s sleep architecture changes during childhood (Tesler, Gerstenberg, & Huber, 2013). Young children exhibit a high proportion of REM sleep, whereas the proportions of non-REM sleep increases when the child grows. Although there is evidence that the relationship is not that clear-cut, it has been argued that the different sleep stages influence different consolidation processes and, thus, supports different types of memory (for a review see Diekelmann & Born, 2010). Specifically, while non-REM sleep is believed to support declarative memory, REM sleep is believed to support procedural memory. Because an individual’s sleep architecture changes during his or her childhood, different types of memories are variably supported during the individual’s development (Chan, Baldeweg, & Cross, 2011). For example, one could argue that the sleep of young children mostly supports procedural memories, such as motor development, while the sleep of older children supports declarative memories, such as factual knowledge.

By supporting memory, sleep has a major impact on learning and cognition (Gomez, Newman-Smith, Breslin, & Bootzin, 2011). Like any other cognitive domain, language development is influenced by processes that take place during sleep. It has been argued that, during non-REM sleep, declarative memory processes support word learning, whereas, during REM sleep, procedural memory processes support auditory skills (Earle & Myers, 2014). On one hand, disruptions to non-REM sleep interfere with the brain’s process of categorising new words and, thus, prevent a flexible and well-organised lexicon. On the other hand, disruptions of REM sleep interfere with speech-sound representation thereby creating problems related to an individual’s understanding of indistinct sounds, such as speech in noise.

### 2.2 Epilepsy

Epilepsy is a brain disorder. It has traditionally been defined as “…an enduring predisposition to generate epileptic seizures…” (Fisher et al., 2005). To be diagnosed with epilepsy, therefore, one should have had “at least one epileptic seizure” (Fisher et al., 2014, p. 476).

An epileptic seizure is a clinical symptom of uncontrolled bursts in the electrical activity of the brain (Fisher et al., 2005). In simplified terms, one could say that this uncontrolled activity, or epileptiform activity, is initiated by irregularities in both exhibiting and/or inhibiting processes (Binnie & Stefan, 1999). However, there are various reasons why epileptiform activity occurs. Epileptiform activity can also affect either the whole brain or parts of it. Depending on which brain areas and how much of the brain is affected,
epileptiform activity could give numerous forms of seizures (Fisher et al., 2005). For instance, if the epileptiform activity is located in the frontal lobes, the seizures could be expressed by sudden alterations in movement. By contrast, if the epileptiform activity is located in the occipital lobes, the seizures could be expressed by visual disturbances. If the whole brain is affected, consciousness will deteriorate. A goal in epilepsy care is freedom from seizures, since there is a strong assumption that seizures, or, more precisely, the epileptiform activity, could have detrimental consequences for the brain (Bronen, 2000).

The prologue of this extended abstract described a rare syndrome called Acquired Epileptic Aphasia (AEA). In this epileptic syndrome, the most characteristic features are not epileptic seizures, but nocturnal epileptiform activity without seizures (NEA) and with a loss of language skills. In fact, in some of the children suffering from this syndrome, epileptic seizures are totally absent. These children would not fulfil the criteria for epilepsy, since the traditional definition of epilepsy requires the occurrence of seizures. However, the International League Against Epilepsy (ILAE) recently published a report in which the traditional definition of epilepsy has been altered to include such epilepsy syndromes as AEA (Fisher et al., 2014). The authors elaborate that “…if evidence exists for an epilepsy syndrome, then epilepsy may be presumed to be present, even if the risk of subsequent seizures is low” (Fisher et al., 2014, p. 477). The report also mentions two other epilepsy syndromes: benign epilepsy with centrotemporal spikes (BECTS) and continuous spike and waves during sleep (CSWS) (Fisher et al., 2014).

For a long time, the symptoms of epilepsy have been assumed to be exclusively “short – lived”. According to Deonna and Roulet-Perez (2005), however, these assumptions have recently shifted. Today, it is widely understood that epilepsy can cause more long-lasting symptoms. For instance, cognitive impairments have been unquestionably linked to epilepsy (Berg, 2011), though the exact causal relationship between epilepsy and cognitive impairments has not yet been fully explained.

In sum, epilepsy is traditionally defined by the occurrence of epileptic seizures. However, this definition has recently been adjusted. According to the new definition, a child with an epilepsy syndrome (e.g. AEA) could have epilepsy without having seizures.
2.2.1 Isolated epileptiform activity

EEGs are used to record the electrical activity of the brain. Thus, an EEG could reveal the characteristic patterns of epileptiform activity, often called spike-and-wave activity (Binnie & Stefan, 1999; Smith, 2005). While epileptiform activity is revealed on an EEG, one can also observe how the seizure is expressed clinically. Epileptiform activity does not always lead to a seizure, as in cases of NEA. In other words, the activity can occur without direct observable, clinical signs. For this reason, the only way to detect epileptiform activity without seizures is through an EEG recording.

Epileptiform activity without seizures has been labelled in different ways. First, it has been given names that describe the unobservable character of the phenomenon, such as “interictal” (i.e. between seizures) and “subclinical” (i.e. without observable symptoms). Second, it has been given names that indicate that the epileptiform activity is confined to the EEG only and not to epileptic seizures, such as “epileptic EEG discharges”, “epileptiform EEG activity” and “EEG abnormalities”. Last, it has been given names that simply characterise the patterns revealed on EEG, such as “continuous spike-and-wave activity”, “paroxysmal activity” and “electrical status epilepticus”. In this text, epileptiform activity without seizures will be called isolated epileptiform activity (IEA) (Boutros, Bowyer, Wang, Urfy, & Loeb, 2015). When IEA takes place during sleep, it will be called nocturnal epileptiform activity (NEA).

Like epileptiform activity with seizures, IEA could strike either different parts of the brain or the whole brain at the same time. IEA can also occur during either wakefulness or sleep. Though IEA is defined as occurring without directly observable clinical signs, there is now ample evidence that IEA affects the clinical picture more than previously thought (Boutros et al., 2015). However, its symptoms are cognitive impairments rather than seizures (El Shakankiry, 2010; Holmes & Lenck-Santini, 2006; Van Bogaert et al., 2012). Evidence for this comes from, among others, studies in which IEA has been found in a substantial proportion of children with different kinds of impairments (Duvallorey-Homme et al., 1995; Zaimoglu & Turkdogan, 2009), but only in a negligible number of typically developing children (Cavazzuti, Cappella, & Nalin, 1980).

IEA is described to give both concurrent and prolonged problems. On one hand, the concurrent problems are often called transitory cognitive impairments (Holmes & Lenck-Santini, 2006). These impairments have been proven by findings that reaction time increases
with IEA (Shewmon & Erwin, 1988). Prolonged problems, on the other hand, could take various forms and are more difficult to prove.

Although there is now growing agreement that IEA has a prolonged effect on cognition, there are still disagreements regarding how IEA affects cognition. There are also disagreements regarding whether seizures or IEA is most damaging to the brain (Holmes, 2014). For instance, some argue that IEA affects language representations more than a transitory seizure (Dijkstra & Ferrier, 2013). These disagreements typically involve discussions of the medical treatment of IEA, which is still a controversial issue.

### 2.2.2 Nocturnal epileptiform activity

The term nocturnal epileptiform activity (NEA) is, in this text, used when IEA takes place during sleep. Like epileptiform activity with seizures, NEA can affect either parts of the brain or the whole brain. NEA can occur in addition to seizures, without seizures, in addition to IEA during wakefulness, or solely during sleep. Furthermore, NEA can occur in various degrees of severity. The degree of severity could be expressed by, among others, the amount of NEA, which could also reflect the percentage of sleep disrupted. There is currently no consensus regarding the optimal method for quantifying the amount of NEA (Scheltens-De Boer, 2009), and the wide variations in quantification methods complicate the synthesis of research in the field. Together with amount of NEA, it is argued that the localisation of NEA impacts the type of difficulties that arise and the extent to which these difficulties are visible (Tassinari, Cantalupo, Rios-Pohl, Giustina, & Rubboli, 2009). NEA is found in children with different types of epilepsy. The combination of NEA localisation and amount could determine whether a child has a specific epilepsy syndrome (Sánchez Fernández, Loddenkemper, Peters, & Kothare, 2012).

NEA is described as being a central part of the pathological picture of the three epilepsy syndromes mentioned earlier: namely, BECTS, AEA and CSWS (Sánchez Fernández et al., 2012). While children with CSWS most often experience IEA during wakefulness and sleep, children with BECTS and AEA more often experience an increase in IEA from wakefulness to sleep or mostly experience NEA (Sánchez Fernández et al., 2012). Additionally, in children with CSWS, NEA could be continuous or nearly continuous. This phenomenon is often referred to as electrical status epilepticus during sleep (ESES) (Overvliet et al., 2010). There is no agreement concerning what amount of NEA qualifies a child for a CSWS diagnosis.
Furthermore, IEA typically affects the whole brain in children with CSWS, whereas IEA is often found in specific locations of the brain in children with BECTS and AEA. In children with BECTS, IEA is, as the name implies, located primarily in the centro-temporal parts of the brain. In children with AEA, IEA is primarily found in the temporal (centro-temporal and posterior temporal) and parieto-occipital parts of the brain (Loddenkemper, Fernández, & Peters, 2011).

While NEA is a central part of the pathological picture of all three syndromes, epileptic seizures are not. In other words, the rate of epileptic seizures varies across the three syndromes. For instance, epileptic seizures will never occur in 20 to 30% of children with AEA (Stefanatos, 2011). When they occur, these seizures are usually mild and easy to treat with medications. Similarly, most children with BECTS have rare epileptic seizures and are often not heavily medicated (Engel Jr, 2006; Overvliet et al., 2010). The seizures usually occur during sleep. Although controversial, some studies have described children with BECTS without epileptic seizures (Ebus, Overvliet, Arends, & Aldenkamp, 2011). By contrast, children with CSWS often suffer severe seizures (Hughes, 2011; Sánchez Fernández et al., 2012). Furthermore, although they appear to be well-defined and clearly distinct syndromes, BECTS, AEA and CSWS can also be difficult to separate. For instance, because of the fluctuating course of the pathological picture, e.g. related to the amount of NEA or the localisation of NEA, there are examples of children who develop from one of the syndromes to another (Datta et al., 2013).

The three syndromes (i.e. BECTS, AEA and CSWS) are argued to lie along a continuum. This text will refer to this continuum as the NEA spectrum. In addition to NEA, the NEA spectrum is characterised by language impairments claimed to range from mild to severe (Overvliet et al., 2010). AEA lies in the moderate part of the spectrum, BECTS represents the milder end and CSWS lies at the more severe end. Moreover, it is argued that impairments in children with AEA are restricted to the language domain, whereas they could affect several domains in children with BECTS and are more general in children with CSWS (Loddenkemper et al., 2011). Elaborated descriptions of the language impairments associated with each of the syndromes will be presented later in this extended abstract (see section 2.4.2). The diagnoses within the NEA spectrum are also associated with specific age groups. In other words, both onset and recovery are related to children and young adolescents (Sánchez Fernández et al., 2012). In terms of incidence, CSWS and AEA are considered to be rare (Loddenkemper et al., 2011). For instance, in Norway, only 25 children with AEA were followed at the Norwegian
National Center for Epilepsy between 1989 and 2010 (Cockerell, Bølling, & Nakken, 2011). However, Singh, Kalita, and Misra (2002) argue that AEA could be underdiagnosed for several reasons, such as misdiagnosis. By contrast, BECTS is the most common childhood epilepsy syndrome. In a study of newly diagnosed children with epilepsy, 10% had BECTS (Berg, Shinnar, Levy, & Testa, 1999).

There are different opinions regarding whether all three syndromes should be included in the same spectrum and what this spectrum should be called. Deonna and Roulet-Perez (2010) conclude that only BECTS and AEA are part of the same epilepsy spectrum, on which symptoms range from relatively mild (in BECTS) to severe (in AEA). Others have concluded that CSWS should also be included in this spectrum (Overvliet et al., 2010). Moreover, AEA and CSWS, along with other syndromes, are often included in the spectrum of epileptic encephalopathies (Sinclair & Snyder, 2005). The label “epileptic encephalopathies” refers to the idea that IEA, either by itself or in combination with other factors, is responsible for cognitive problems (Chan et al., 2011). Finally, Berg et al. (2010) list the three syndromes, amongst others, under “electroclinical syndromes”.

In the current project, the NEA spectrum is defined as children with NEA, regardless of syndrome. Therefore, this spectrum includes not only children with one of the three syndromes, but also children without one of the diagnoses. Since the project seeks to explore the relationship between NEA and language impairments, other potential causes of language impairments should not be present. This particularly concerns the diagnosis of CSWS, since brain lesions can occur in several children with this syndrome (Caraballo et al., 2013) and explain the high prevalence of general cognitive deterioration in children with CSWS.

One could argue that NEA is an underdiagnosed condition. If epileptic seizures are rare or absent or occur only during sleep, the language impairments could be the most noticeable or the only clinical sign of the condition. When language impairments are the primary symptom, an EEG is not an obvious diagnostic tool. Therefore, there could be children with unidentified NEA among the group of children with language impairments. For this reason, some have suggested including language impairments as part of the NEA spectrum (Overvliet et al., 2010).

To sum up, this project defines the NEA spectrum as comprising all children with the BECTS, AEA and CSWS syndromes and children with NEA, regardless of syndrome. When the NEA
spectrum is referenced in this text, the term refers to children with NEA for whom no known potential cause of language impairments is present. The spectrum is characterised by two dimensions: namely, NEA and language impairments. Both dimensions are argued to range from mild to severe in character. Children within the spectrum most often suffer from epileptic seizures, but these are usually rare or mild or come only during sleep. In some children, the seizures are totally absent or follow the onset of language impairments. Thus, language impairments could be the first, the most prominent or the only symptom of NEA. Treatment can only be considered once NEA is detected; therefore, it is crucial to identify NEA early. To enable such early identification of NEA, it is essential to know what characterises NEA’s language symptoms. Furthermore, it is vital to know whether and how the language symptoms of NEA are distinguished from language development in general and language impairments in particular. Therefore, the next sections provide background knowledge on different types of language impairments. The sections also define language and give an overview of language components.

2.3 Language

On one hand, language is argued to be the tool of thought; on the other hand, it is argued to shape thought (Boroditsky, 2001; Walqui, 2006). The term “language” encompasses several meanings, such as our ability to speak and understand. In this text, language refers to the cognitive domain of language, which, in itself, encompasses a range of components.

Although there is not yet a universal way to name and arrange the components of the cognitive domain, language components are commonly divided into the following: phonology, grammar, semantics and pragmatics (Hulme & Snowling, 2009). First, phonology deals with the system of speech sounds. In other words, it concerns our ability to process the smallest meaningfully distinguishing sounds, also called phonemes. Second, grammar deals with two systems: morphology and syntax. Whereas morphology concerns our ability to process the smallest meaningful elements, also called morphemes, syntax is our ability to process how words can be combined to form meaningful sentences. Third, semantics deals with meaning and refers to our ability to understand words, often referred to as vocabulary. Last, pragmatics deal with communication and represent our ability to understand and use language in context (Botwinik-Rotem & Friedmann, 2009). In addition to this taxonomy, language can be divided into receptive and expressive language skills (Hulme & Snowling,
While receptive language concerns our ability to understand language, expressive language refers to our ability to produce language. Language is commonly separated from speech because speech can refer solely to our ability to articulate (Norbury, Tomblin, & Bishop, 2008). Language is also commonly separated from academic skills, such as reading, even though the ability to read is clearly a language-dependent skill (Shaywitz & Shaywitz, 2016).

One could separate the ability to process language, or auditory verbal information, from the ability to process auditory non-verbal information (Thierry & Price, 2006). Whereas auditory processing refers to the ability to understand all kinds of sounds (e.g. the ability to recognise a dog barking), verbal processing concerns only language (e.g. the ability to understand spoken words). One could also separate the ability to process auditory information from the ability to process other types of information, such as visual information (Tallal & Piercy, 1973).

Language is often separated from other cognitive domains. For instance, language could be separated from the cognitive domain of memory (Purves et al., 2008). Nevertheless, memory depends on other domains. For instance, the ability to recall words depends on the ability to process language and can be referred to as a linguistic cognitive skill. Furthermore, there are indistinct borders between cognitive domains. On one hand, vocabulary could refer to our ability to understand words, in which case it can be considered a component of language. On the other hand, vocabulary could refer to our ability to store words in a mental lexicon, in which case it can be considered a component of long-term memory (Hulme, Maughan, & Brown, 1991).

### 2.3.1 Language impairments

A child with language impairments has disturbed functioning in one or several language components. Several attempts have been made to categorise disturbed language functioning into different types of language impairments, which will be presented in the following. The categories are not mutually exclusive.

First, language impairments can be categorised according to the extent to which the impairments show. For example, language impairments could be part of a generally atypical development or part of an atypical development specific to language. Children with atypical
language development have traditionally been required to exhibit considerable discrepancies between language skills and other skills, such as non-verbal skills (Bishop, 1997).

Second, language impairments can be categorised according to patterns of acquisition. In other words, they can be categorised as part of either delayed or deviant language development (Szatmari, Archer, Fisman, Streiner, & Wilson, 1995). The distinction between delayed and deviant language development corresponds to the distinction between quantitatively and qualitatively different language development (Snow & Hoefnagel-Höhle, 1978). Delayed language development refers to a development that is similar to, but progresses more slowly than, typical development. The attempt to differentiate delayed language development from typical language development is challenged because of the wide variations in typical language acquisition. For example, ten-month-old children can understand anywhere between zero and 144 words (Bates, Dale, & Thal, 1995). Deviant language development refers, in this context, to a development that differs from typical development. Deviant language development implies that some language components are more affected than others. The most affected language component could vary between children. For instance, in some children, the expressive part of language could be the most affected component.

Third, language impairments can be categorised according to cause of the impairments. Simply put, language impairments might or might not have a known cause. Language impairments without a cause are often referred to as primary language impairments, whereas language impairments with a cause are often referred to as secondary language impairments (Baird, 2008). Secondary language impairments can be caused by a range of factors, such as a poor environment, hearing impairments or brain damage (Naigles & Bavin, 2013). When primary language impairments is restricted to the language domain, in other words, when there is no known explanation for the atypical language development, these impairments are often referred to as a specific language impairment (SLI) (Hulme & Snowling, 2009).

Last, language impairments can be categorised according to time of manifestation. Language impairments can be either developmental or acquired (Marinac & Harper, 2009). While developmental language impairments are apparent from early language acquisition, acquired language impairments have a later onset. Developmental language disorders could, thus, be understood as being congruent with SLI.
In the current International Classification of Diseases (ICD-10) manual, language impairments that are apparent in early development and have no known cause are labelled under “Specific development disorders of speech and language (F80)” (World Health Organization: WHO, 2016). In the revised not yet released ICD manual (ICD-11), it is likely that it will be renamed as follows: “Developmental speech or language disorder” (WHO, 2017).

Disturbed functioning in speech and disturbed functioning in reading (dyslexia) are commonly separated from language impairments, although one could argue that they are language-related impairments.

To enable early identification of NEA, it is vital to know whether and how language impairments in children with NEA differ from other language impairments. More specifically, since children with NEA often are described as having language-specific impairments, it is important to know whether and how the language impairments in children with NEA differ from language impairments in other children with atypical language development. Therefore, the following sections will elaborate on language impairments in two different types of atypical language development: acquired language impairments and SLI.

**Acquired language disorders**

Language development in children with acquired language impairments is characterised, as the name implies, by alterations in language acquisition. In other words, these children experience an onset of language impairments after normal language development. Lees (1993) argues that the causes of acquired language disorders can be either convulsive or traumatic. Children with acquired language impairments caused by convulsions could be diagnosed as having, among others, AEA. In this extended abstract, descriptions of children with AEA are included in the population of children with NEA and will, therefore, be described later (section 2.4.2). The present section, thus, focuses on the latter group: children with acquired language impairments caused by trauma.

When a person experiences traumatic brain damage, it is common for the function of the damaged brain area to be disrupted. In other words, when language is disrupted, the localization of the damage actuates and influences which language component suffers the disruption. In children, however, the relationship between brain damage and language impairments is not that simple. This has been described in several studies. For instance, in a
study of toddlers (16 to 31 months) with brain damage in one hemisphere, about two-thirds were not defined as late talkers (Bates, Dale, & Thal, 1995). Although the children with left hemispheric brain damage were most affected, about one-half of these children had language skills within the normal range of variation. Moreover, one child with traumatic brain damage (at the age of 17 months) experienced no subsequent impairments in language development (Trudeau, Poulin-Dubois, & Yves, 2000). These findings could be explained by the possibility that disrupted functions are taken over by other areas of the brain. In other words, plasticity could explain why children with traumatic brain damage in language areas do not always acquire language impairments or acquire milder language impairments than expected. Plasticity, therefore, is a mechanism that influences not only the brain’s ability to develop, but also its ability to compensate. Since the capacity for plasticity decreases during adulthood and late life, it is generally agreed that a brain injury during childhood will produce fewer language difficulties than an equal injury in adulthood (Rapoport & Gogtay, 2007). Nevertheless, the possibility to compensate is influenced to a certain degree by the size of the brain damage. Crowe, Anderson, Barton, Babl, and Catroppa (2014) found that children with mild brain damage achieved normal language abilities, while children with more severe damage acquired language impairments.

**SLI**

Unlike acquired language impairments, language impairments in children with SLI do not have a clear onset. Rather, the language development of children with SLI often progresses slowly and the children exhibit deviant development (Hulme & Snowling, 2009).

In children with SLI, expressive language is often poorer than receptive language, and the most often affected language component is grammar (Hulme & Snowling, 2009). Despite these common features, however, language impairments in children with SLI can vary extensively, and the various components of language can be affected differently (Baird, 2008). Some children could have impairments within one component in isolation, whereas others could have impairments within several components. A widely used classification for impairments in children with SLI was proposed by Rapin and Allen in 1987 (see for instance Bishop, 1997, p. 36). In this taxonomy, a child with speech production problems could be diagnosed with phonological programming deficit syndrome, and a child with grammar and sentence-production problems could be diagnosed with lexical syntactic syndrome. Bishop (1997) adds that the most affected language component could change with age.
These kinds of language impairments have also been described with other terms, such as developmental dysphasia, developmental aphasia and developmental language disorder (Norbury et al., 2008). Norbury et al. (2008) avoids using the term “specific” in order to include children who experience difficulties in other domains.

A range of theories have been proposed to explain why children develop SLI. The theories are commonly divided into two main groups (Schwartz, 2009): linguistic theories and information processing theories. The linguistic theories suggest that language impairments are caused by disruptions in linguistic knowledge and focus mainly on the fact that children with SLI have poor grammatical skills. According to Schwartz (2009), however, these linguistic theories do not consider the whole range of language impairments in children with SLI. Additionally, Hulme and Snowling (2009) argue that these theories often describe children’s poor grammatical skills, but fail to explain why the children develop SLI.

The information processing theories generally agree that language impairments in children with SLI are caused by limitations within processing. However, they dispute if these limitations influence speed or memory (among others). In addition, they dispute the extent to which the impairments are visible: Some argue that children with SLI struggle with processing of information in general, and others argue that children with SLI struggle with processing language (or acoustic) information in particular.

One of the theories belonging to the latter group postulates that auditory processing is disrupted (Tallal & Piercy, 1973). This theory suggests that children with SLI have difficulties quickly processing acoustic stimuli, such as speech (Schwartz, 2009). A critique of this theory is that the impairments could be caused by more general processing difficulties (Hulme & Snowling, 2009). For example, findings of slowed verbal and non-verbal information processing in children with SLI suggest that the children’s difficulties are related to more general processing limitations (Miller, Kail, Leonard, & Tomblin, 2001).

Another theory arguing that children with SLI struggle with language processing in particular postulates that phonological memory is disrupted (Gathercole & Baddeley, 1990). The limitations in phonological memory are proposed to influence vocabulary (Schwartz, 2009). It has been claimed that children with SLI have problems retaining phonemes and that non-word repetition is a preferred marker of SLI (Hulme & Snowling, 2009); however, the claim that
non-word repetition can influence vocabulary development has been refuted by Melby-Lervåg et al. (2012).

One theory focusing on memory postulates that children with SLI suffer disruptions in their procedural memory system (Ullman & Pierpont, 2005). This theory hypothesises that the neurological network behind the procedural memory system is poorly developed and that this causes problems with, among other skills, grammar. According to this theory, declarative memory is not affected in children with SLI. It argues that problems with semantics (lexicon) stem not from poorly developed verbal declarative memory, but from poor working memory (Lum, Ullman, & Conti-Ramsden, 2015). However, this theory has been challenged by, for instance, studies showing that children with SLI have difficulties with sequence-specific procedural learning, but not general procedural memory impairments (Hsu & Bishop, 2014).

Children with SLI are found to struggle with a variety of difficulties. For instance, a less-studied difficulty within processing abilities is executive functioning. The basis for this theory is that children with SLI have difficulties controlling attention (Schwartz, 2009). A lack of sufficient control over cognitive attention is argued to influence a variety of abilities. For instance, Barrett, Tugade, and Engle (2004) propose that the ability to control attention is closely related to working memory. Furthermore, a high prevalence of reading impairments in children with SLI has been recognised (Bishop & Adams, 1990).

The prevalence of SLI in children is described to be around 7% (Tomblin et al., 1997). While, for some children, the language impairments persist throughout life, for others, the impairments are shorter-lived. In a follow-up study, Stothard, Snowling, Bishop, Chipchase, and Kaplan (1998) found that children with persistent SLI at 5.5 years showed impairments in all language and literacy components during adolescence. Interestingly, however, the children with resolved SLI at 5.5 years still showed impairments in phonology and literacy during adolescence.

2.4 The relationship between nocturnal epileptiform activity and language impairments

NEA has been known for several decades. Still, there are many uncertainties surrounding the phenomenon. One highly debated issue is the relationship between NEA and language impairments. Related discussions concern, among others, whether NEA is a primary or a
contributing cause of language impairments and whether NEA and language impairments share an underlying cause. The discussions also explore which language impairments are associated with NEA.

Based on the framework proposed by Morton and Frith (1995), the following sections will address the roles of NEA at the biological, symptomatic (originally called behavioural) and cognitive levels. Explanations at the biological level would for instance be if amount of NEA correlate with impairment severity, or if online monitoring of the brain during a language task show that children with NEA exhibit activation in other parts of the brain than children without NEA exhibit. Explanations at the symptomatic level would be if children with NEA show delayed development of reading skills or higher sensitivity to noise than other children.

There are disagreements regarding what falls within the cognitive level. As Frith, Morton, and Leslie (1991) note, explanations at the cognitive level should focus on integrating the biological and the symptomatic levels. Frith (2001) argues that such integration should comprise theories. Others have comprised observable measures of cognitive abilities within the cognitive level, such as abilities hypothesised to influence skills at the symptomatic level (Helland, 2007). Although the cognitive level should serve as a theoretical link, the level’s measurable potency must also be recognised. Explanations at the cognitive level, therefore, would for instance be if children with NEA have difficulties with cognitive functions, such as memory.

Though the framework appears to have three well-defined levels, the borders between these levels are not always distinct. Furthermore, each level comprises a hierarchy of sublevels. Within the biological level, for instance, NEA could be understood as the superior biological factor influencing different biological sub-functions.

Morton and Frith (1995) state that one should follow certain rules when using the framework to explain a condition. First, one should begin at the biological level. Next, after sketching causal links between the levels, one should describe all possible symptoms of the condition and determine which of these symptoms can be considered specific to the condition. Based on these rules, the following sections will first discuss the biological level and then describe all possible symptoms of NEA. At this point, it will not be distinguished between the cognitive and symptomatic levels, since these levels are often not differentiated in the literature. Later,
in the general discussion (section 5), it will be discussed how to differentiate between the levels and clarify their causal links.

2.4.1 Biological level

NEA can be understood as the primary cause or origin of impairments. Explanations at the biological level are related to how NEA disrupts brain functions. First, because NEA takes place at night, it can disturb different sleep functions. On one hand, it is hypothesised that NEA disturbs sleep consolidation. More precisely, it is hypothesised that NEA disturbs the consolidation processes, through which links used during the daytime are reactivated to preserve memories, because NEA activates links that are not used during day. This has been proven in studies in which children with NEA have exhibited poorer overnight recall than other children (Galer et al., 2015). On the other hand, the sleep architectures of children who fall within the NEA spectrum have been shown to differ from those of other children (Bruni et al., 2010). Keeping in mind the specific processes of each sleep stage and recalling that the composition of sleep stages changes throughout childhood, disruptions to a child’s sleep architecture could influence memory and development. Since NEA primarily affects specific sleep stages, it might also primarily affect particular processes. This further illustrates how NEA may disturb the types of memory consolidation that should take place. A study of children with NEA during non-REM sleep, for instance, found impairments in declarative memory (Galer et al., 2015).

Second, NEA may disturb mechanisms of development. For instance, it is hypothesised that NEA disturbs functional plasticity in much the same way as NEA disturbs sleep consolidation. In other words, plasticity is disturbed because links that should prune persist when activated by NEA. Since the processes of plasticity affect brain development, NEA could affect the thicknesses of grey and white matter. This has been demonstrated in studies in which children with BECTS have had different cortical thicknesses than other children (Garcia-Ramos et al., 2015). Furthermore, in relation to the theory of critical development periods, NEA could disturb the critical period for learning a specific skill. Several findings have supported this hypothesis by showing that the age of NEA onset impacts which skills are affected (El Shakankiry, 2010).

Third, one could say that NEA disrupts the balance between exhibiting and inhibiting neurotransmitters. Although this disruption takes place when a child sleeps, the balance is not
always re-established when the child awakes. Therefore, a child could be affected by NEA even during daytime. A study supporting this theory found that children with an extensive amount of NEA showed disruptions on an objective auditory discrimination measure considered to depend on neurotransmitter functions (Filippini et al., 2015).

NEA could also disturb localisation and lateralisation by influencing which areas of the brain are in charge of specific skills. Evidence for this has been found in studies showing that children with NEA located in particular areas score poorer on specific tasks than children with NEA located in other areas (Wolff et al., 2005) and studies showing that children with BECTS exhibit activation in different parts of the brain during specific tasks than children without NEA (Vannest et al., 2013).

Last, NEA may disturb the construction of networks and, as a consequence, produce less efficient networks. For instance, a study on children with BECTS showed that these children exhibited less activation than children without NEA in networks typically involved in language operations (Besseling et al., 2013). Also, the networks could explain why NEA symptoms sometimes differ from what would be expected based on the localisation of the activity (De Tiège, Goldman, & Van Bogaert, 2009).

Perhaps one of the most common explanations at the biological level is that the amount of NEA correlates with the degree of cognitive impairments (Vannest, Tenney, Gelineau-Morel, Maloney, & Glauser, 2015). Also, studies have explored the correlation between the rate of epileptic seizures and the degree of impairments. However, it is not always the case that amount of NEA or seizures correspond to the degree of impairments. A complicating factor when studying the effect of NEA and seizures is medical treatment. On one hand, medical treatment can reduce NEA and seizures and, thus, reduce the severity of impairments. On the other hand, medications affect not only NEA and seizures, but also other brain functions. As a consequence, the medication could, indirectly, disturb language development.

Other explanations at the biological level come from studies of genetics and heredity. For instance, one study found that relatives of children with BECTS also exhibited difficulties with language-related tasks (Clarke et al., 2007). However, several of these studies have not controlled for NEA among the relatives. In other words, NEA could also be the cause of the relatives’ language impairments.
As the above research shows, there are several explanations for NEA’s role at the biological level. This illustrates the complexity of causal mechanisms related to NEA.

2.4.2 Cognitive and symptomatic level

At the cognitive and symptomatic levels, explanations for NEA’s impact on language impairments come from studies on language impairments in children with NEA and studies of NEA in children with language impairments. The following presentation is divided according to this distinction.

Children with NEA

Language impairments are argued to be among the most prominent concerns in children with NEA (Overvliet et al., 2010). However, there are wide variations in the types of language impairments described. Descriptions vary not only across different syndromes, but also within individual syndromes. Therefore, the following sections first present studies in which the syndromes are examined separately and then present studies that examine NEA regardless of the syndrome. Due to uncertainties related to defining CSWS, different studies could categorise relatively identical cases as either CSWS or not. Studies on children with CSWS are, therefore, presented together with studies on NEA regardless of syndrome.

BECTS

Children with BECTS are usually described as exhibiting general cognitive functioning within the normal range of variation (Vannest et al., 2015). However, studies have found that many children exhibit disrupted language function (Overvliet et al., 2010).

Children with BECTS are described as exhibiting a range of different language impairments, but they are seldom described as exhibiting language regression (Sánchez Fernández et al., 2012). Most often, their language impairments are subtle and related to specific language components (Overvliet et al., 2010). For instance, a study of 20 children with BECTS showed that, compared to controls, the children had impairments in receptive and expressive vocabulary (Völkl-Kernstock, Bauch-Prater, Ponocny-Seliger, & Feucht, 2009). Another study found that 47 children with BECTS, in addition to exhibiting poor performance on
vocabulary and similarities, struggled with both phonological and morphological awareness compared to a control group (Liu, Zhang, Han, Guo, & Wang, 2012). Next, while a study of 40 children with BECTS showed that the children struggled with different types of memories, including immediate, short-term and long-term memories of both visual and verbal materials (Northcott et al., 2007), another study of 61 children with BECTS showed that the children had impairments in verbal fluency (measured by a word generation task), speeded naming and instruction of comprehension compared to controls (Jurkeviciene et al., 2012). Studies have also described academic skill-related problems among children with BECTS, explaining these challenges as related to impairments in auditory processing functions (Miziara et al., 2012). Furthermore, a study of 36 children with BECTS concluded that the children had difficulties processing verbal information (Goldberg-Stern et al., 2010). Likewise, a recently published review stated that phonological processing and reading were the most affected language components among children with BECTS (Smith, Bajomo, & Pal, 2015). Taken together, these studies show the heterogeneity among children with BECTS with respect to which language components are affected.

If NEA is the cause of language impairments, the onset of BECTS should lead to the onset of language impairments. However, a study of 48 children with BECTS found that approximately one-fifth of the children received speech therapy before being diagnosed with BECTS (Overvliet, Aldenkamp, Klinkenberg, Vles, & Hendriksen, 2011a). The authors discuss the possibility that the language difficulties could be the initial symptoms of the condition.

Concerning predictions, studies show persistent impairments across a variety of language components in children with BECTS. A retrospective study of 33 children with BECTS showed persistent language impairments and various types of language-related impairments, including problems with lexical retrieval, digit span, phonological decoding and working memory, after a two-year period (Filippini, Boni, Giannotta, & Gobbi, 2013). A follow-up study showed that, after controlling for non-verbal abilities, 13 children in remission from BECTS had poorer skills than controls within several language components, such as receptive vocabulary, expressive language and reading (Monjauze, Broadbent, Boyd, Neville, & Baldeweg, 2011).

Although BECTS is described as benign, it is now recognised that the condition is far from benign with respect to its cognitive features. In fact, the new diagnostic manual of epilepsies
published online by the International League Against Epilepsy (ILAE) (EpilepsyDiagnosis.org) excludes the term “benign”. Instead, the ILAE has renamed the syndrome “childhood epilepsy with centrotemporal spikes”.

Children with BECTS are suited for studying the effects of NEA because they have no or few seizures and because they are not always medicated. Therefore, neither the transitory cognitive effects of seizures nor the side effects of drugs are potential contributing causes of their impairments. However, the amount of NEA in children with BECTS is often limited, and the effects on language impairments could, therefore, be minimal.

**Acquired epileptic aphasia**

Unlike the other syndromes within the NEA spectrum, AEA is currently included in the list of specific developmental disorders of speech and language (F80) in the ICD-10 diagnostic manual (WHO, 2016) under the label “Acquired aphasia with epilepsy”. AEA is commonly called Landau Kleffner Syndrome. It should be commented that AEA, instead of being listed under specific developmental disorders of speech and language, is likely to be listed under epileptic encephalopathies in ICD-11 (WHO, 2017).

The most prominent language feature of AEA is language regression preceded by normal language development (Bishop, 1985). Other cognitive abilities typically remain intact. The language regression usually onsets between the three and seven years, and the regression could exhibit either an acute onset (over several days) or a more prolonged onset (over several weeks) (Stefanatos, 2011). Following the initial language regression, a worsening of the language impairments may occur (Fandino et al., 2011). Some children experience epileptic seizures before the onset of language impairments, but language regression could also be the first symptom of AEA.

Although expressive language impairments can occur in children with AEA, receptive language are often described as most impaired. Receptive language impairments vary drastically. Traditionally, it has been emphasised that children with AEA have difficulties with verbal processing, although some children have difficulties processing all types of auditory information, not only verbal (Stefanatos, 2011). As a consequence, a child with AEA could “…behave as if [he were] deaf…” (Bishop, 1997, p. 75). Other children could have more subtle processing difficulties, such as difficulties processing only phonological information. Processing difficulties in children with AEA can, thus, be categorised as
auditory, verbal or phonological. A similar three-fold categorisation of processing difficulties, called auditory agnosia, verbal agnosia and auditory discrimination difficulties, was applied in a study of 19 children with AEA (Cockerell et al., 2011). Most of the children in this study showed auditory discrimination difficulties, such as difficulties processing speech in noisy environments. Additionally, all children were described as being sensitive to noise (Cockerell et al., 2011).

Descriptions of long-term outcomes for children with AEA have been heterogeneous. Even when NEA withdraws, the language impairments often persist. In a study of 29 participants with AEA, only eight recovered their language functions (Caraballo et al., 2014). Another study reported recovered language skills in four of 19 participants (Cockerell et al., 2011). Some of the participants with persistent language impairments were, in fact, sign language users at follow up.

Considering its rarity, AEA has attracted significant research attention. First, the language regression indicates a defined cause and increases research interest in disentangling the causal mechanisms. However, since AEA is a rare condition, mostly of the studies have been case studies or small-sample studies; thus, the extant literature provides weak evidence regarding the relationship between NEA and language impairments.

**CSWS and NEA regardless of syndrome**

Like children with AEA, children with CSWS experience regression that onsets between approximately age three and age seven (Sánchez Fernández et al., 2012). However, the regression in children with CSWS is more general and influences several cognitive domains (Loddenkemper et al., 2011). In other words, impairments in children with CSWS are not always restricted to the language domain. For instance, a study of 14 children with severe NEA found that multiple cognitive domains, such as academic skills and behavioural skills, were affected (Raha, Shah, & Udani, 2012). With respect to language development, a study of 19 children with (focal) NEA found three patterns: regression after typical early language development, regression after delayed early language development and slow development after delayed early language development (Rejno-Habte Selassie, Hedstrom, Viggedal, Jennische, & Kyllerman, 2010). The authors also state that all children have auditory attention dysfunction. Children with CSWS and children with high amounts of NEA are also often affected by comorbid conditions, such as brain lesions or autism. Studying the relationship
between NEA and language impairments in these children can, therefore, be challenging because of other potential causes (e.g. brain lesions or autism) of the language impairments.

To address the challenges with other potential causes of language impairments, some studies have excluded children with comorbid conditions. One of these studies, which sampled 326 children referred to an epilepsy centre, found that the children with only NEA had poorer verbal and performance skills than the 137 children with only IEA during wakefulness (Overvliet et al., 2011b). Furthermore, a study of 10 children with NEA who experienced disturbances during at least 85% of their sleep and who lacked clear causes for epilepsy found that the children had difficulties with several language components, including lexical and grammatical judgment and pragmatics and written language (i.e. reading and spelling) (Debiais et al., 2007).

Studying children with CSWS or NEA regardless of syndrome could be difficult because of the spectrum’s complexity. First, the presence of comorbid conditions is high. Second, although excluding children with comorbid impairments reduces complexity, other factors make it difficult to study the relationship between NEA and language impairments in these children; for instance, children with high amounts of NEA are often additionally affected by IEA during wakefulness and/or by severe epileptic seizures, which could intervene with the studied relationship.

**Children with language impairments**

The fact that language impairments could be the only symptom of NEA has raised questions about the prevalence of NEA in children with language impairments.

For instance, one study conducted sleep EEGs of 24 children with expressive language impairments and 39 control children (Duvelleroy-Homme et al., 1995). The study excluded children with epileptic seizures or other neurological diseases from both groups. The study revealed NEA among nine children with expressive language impairments and two children in the control group. Another study conducted routine EEGs in 111 children with SLI (Venkateswaran & Shevell, 2008). Excluding children with febrile seizures, language regression, developmental delays and neurological diseases, the study uncovered IEA in seven children.
The studies exploring the prevalence of NEA in children with language impairments differ. First, these studies differ with respect to sample characteristics, such as the type of language impairments. Second, these studies differ with respect to the kind of EEG conducted. For this reason, previous reviews have reached different conclusions concerning the prevalence of NEA in children with language impairments. This has resulted in inconclusive advice related to the utility of EEG when assessing children with language impairments.

### 2.5 The present PhD project

There is ample evidence of a relationship between NEA and language impairments, but this relationship is not fully understood. Additionally, there is no consensus regarding language impairments in children with NEA, and there is a lack of information on which language symptoms to be aware of when identifying children with NEA. Therefore, the overall aim of this project was to explore the relationship between NEA and language impairments. The project’s prolonged goal was to gain knowledge to support the early identification of children with NEA. Therefore, particular focus was given to identifying the language symptoms of NEA. Because of this focus on language symptoms, the project primarily explored the roles of NEA at the cognitive and symptomatic levels. The project comprised two studies: one focusing on the NEA dimension and one focusing on the language impairments dimension.

#### 2.5.1 Hypotheses

The main hypothesis was that NEA plays a role in children’s language development. In other words, it was hypothesised that NEA is a contributing factor in language impairments. Therefore, one should find more cases with IEA among children with language impairments than in children with no such impairments, and one should find language impairments among children with NEA. Furthermore, NEA-related factors should affect language impairments.

Furthermore, it was hypothesised that specifically NEA is a contributing factor in the development of language impairments in particular. Therefore, children with language impairments should exhibit NEA, but should not exhibit IEA during wakefulness. Furthermore, children with NEA should exhibit language impairments, but no impairments or less pronounced impairments in other cognitive domains.
Last, it was hypothesised that NEA affects certain aspects of language. Therefore, children with certain types of language impairments should exhibit NEA. Furthermore, children with NEA should exhibit certain types of language impairments and certain types of early language symptoms.
3  Methodological reflections

To explore the relationship between NEA and language impairments and to identify the language symptoms of NEA, this PhD project was designed to comprise two studies: one focused on the NEA dimension and one focused on the language impairments dimension. To optimise the validity of the study results, several methodological choices were made. Many of these choices will be discussed in the following sections. This discussion will draw on the widely accepted typology developed by Shadish, Cook, and Campbell (2002), which addresses different aspects of validity in quantitative studies. The system divides validity into four main aspects: internal validity, which concerns causal aspects; external validity, which concerns generalisation aspects; construct validity, which concerns the concepts and measures used; and statistical conclusion validity, which concerns statistical inferences. In spite of this division, it is important to recognise that a methodological choice made in a study will influence several types of validity at the same time (Shadish et al., 2002).

3.1  Study 1: Nocturnal epileptiform activity in children with language impairments (article I)

To study NEA in children with language impairments, we sought to explore the presence of IEA during sleep among children with language impairments. First, if our hypotheses were true, we could expect to find more cases with IEA among children with language impairments than in children with no such impairments. Second, we could expect to find IEA in children with certain types of language impairments. Since we wanted to incorporate a wide range of language impairments, we chose to include children with speech and/or language impairments. Finally, we could expect to find IEA during sleep (in other words, NEA), but not IEA during wakefulness, in children with language impairments. Additionally, since NEA is an age-dependent condition confined to childhood and early youth, we also included adolescents in this study.

As discussed in the general introduction (section 2.4.2), there is no consensus regarding the prevalence of NEA in children with speech and language impairments. Although several empirical studies have been conducted, they have often been conducted on small samples. Hence, these studies have produced no consistent results. The reason for these studies’ small samples could be that, despite being well-known conditions, speech and language
impairments are difficult to diagnose, creating challenges relating to enrolling children into studies. Furthermore, studying the prevalence of NEA would entail an EEG registration, which is time intensive and could be considered invading. As a consequence, it can be difficult to recruit children to participate in these kinds of studies. This was also the case for an empirical study originally planned to be included in the current PhD project (see appendix B). Because of difficulties in recruiting an appropriate number of participants, the study was not included in the PhD. Instead, a systematic review of recent studies was conducted.

Several narrative reviews have commented on the prevalence of NEA in children with speech and language impairments, and a few systematic reviews have been conducted (Overvliet et al., 2010). However, we failed to find reviews including studies not published as articles (grey literature) and non-English literature, and we also failed to find reviews that had quantitatively synthesised the data. We consider these two issues to be highly important for establishing the prevalence of NEA among children with speech and language impairments. Therefore, we chose to conduct a systematic review that included grey and non-English literature and that quantitatively synthesised the data. The following sections will elaborate on these choices.

### 3.1.1 The choice of including grey and non-English literature

One of the strengths of conducting a systematic review is that exhaustive searches identify all studies that exist within a field. If a search is not conducted properly (or, in other words, if not all existing studies are identified), the studies included in the review could yield biased results (Gough, Oliver, & Thomas, 2012). This is because the studies included in a systematic review could differ systematically from the studies not identified or included. Concerns regarding biased results are mostly related to the publication statuses of the included studies. Naturally, compared to an unpublished study, a study published as an article has a greater chance of being identified and, thus, a greater chance of being included in a systematic review.

Furthermore, a study published internationally (i.e. published in English) has a greater chance of being included in a systematic review than a study published nationally (i.e. not published in English). However, the fact that a positive finding has a greater chance of being published (Hopewell, Loudon, Clarke, Oxman, & Dickersin, 2009), and that articles published in English tend to report positive results more often than nationally published articles (Egger et al., 1997), highlights the need to conduct exhaustive searches. Although a biased sample of studies could influence several issues related to the validity of a systematic review, it would
mostly influence the generalisability of the results. Taken together, the present systematic review also included studies not published as articles and studies published in languages other than English.

3.1.2 The choice of quantitatively synthesising the results

There are several advantages to quantitatively synthesising the results of primary studies. One advantage of a quantitative synthesis is that it limits subjective interpretations of the results (Cooper & Rosenthal, 1980). It also facilitates an objective investigation of the diversity in the studies by revealing how specific differences (e.g. different types of speech and language impairments) affect the overall results. Furthermore, synthesising results from several small sampled studies has the advantage of increasing the power and, thus, proving true findings (Borenstein, Hedges, Higgins, & Rothstein, 2009). In other words, findings that would be nonsignificant in primary studies due to low power could be significant when combined with findings of other studies. Therefore, a quantitative synthesis of the results enhances the statistical validity of the study. Another advantage of a quantitative synthesis is that the contribution of the primary studies are weighted according to each study’s precision, which is primarily influenced by sample size (Gough et al., 2012). As a consequence, results from a study with a large sample size will impact the overall measure more than results from a study with a small sample size. This is advisable because well-powered studies are argued to be less flawed than low-powered studies (Ingre, 2013).

3.2 Study 2: Language impairments in children with nocturnal epileptiform activity (articles II and III)

To explore the presence of language impairments in children with NEA, we sought to study language in an exhaustive manner. This entailed not only studying a range of language skills, but also studying both current language skills and early language development. We chose a cross-sectional design, one part of the study focused on current language skills (article II) and another focused on early language development (article III). If our hypotheses were true, we could expect to find language impairments in children with NEA. Furthermore, we could expect to find no (or minimal) impairments in other domains in these children. Last, we could expect to find certain types of language impairments and certain types of early language symptoms in children with NEA. This study also explored the role of NEA by examining
various NEA-related factors (e.g. amount of NEA, lateralisation and localisation of NEA and number of antiepileptic drugs [AEDs]) at a biological level. According to the hypotheses, we could expect to find that NEA-related factors affected language impairments.

As discussed above, there is no consensus regarding the presence of language impairments in children with NEA. Furthermore, the existing literature was lacking studies representing three methodological approaches. First, we found few studies including children with NEA regardless of syndrome. Second, we found no studies using comparison groups other than age-matched comparison groups. Third, we found few studies using a range of different approaches to explore language abilities. There are several advantages to conducting a study using these three methodological approaches. Therefore, we chose to conduct an empirical study in which these aspects were taken into consideration: We studied children with NEA regardless of syndrome; we compared children across several comparison groups and we used a range of different approaches to explore language abilities. In the following, the choices underlying these three methodological approaches will be elaborated on. For more detailed information on the participating groups (e.g. recruitment and exclusion criteria) and the measurements used, I refer to the articles (articles II and III).

3.2.1 The choice of nocturnal epileptiform activity group

Based on the theory of a spectrum of related NEA syndromes, we chose to include all children with NEA, regardless of their specific syndrome. Although one could argue that the three syndromes differ and should be studied separately, there is also evidence that the syndromes are not distinct. For instance, children who have been initially diagnosed with one syndrome have later been diagnosed with another syndrome (Datta et al., 2013). Furthermore, unlike several other studies on NEA, we also chose not to restrict NEA to a specific quantity, except for a, at least, four folded increase from wakefulness to sleep. We made this choice because both researchers and clinicians still disagree on how to define specific quantities (Fernandez et al., 2013). For instance, while many researchers consider that an NEA level greater than 85% (i.e. 85 % of non-REM sleep disrupted of NEA) marks the border for the NEA-related syndrome CSWS (Fernandez et al., 2013), Nabbout and Dulac (2003) argue that this border was originally proposed only as a proposition. Now, there is evidence that children below and above this border show no distinct differences in cognitive impairments (Caraballo et al., 2013). Although our choices enhance external validity, it should be mentioned that the place from which the children with NEA were recruited could threaten it. Specifically, recruiting
children from a tertiary hospital meant that only children with the most severe conditions were included. This point is discussed in more detail in article II and III.

In addition, it was critical to operationalise NEA to maximise the chances of measuring the impact of NEA and no other factors. This strengthened the internal validity of the results. First, to ensure that we measured the impact of NEA and not the impact of IEA during wakefulness, the presence of NEA was operationalised as a four-fold increase (or more) in IEA from wakefulness to sleep. Second, to ensure that we measured the impact of NEA and no other potentially contributing factors, we applied several exclusion criteria, such as cerebral palsy, hearing impairments, autism and mental retardation, to the NEA group. Furthermore, to ensure that the transient effect of seizures would not interfere with the language impairments, we excluded children with active seizure situations. An active seizure situation was operationalised as the presence of seizures within the last six weeks before inclusion in the study. However, following the precedent set by other studies (Garcia-Ramos, 2015) we did not exclude children with attention-deficit hyperactivity disorder (ADHD). In other words, ADHD could be a contributing factor to language impairments. This could lead us to misinterpret language impairments as an effect of NEA, when it is actually an effect of ADHD. The reasons for not excluding children with ADHD were, on one hand, that ADHD and epilepsy are highly comorbid and, on the other hand, that ADHD could be secondary to language impairments. We did not have access to any information regarding an ADHD diagnosis beyond whether a child was being medicated for ADHD. Finally, in addition to the abovementioned factors, the use of antiepileptic drugs could interfere with the relationship between NEA and language impairments. Therefore, we investigated whether drug use was a contributing factor for language impairments.

Though we included children with different syndromes, we argue that by including children with IEA during sleep and by applying exclusion criteria, we minimised the possibility of measuring other factors and maximised the possibility of measuring NEA.

### 3.2.2 The choice of comparison groups

Comparison groups are commonly used to study the characterisations of various diseases or syndromes (Hulme and Snowling, 2009). By comparing children with NEA to other groups of children, we sought to determine whether and how the groups differed and, thereby, reveal the characterisations of NEA. We chose to use two comparison groups in each part of the study.
(both the prospective part and the retrospective part). In describing the choices for selecting these comparison groups, each part of the study is presented separately.

In the prospective part of the study, article II, we studied data on language, linguistic-cognitive and general abilities. We determined whether children with NEA had impairments in all or some of these abilities by comparing the children to children with typical development. Based on findings from former research, we anticipated that the typically developing children did not have NEA (Cavazzuti et al., 1980). Therefore, if we found impairments in children with NEA and wanted to determine whether these impairments were characterisations of the NEA condition (and not caused by other factors), we needed to match the typically developing children with the children in the NEA group with respect to these other potentially causal factors. The properties of a comparison group (e.g. the matching factor) could add to the causal inferences. Age and gender are two highly causal factors for children’s language abilities. Therefore, these factors were used to match one comparison group with the group of children with NEA. If the findings revealed that the children with NEA scored poorer on all tasks than the age-matched children, we could argue that delayed language is a characterisation of children with NEA. However, if the findings revealed that the children with NEA, in addition to exhibiting overall poorer results than the age-matched children, scored specifically poor on one of the language tasks, the results could be difficult to interpret. On one hand, poor results on a specific language task could reflect that children with NEA struggle with that task in particular. In other words, such results could suggest that deviant language is a characterisation of children with NEA. On the other hand, poor results on a specific task could reflect that the task was influenced by overall language level. In other words, it could be argued that any child at the same overall language level would perform poorer on that specific language task. To control for this possibility, we chose to also include a comparison group matched on language ability.

A comparison group matched on the presumed core deficit could add to the understanding of the characterisations of the impairments (Hulme & Snowling, 2009). Based on the theory suggesting that NEA influences the consolidation process and, thereby, affects memory (Holmes & Lenck-Santini, 2006), the ability-matched comparison group was matched with the NEA group on verbal long-term memory, namely vocabulary. If vocabulary is the core deficit among children with NEA, then the NEA group could be expected to perform similarly to or better than the vocabulary-matched group on other language tasks. However, if the children with NEA perform similarly to the vocabulary-matched children on all language
tasks, we would be unable to prove that vocabulary is the core deficit of children with NEA, since a match on any of the language components would yield the same results. Furthermore, if the NEA group exhibited poorer results than the language ability-matched group on a language task other than vocabulary, then vocabulary could not be the core deficit in children with NEA. This latter finding would further weaken the consolidation theory, thus, introducing new hypotheses.

In article III, we studied retrospective data on early development. By comparing children with NEA with other groups of children, we investigated whether some aspects of early development were characteristic of children with NEA and could, therefore, be regarded as early indicators of NEA. First, we sought to prove that these aspects of early development were characteristic of children with NEA and not children with typical development. To accomplish this, we included a comparison group comprising typically developing children. Second, if NEA causes impaired language development, we sought to prove that the aspects of early development are characteristic of children with NEA, not other children with impaired language development. Therefore, we included a comparison group comprising children with language impairments (drawn from the sub study “EEG and children with language impairments” not included in this thesis, see appendix B). Furthermore, if NEA causes language impairments, we needed to control for NEA in the comparison group of children with language impairments. Therefore, based on results from an overnight EEG registration, we included only those children in whom NEA was absent.

### 3.2.3 The choice of measurements

While one part of the study (article II) collected prospective data on language skills, the other (article III) collected retrospective data. As mentioned, the studies focused specifically on language symptoms; thus, the project primarily included measures at the cognitive and symptomatic levels. However, some measures at the biological level were also included. Each measure is fully described in the two articles.

In the prospective part of the study, we aimed to measure different components of language in order to determine whether certain types of language impairments were present in children with NEA. Because most children in the comparison groups were drawn from a cohort that was part of a large-scale longitudinal study (the cohort study) that had already been running for several years at the time of this PhD project’s start, several measures were chosen from the
wide range of measures used in the cohort study. At the symptomatic level, we included measures of phonology, grammar (morphosyntax and syntax), vocabulary and reading skills (orthographic skills and phonological decoding skills). At the cognitive level, we included measures of short-term memory (sentence repetition) and naming speed. Because the two measures at the cognitive level were assessed with tests that required verbal responses, the measures could be described as measuring linguistic-cognitive abilities (see article II). In this part of the study, vocabulary was also used as a measure at the linguistic–cognitive level. More precisely, it was used as a measure of verbal long-term memory.

In the prospective part of the study, we wanted to determine whether language was particularly affected in children with NEA; thus, we measured the children’s non-verbal abilities. Because different versions of this measure were conducted according to the age of the child, the raw scores had to be converted into standardised scores for the measure to be comparable. However, this meant that the results of the measure could not be compared to those of the other measures (which were presented as raw scores). Therefore, in order to prove that language was particularly affected in children with NEA, we included a measure on verbal ability that also was converted into standardised scores. In other words, if the children with NEA scored poorer on the verbal ability measure than on the non-verbal ability measure, it would suggest that NEA particularly affects language.

Last, we collected measures at the biological level in the prospective part of the study. In order to prove that NEA-related factors affected language impairments, we included measures from the EEG, specifically the amount of NEA and the lateralisation and localisation of NEA, and measures on the use of AED.

In the retrospective part of the study, the objective was to prove that children with NEA exhibited certain types of early language symptoms and no other types of early symptoms. Therefore, this part of the study primarily collected data at the symptomatic level. In order to identify all possible indicators of NEA, information on a range of different issues was coded. Data were drawn from two sources: medical records and a parental questionnaire (see article III for full descriptions of these measures). Whereas the parental questionnaire was designed for the cohort study and consisted primarily of closed questions, the medical records were not standardised. Nevertheless, despite some variations, the medical records sufficiently described information related to medical issues. This was not always the case for information related to cognitive or language development. In other words, if a medical record lacked descriptions of
a particular difficulty (e.g. with speech), this do not necessarily mean that the child did not have such difficulties. To fill these gaps, the parental questionnaires asked specific questions related to language development. Therefore, by combining the information from the medical records and the parental questionnaire, we were able to gather rich information on the children’s early development.

By exploring language in various ways, we sought to provide comprehensive and rich descriptions of the presence and profile of the language impairments in the children with NEA, thus strengthening the construct’s validity and reliability. This included exploring language from different sources, exploring the different components of language and exploring whether language differed from other cognitive domains. More detailed descriptions of these investigations are provided in each article.

3.3 Ethical considerations

The empirical study (study 2), and the sub study, were approved by the Regional Committee for Medical and Health Research Ethics (REK) (see appendix A and B for original approval letters). All additional smaller changes were also approved by REK. This section will briefly discuss some of the ethical considerations related to research on children, specifically children with NEA (article II and III) and children with language impairments (article III).

All research should be based on informed consent. In studies enrolling children, this informed consent is gathered from parents (see appendixes). However, the empirical study emphasised ensuring that the children received sufficient information on the study to decide whether or not to participate (see appendixes). For some children with NEA, the testing was done as part of the general hospitalisation process; therefore these children did not receive the information letter. Also, the children participating in the cohort did not receive such information.

This project acknowledged that children with NEA would be exposed to tasks that they would find particularly difficult. To minimise the impact of these tasks, the assessments were generally included in periods of hospitalisation and performed by experienced examiners (either special needs teachers or psychologists). This prevented the children from being exposed to unnecessary testing and allowed the testing to support each child’s specific needs.

Second, the children with language impairments included in the study (article III) needed to be registered with EEGs while they slept to rule out potential NEA. In order to ensure the
children’s well-being, the registration was conducted in an ambulatory manner so that the children could sleep at home.
4 Overview of the studies and results

4.1 Summary of the studies

In table 1, an overview of the studies and articles are presented.

Table 1. Overview of the design, focus and data material of the studies and the articles.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Article</th>
<th>Focus</th>
<th>Data material</th>
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<tr>
<td>Study 1: NEA in children with language impairments</td>
<td>Systematic review and meta-analysis</td>
<td>Article I: “The value of EEG in assessing children with speech and language impairments”</td>
<td>To examine the risk of IEA in children with speech and language impairments compared to typically developing children</td>
<td>Studies of children with speech and language impairments and a typically developing comparison group (N=8)</td>
</tr>
<tr>
<td>Study 2: Language impairments in children with NEA</td>
<td>Cross-sectional prospective and retrospective study</td>
<td>Article II: “Watch the language! Language and linguistic-cognitive abilities in children with nocturnal epileptiform activity”</td>
<td>To explore in what way the language and linguistic-cognitive abilities of children with NEA differ from those of typically developing children</td>
<td>Children with NEA (N=33) Age-matched children (N=33) Ability-matched children (N=66)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Article III: “Early indicators of nocturnal epileptiform activity”</td>
<td>To identify early indicators of NEA</td>
<td>Children with NEA (N=26) Age-matched children (N=25) Language-impaired children (N=8)</td>
</tr>
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</table>
4.2 Summary of the results

The overall aim of this project was to explore the relationships between the dimensions of NEA and language impairments. A prolonged aim was to identify the language symptoms of NEA. The project comprised two studies focusing on each of these dimensions and the studies are presented in three articles (see table I for an overview). The project also proposed several hypotheses (section 2.5.1). A summary of the results in relation to these hypotheses will be presented in the following. More detailed results are presented in the articles.

First, we found that IEA was more common in children with language impairments than in typically developing children (article I). We also found language impairments in children with NEA (article II). However, we did not find that NEA-related factors (amount of NEA, number of AEDs, lateralisation and localisation) affected language impairments (article II) although it seems that NEA lateralisation and localisation could have some effects on language impairments. Overall, our findings suggest that the presence of NEA is a contributing factor to language impairments.

Second, we found that EEGs during sleep were more likely to reveal IEA in children with language impairments, implying that NEA is more common than IEA during wakefulness (article I). We also found delayed language abilities and less pronounced difficulties in non-verbal domains among children with NEA (article II). These findings could indicate that specifically NEA contributes to language impairments in particular.

Last, we found that NEA occurs more often in children with language regression and language impairments (e.g. SLI) than in children with speech impairments (article I). In accordance with these results, we found that alterations in language development, such as language regression, could be indicators of NEA (article III). We also found, in addition to overall delayed language abilities, specifically poor results on phonology and naming speed among children with NEA (article II). Taken together, these findings suggest that NEA affects certain aspects of language. Additionally, we found that cognitive impairments (for instance problems related to executive functioning and particularly if alterations in functioning is present), sleep problems and sound sensitivity, together with suspected seizures, could be NEA indicators (article III).
4.3 Comments concerning validity

The present project sought to increase the validity of results by making several methodological choices. Many of these methodological choices and its related validity aspects were discussed in chapter 0. Methodological choices made in the two studies have also been extensively discussed in the three articles. Rather than repeating these discussions, this section will comment on some crucial aspects of validity when conducting studies exploring the relationship between nocturnal epileptiform activity and language impairments. Specifically, internal validity will be focused.

First, considering the overall aim of the project, internal validity is a central validity aspect. The underlying assumption is that NEA disrupts language by disrupting one or several brain mechanisms. To study this hypothetically causal relationship is challenging for several reasons. For instance, it is challenging because the dimensions involved are non-static in nature. Not only does NEA affect a non-static condition (i.e. a brain in development), but NEA is also, in itself, a non-static condition. Therefore, language impairments are hypothetically by-products of a single non-static condition (NEA) influencing another non-static condition (the brain). The relationship is also challenging to study because several potentially disturbed underlying brain mechanisms could produce the same language impairments. Therefore, proving that children with NEA have particular language impairments does not necessarily prove that NEA affects particular underlying brain mechanisms. It is also difficult to determine whether NEA is the main cause or a contributive cause of language impairments or whether both NEA and the language impairments are caused by an underlying factor. Furthermore, studying the relationship between NEA and language impairments is challenging because NEA is a naturally occurring condition. In other words, as in all naturally occurring conditions, it is not possible to conduct a study in which NEA is applied to a randomly selected sample. Of course, one can manipulate the condition through medication and study the effects on language impairments; however, as described earlier, these studies are problematic because the medication could affect the brain. Next, longitudinal studies could be suited to reveal possible causal relationships. However, the few longitudinal studies that exist follow groups of children already recognised as having NEA. Clearly, it would be most informative to follow children from before the onset of the condition. In such a study, one could examine developmental patterns before and after the onset of the condition and reveal causal relationships with greater certainty. However, this
would require following a great number of unselected children and then studying them regularly until a handful exhibit NEA. To the best of my knowledge, no such studies currently exist. Based on the abovementioned reflections, the empirical study confined in this PhD project was chosen to have a cross-sectional design. As Hulme and Snowling (2009) argue, this design is unable to prove causal relationships. Nevertheless, several methodological choices were made in order to increase internal validity. For instance, the choice of NEA group and the choice of comparison groups were made in order to increase the possibility of measuring NEA and not confound factors. Discussions related to internal validity are further focused on in the general discussion concerning the role of NEA (section 5.1.1).

Studies exploring the relationship between NEA and language impairments at the cognitive and symptomatic levels could produce results about what characterises the language impairments in children with NEA. However, much of this research, included the present empirical study, are hampered with several challenges. One of these challenges is related to statistical inferences, above all, the problem with statistical power. For instance, the empirical study has small sample size and thereby lacks statistical power. Low statistical power minimize the chance of producing significant results, thus increase the risk of rejecting true hypotheses (Shadish et al., 2002). Discussions and comments concerning statistical power related to the empirical study are elaborated in article II. Another problem related to statistical power, is missing data. Based on ethical considerations, the testing was shortened if it was too challenging for the child leading to missing data on several measures. In addition to reducing power, missing data could influence internal validity. This is because the results would be incorrectly high on some measures due to missing data from the, presumably, most affected children. As explained in article II, this potentially threat to validity was handled by conducting additional analyses with list-wise deletion. Contrastingly to the empirical study, there are several statistical advantages of conducting a meta-analysis. These aspects were discussed in section 3.1.2, “The choice of quantitatively synthesising the results”.

Considering the prolonged aim of the project (identifying the language symptoms of NEA) construct validity should be emphasized. It was particularly important to appropriate measure language components in the empirical study. This aspect was commented on in the previous section 3.2.3, “The choice of measurement”, as well as commented on in article II and III. It could be accentuated that the empirical study sought to increase construct validity by using several measures (standardized tests, parental questionnaire, and medical records). Related to the hypothesis saying that NEA contributes to the development of language impairments in
particular, it was crucial to measure cognitive skills other than language in order to explore if children with NEA exhibit language impairments and not, or less pronounced impairments in other cognitive domains. Aspects related to construct validity are further discussed in section 5.1.2, “The language symptoms”.

Last, external validity is a crucial aspect in the present studies. Related to the systematic review, threats to generalisability, and particularly the risk of biased results, are extensively reviewed and discussed both in this extended abstract (section 3.1.1) and in article I. However, one issue should be commented on: the majority of the included studies did not report sufficient information so that the prevalence of speech- and language-impaired children with IEA could be coded. The reasons for this were two-folded: First, several studies did not report if IEA had been measured. Second, several studies did not report detailed information on children with speech and language impairments. For instance, some documents described that the study had included children with various types of impairments without specifying information on the children with speech and language impairments. The studies, in which information was lacking, were not incorporated in the meta-analysis and this could have biased the result. However, the reasons for not reporting sufficient information could be that the main focus of the study was not to reveal IEA in children with speech and language impairments. Therefore, there are reasons to believe that leaving out these studies would not bias the results of the systematic review. Related to the empirical study, challenges concerning generalisability are particularly crucial when it comes to the children with NEA. As discussed both in section 3.2.1 and in article II and article III, the recruitment place for children with NEA (tertiary hospital) could bias the group and decrease generalisability. In addition, it should be commented that a biased NEA-group, in terms of having especially severe impairments, could influence internal validity by exaggerating the relationship between NEA and language impairments.

The methodological choices and its related validity aspects have been presented and discussed in the previous section, in the chapter concerning methodological reflections (chapter 0) and in the three articles. Considering the aim and prolonged goal of this PhD project, particularly internal validity and construct validity is central. Therefore, discussions related to causal relationship will be reflected on in the general discussion concerning the role of NEA (section 5.1.1) and discussions related to operationalising constructs will be reflected on in the general discussion concerning the language symptoms (section 5.1.2).
5 General discussion

The overall aim of this project was to explore the relationship between NEA and language impairments, with a particular focus on identifying the language symptoms of NEA. To achieve this aim, two studies were conducted. First, we examined the prevalence of NEA in children with language impairments. Second, we identified language impairments in children with NEA. The results of these studies are presented in three articles, each of which contains a specific discussion of the results. Rather than repeating these specific discussions, this general discussion compiles the results and concentrates on discussing these results in relation to the main aim and hypotheses of the project. Last, scientific and clinical implications will be discussed.

5.1 The relationship between nocturnal epileptiform activity and language impairments

Our results indicate that there is a relationship between NEA and language impairments. More precisely, the results suggest that NEA, in particular, affects language, in particular. Furthermore, our results offer information on what language symptoms should be considered when identifying NEA. For instance, our results indicate that a child who experiences language regression should be referred to an EEG.

Based on Morton and Frith (1995) framework, the relationship between NEA and language impairments will be discussed at the biological, symptomatic and cognitive levels. First, the biological level is focused and the role of NEA is discussed. Next, the symptomatic level is focused and the language symptoms of NEA and how to classify the language impairments found in children with NEA are discussed. Last, the cognitive level and an integration of the biological and the symptomatic level are focused and possible theoretical links between them are discussed.

5.1.1 The role of nocturnal epileptiform activity

Several explanations at the biological level have been proposed to describe which neurological processes are most affected by NEA and, thereby, lead to language impairments in children with NEA. This project did not seek to identify which of these neurological processes are most affected by NEA; therefore, the studies were not design to examine one or
several of the described neurological processes in isolation. Nevertheless, our results offer some information about the causative role of NEA in neurological processes. In particular, they reveal information about NEA’s role on consolidation processes. This PhD project was not designed to make causal inferences; however, because the project’s overall hypothesis was that NEA is a contributing cause of language impairments, a discussion of NEA’s possible role in language impairments is appropriate.

Evidence suggesting that NEA plays a role in language impairments was found in several of the project results. For instance, EEGs during sleep recorded IEA more often than EEG during wakefulness in children with language impairments. We also found that children with NEA had poorer language skills than non-verbal skills and that NEA was more common among children with language impairments than children with speech impairments. These findings suggest that neurological processes during sleep could be disturbed by NEA and, thereby, affect language development in particular.

It would be natural to expect that the degree of language impairments would correspond to the extent of NEA. However, we found no solid evidence that NEA-related variables, such as amount or localisation of NEA, influenced the degree or type of language impairments. One explanation for this inconclusiveness could be that NEA-related variables may vary from registration to registration. For instance, prior research has shown considerable variations in amount of NEA from one night to another (Libenson, Haldar, & Pinto, 2014). Also, the inconclusiveness could come from instability in the localisation of NEA (Datta et al., 2013). Clearly, the findings concerning alterations in language function could potentially be explained by the variations in the amount or localisation of NEA.

The lack of results suggesting that NEA-related factors influence language could also reflect that the studies have failed to measure central NEA-related variables. One such variable is age of NEA onset. For instance, Bishop (1985) discuss that early NEA onset is correlated with more severe language outcome. This is in contrast to children with acquired language impairments caused by trauma in which early onset is favourable for outcome because of the brain’s ability to compensate. The difference between children with acquired language impairments caused by trauma and those with acquired language impairments caused by NEA could be explained by NEA interfering with the compensatory plasticity of the brain. For instance, persistent epileptiform activity could constantly disrupt the ability for the brain to compensate (Datta et al., 2013). To confirm exact age of NEA onset could, however, be
difficult because of the subclinical character of the condition. Nevertheless, if NEA is the cause of language impairments, one should expect an onset of impairments concurrent with the NEA onset. In other words, children with NEA should exhibit acquired language impairments. The most striking pattern of acquired language impairments occurs when a child regresses in language development, as is the case in children with AEA. This pattern was also evident in some of the study results. First, the systematic review postulated that the highest incidence of IEA was found in children with language regression. Second, the retrospective part of the empirical study found that a group of children with NEA were initially described as exhibiting language regression. However, the results also revealed NEA in children with language impairments other than language regression and children with NEA who were initially described as exhibiting language impairments other than language regression. As some have debated, revealing acquired language impairments in very early language development is challenging (Echenne et al., 1992). In other words, one explanation for the lack of descriptions of language regression across all children with NEA is that an observable onset of language impairments presupposes a certain level of language acquisition.

Additionally, the lack of supporting results could reflect that the causal effect of NEA on language is not very strong. In other words, NEA is not the main cause of language impairments in children with NEA. Rather, the cause of language impairments in children with NEA could be, for instance, epileptic seizures. Although specific information on seizure history was lacking in the empirical study, some general information was available. First, we knew that the majority of all included children with NEA did not have a diagnosis of epilepsy other than NEA. With respect to the traditional definition of epilepsy, it could be argued that a child with an epilepsy diagnoses is more likely to have epileptic seizures than a child without an epilepsy diagnosis. Therefore, it is reasonable to infer that most children in the study were not heavily affected by seizures. Second, we had information about seizure history in approximately two-thirds of the group of children with NEA (N=22). Within this subgroup, seven of the children were described as never having epileptic seizures and few children were described as having frequent seizures. Note that this information was drawn from the two medical records: referral letter to and discharge summary from the first hospitalization at the National Centre for Epilepsy. In other words, the children could have developed seizure later on. However, together these findings suggest that the children in our NEA sample were seldom affected by severe seizures; thus, seizures were not a strong cause of language
impairments in our sample. This is in line with the conclusion drawn by Dijkstra and Ferrier (2013), who state that IEA could be more harmful for language than epileptic seizures.

One of the most cited theories concerning NEA’s causative role is that NEA disrupts consolidation processes, thereby disrupting memory tracks. In our empirical study, one of the comparison groups was therefore matched with the NEA sample according to a measure of verbal long-term memory, namely vocabulary. Although the results proposed that the children with NEA performed similarly to the vocabulary-matched children, there was some evidence that the children particularly struggled with other language components. This may indicate that NEA disrupts several neurological processes in addition to consolidation. For instance, it could be that NEA also affects different sleep functions depending on which part of sleep is disrupted. In other words, if NEA disrupts the sleep architecture—that is, if it disrupts the distribution of sleep stages—it will indirectly affect the function of each sleep stage. Therefore, a measure of sleep architecture could offer interesting information.

Though the project was not designed to reveal causative mechanisms, several aspects of NEA’s causal role on language impairments have been discussed. Still, it remains unclear whether NEA is the main cause or a contributive cause of language impairments or whether NEA and language impairments are both simply caused by an underlying factor. Furthermore, the specific role of NEA on language impairments is still uncertain. However, regardless of whether NEA is the main cause of language impairments or not, it is clear that there is a strong link between NEA and language impairments. In other words, language impairments often coexist with NEA. This emphasises the need for information on what types of language impairments frequently co-occur with NEA. In the next section, the possible language symptoms of NEA are discussed.

### 5.1.2 The language symptoms

This project sought to facilitate the early identification of NEA by identifying its possible language symptoms. Several study results illustrated the importance of gaining knowledge about the language symptoms of NEA. First, we found that language impairments were the first symptom of NEA in some children. Second, we found that epileptic seizures were never confirmed in some children with NEA. Last, we found NEA in a considerable number of language-impaired children without epilepsy. Taken together, language impairments could be the first or the only symptom of NEA. The following section addresses how to categorise
language impairments in children with NEA and discusses the possible language symptoms of NEA.

First, atypical language development could be argued to be a language symptom of NEA. Several study results support this claim. For instance, the results of the empirical study showed that language was particularly impaired in children with NEA. Furthermore, results from the systematic review illustrated that NEA was less frequent in children with speech impairments than in children with language impairments, thus proving that language, and not speech, seems to be impaired in children with NEA.

Additionally, our results suggest that regression in language development could be a language symptom of NEA. In other words, several children with NEA seem to have acquired language impairments, as evidenced by results from both the systematic review and the empirical study. First, the systematic review found that children with language regression exhibited the highest incidence of NEA. Second, the empirical study showed that several children with NEA experienced language impairments following typical early language development. However, the studies also postulated that not all children with NEA have acquired language impairments. For instance, the systematic review found NEA in language-impaired children without language regression, and the empirical study found that some children with NEA did not exhibit language regression. Nevertheless, the empirical study revealed that several children presented with altered language function.

Concerning developmental patterns, our results suggest that children with NEA experience delayed language development. In other words, the language development of children with NEA could be described as similar to, but progressing more slowly than, the language development of typically developing children. This suggests that slow language acquisition could be a language symptom of NEA. However, the results of the empirical study show that NEA might affect some language components more than others. More specifically, our results suggest that children with NEA tend to have particular difficulties with naming speed and phonology. Though the evidence supporting this claim was weak, this was due mainly to a lack of statistical power; thus, one could argue that the trend is clinically relevant. This means that, assuming that children with NEA experience deviant language development, difficulties with naming speed and phonology could be language symptoms of NEA.
With respect to early symptoms of NEA, the retrospective part of the empirical study also found symptoms of NEA not related to language, for instance difficulties related to executive function. More specifically, one symptom of NEA could be altered executive function. Additionally, the retrospective part of the empirical study found that sleep problems could be a symptom of NEA. Sleep problems were also the most frequent referral reason for EEGs in a retrospective study describing 26 children in whom NEA had been coincidentally found (McNally & Kossoff, 2015). The remaining children had been registered with EEGs because of staring spells, psychiatric issues and developmental delays. Only seven children later developed seizures. Finally, the retrospective part of the empirical study in this PhD project found sound sensitivity to be a symptom of NEA. Although sound sensitivity also occurred in language-impaired children without NEA, in these children, it was most common in the context of temporary hearing difficulties. This was not the case in children with NEA. Therefore, sound sensitivity that cannot be explained by temporary hearing difficulties, such as otitis media, could be a symptom of NEA.

When explaining a condition like NEA, Morton and Frith (1995) claim that one should strive to determine which symptoms could be specific to the condition. The results of the studies point to several language symptoms that could considered specific to NEA: for instance language regression. However, several of the foregoing descriptions of language symptoms in children with NEA—namely, atypical language development and difficulties with naming speed and phonology—are more general and could indicate conditions other than NEA. As a consequence, it is not always apparent when language impairments are a symptom of NEA and when it is not.

5.1.3 Theoretical explanations

The following section seeks to integrate the biological and symptomatic explanations by discussing the relationship between NEA and language impairments at a cognitive level. Above all, this discussion concerns the theoretical explanations of the language impairments observed in children with NEA.

In the previous section, the relationship between NEA and language impairments was discussed at a symptomatic level. It was argued that children with NEA, in addition to having acquired language impairments (caused by NEA), and, therefore, secondary language impairments, exhibit atypical and deviant language development. The conclusion that children
with NEA experience atypical language development was based on findings that there was a discrepancy between verbal and non-verbal abilities, while the conclusion concerning deviant language development was based on findings that rapid naming and phonology were particularly affected. These conclusions challenged the consolidation hypothesis. Based on the findings concerning executive impairments as a symptom of NEA, the discussions argued that NEA could also affect cognitive domains other than language. There are several partly related issues regarding these conclusions that deserve attention.

First, the hypothesis stating that NEA affects consolidation was challenged because long-term memory was not the most impaired language component in children with NEA. In other words, poor long-term memory (measured with vocabulary) could not account for all language difficulties in children with NEA. Rather, in addition to causing overall poor language abilities, NEA seemed to cause particular difficulties with rapid naming and phonology. Rapid naming and phonology were categorised as two different components: a linguistic-cognitive component operationalised by a rapid automatised naming task and a language component operationalised by a non-word-repetition task, respectively. However, it could be argued that these two tasks depend on the same component: namely, verbal processing ability. As mentioned, limitations in verbal processing ability could influence both speed and memory. Therefore, one could say that, depending on speed, rapid naming (rapid automatised naming) measures access to “word packages” (Miller et al., 2016) and, depending on memory, phonology (non-word repetition) measures the ability to recall phonological units (Gathercole & Baddeley, 1990).

It is important to recall that a sub-group of NEA children who could read did not struggle with rapid naming when accounting for language ability level. In article II, this was explained by the fact that both rapid number naming and reading draw on the same ability: namely, retrieval skills. In other words, a child who has efficient access to the phonological units could perform adequately on a rapid naming task and could learn to read. Supporting this, Furnes and Samuelsson (2011) state that access to phonological units is one of the prerequisites of learning to read. Furthermore, the results showed that only the rapid naming of digits, not the rapid naming of pictures, was challenging for children with NEA. Because rapid naming of pictures tests were given to the youngest children and rapid naming of digits tests were given to the oldest children, the poor number naming was hypothesised to be an age effect of NEA. In other words, this result suggests that the impairments caused by NEA increase with age. However, one could alternatively argue that the two naming tasks differ and that their
differences are the reason for the poor rapid number naming results. For example, one could argue that the two tasks differ because rapid picture naming seems to predict early reading development, while rapid number (and letter) naming seems to predict later reading development (Lervag & Hulme, 2009). Furthermore, rapid number naming not only measures access to a “word package”, as rapid picture naming does, but also measures the level of automation of, in this case, digits. Similarly, Wagner and Torgesen (1987) note that even when a child has learned the alphabet, rapid letter naming is influenced by the level of letter–sound automation.

While poor processing abilities are arguably a theoretical explanation for language impairments in children with NEA, they have also been hypothesised to be one of the main causes of language impairments in children with SLI. In fact, poor processing abilities, as operationalised by non-word repetition, have been argued to be a prominent symptom of SLI (Schwartz, 2009). In the same way as with SLI, one could discuss the extent to which children with NEA exhibit processing limitations. In other words, one could discuss whether these children’s poor processing abilities are of a general or a specific nature. On one hand, the abovementioned difficulties with verbal processing abilities in children with NEA support the perspective that these processing difficulties are of a specific nature. This is also in line with the conclusion that children with NEA experience atypical language development. On the other hand, other study results support the view that the processing difficulties are of a more general nature.

First, impairments in executive functioning found in the retrospective part of the empirical study could be taken as evidence of the general nature of the difficulties seen in children with NEA. Difficulties with executive function could produce various impairments. Again, poor executive function has been proposed as a theoretical explanation for the language impairments seen in children with SLI.

Furthermore, the view that the difficulties exhibited by children with NEA are general in nature could be supported by the poor reasoning abilities found in the prospective part of the empirical study. In children with NEA, reasoning abilities were found to be poorer than nonverbal abilities. One should expect these abilities to be comparable, since they were measured with subtests drawn from the performance scales of Wechsler’s intelligence scales (Wechsler Preschool and Primary Scale of Intelligence [WPPSI] and Wechsler Intelligence Scale for Children [WISC]) (Wechsler, 2002, 2003). Therefore, poor reasoning abilities could
be taken as evidence that the impairments experienced by children with NEA are not confined to language. However, the comparison group was also found to have surprisingly poorer reasoning abilities than non-verbal abilities. The reasons for this difference could be explained by the sub-tests belonging to two different indexes. While the reasoning ability subtest, Matrix Reasoning, belongs to the fluid reasoning index, the non-verbal ability subtest, Block Design, belongs to the visual spatial index. Additionally, it could be argued that matrix tasks depend on other cognitive domains. For instance, it has been proposed that matrix tasks are closely related to working memory capacity (Harrison, Shipstead, & Engle, 2015). Even more interestingly, Baldo, Bunge, Wilson, and Dronkers (2010) have proposed that reasoning tasks are closely related to language, even when these tasks are non-verbal.

In this section, theoretical explanations for the relationship between NEA and language impairments have been discussed. Based on the results postulating that the language impairments in children with NEA resemble the language impairments in children with SLI, it has specifically been discussed how the theoretical explanation of SLI fits the language impairments in children with NEA. One issue to reflect on is that, as Bishop (1997) comments, prior studies may have unintentionally included children with unidentified NEA in their samples of children with SLI. Based on the results of the systematic review, such groups of children with unidentified NEA could be considerable.

5.2 Implications and concluding remarks

This work contributes to both the research field and clinical practice. First, the empirical study supports earlier research suggesting a relationship between NEA and language impairments with its findings of overall poor language abilities in children with NEA. In addition, the results suggest that verbal processing abilities seem to be particularly affected in children with NEA. The systematic review also supports earlier research by showing that alterations in language development, such as regression, could be symptoms of NEA. However, the systematic review also provides new insights by showing that language impairments could be the only symptom of NEA, as evidenced by the finding of a considerable prevalence of NEA in children with language impairments without regression. Finally, the retrospective part of the empirical study concludes that, in addition to suspected seizures, sleep problems, sound sensitivity and difficulties with cognitive functioning (for instance executive functioning and particularly if alterations in functioning are involved) could be symptoms of NEA.
Our results indicate that the NEA condition might be more common in children with language impairments than previously thought. This could have several implications. For instance, a clinical implication could be that children with the symptoms described above should be referred to EEGs. Furthermore, a scientific implication could be that the indicated prevalence of language-impaired children with NEA could make it easier to conduct large-scale studies.

Although identifying NEA in children is important, there is currently no consensus regarding how to treat such children. Specifically, we lack studies examining the medical treatment of NEA. Therefore, future research should emphasise treatment studies, including, particularly, large-scale pharmacological effect studies.

Hulme and Snowling (2009) state that to be able to treat a child with a disorder, one need to understand the disorder. The findings of this project could, therefore, guide pedagogic practice. Also, knowing which language components are particularly affected in children with NEA could guide future intervention studies.
6 Epilogue

A girl is born. She develops as expected, and around her first birthday, she says her first word. Her parents are delighted and enjoy life with their first born. The girl is doing well, but the parents begin to wonder about their daughter’s language development. They notice that their daughter is developing more slowly than her peers. After her second birthday, she begins to put words together into sentences, but her progress is slow. The girl also begins to react to loud sounds. For example, she often refuses to go to birthday parties. Some days, the parents notice that the girl seems to have forgotten words she usually knows. Her kindergarten teachers share similar concerns and advise the parents to make an appointment with the family doctor. The family doctor examines the girl’s hearing, but finds it to be normal. However, once hearing impairments are ruled out as a cause for the language impairments, the girl is referred for further examination. Among a variety of other assessments, she is registered with a whole-night EEG, and the registration indicates NEA. To address the condition, both medical and pedagogical interventions are considered. For example, the kindergarten takes the girl’s variable language function into account. Furthermore, the girl’s development, particularly with regard to verbal processing abilities, is supported both before and after the girl enters school.
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Appendixes A - J
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2010/2865b Nattlig epileptiform aktivitet og språklig fungering
Projektleder: Solveig-Alma Halaas Lyster
Prosjektansvarlig: Universitetet i Oslo, Institutt for spesialpedagogikk

Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt. Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk, REK sør-øst B, i møte 08.12.2010.

Saksfremstilling

Forskningsetisk vurdering
Komiteen vurderer prosjektet til å falle innunder helseforskningslovens virkeområde fordi prosjektets formål er å undersøke relasjonen mellom epileptiform aktivitet og språklig fungering hos et utvalg barn som har fått påvist epileptiforme forstyrrelser. Kontrollgruppe i prosjektet er et uselektet utvalg på 220 barn (normalpopulasjon), testet med en rekke språklige prøver på forskjellig aldersnivå. Komiteen har ikke forskningsetiske innvendinger til prosjektet.

Informasjonsskriv og samtykkeerklæring
Barna skal ikke selv gi noe selvstendig skriftlig samtykke, men deres mening om det å delta i prosjektet skal bli respektert. Det er derfor nødvendig at prosjektet utarbeider informasjonsskriv tilpasset barna som skal være forskningsdeltakere (jfr. helseforskningsloven § 17 og pasientrettighetsloven § 4-4). Komiteen imøteser en innsendelse av nytt informasjonsskriv for barn.

Vedtak
Vedtak i saken utsettes.
Det bes om at informasjonsskriv til mindreårige forskningsdeltakere sendes komiteen som er anført ovenfor, før endelig vedtak fattes.

Komiteens leder tar stilling til godkjenning av prosjektet etter mottatt svar.

Komiteens avgjørelse var enstemmig.

Komiteens vedtak kan påklages til Den nasjonale forskningsetiske komité for medisin og helsefag, jfr. helseforskningsloven § 10, 3 ledd og forvaltningsloven § 28. En eventuell klage sendes til REK sør-øst B. Klagefristen er tre uker fra mottak av dette brevet, jfr. forvaltningsloven § 29.

Vi ber om at alle henvendelser sendes inn via vår saksportal: http://helseforskning.etikkom.no eller på e-post til: post@helseforskning.etikkom.no

Vennligst oppgi vårt referansenummer i korrespondansen.

Med vennlig hilsen

Stein Opjordsmoen Illner (sign.)
leder

Katrine Ore
komitésekretær/rådgiver

Kopi: Universitetsdirektøren, universitetsdirektørens kontor, Pb 1072 Blindern, INTERNPOST
Silje Systad
phd-student i spesialpedagogikk

2010/2865 Nattlig epileptiform aktivitet og språklig fungering

Prosjektleder: Solveig-Alma Halaas Lyster
Forskningsansvarlig: UiO ved øverste ledelse og Institutt for spesialpedagogikk

Komiteen har mottatt tilbakemelding på e-post som svar på merkander til prosjektet. Følgende vedlegg fulgte tilbakemeldingen:

1. Informasjonsskriv og samtykkeerklæring
2. Informasjonsskriv til barna 4-6 år
3. Informasjonsskriv til barna 6-10 år
4. Barnas oversikt, epilepsigruppen

Prosjektleder anfører i sin tilbakemelding følgende beskrivelse av innsendte informasjonsskriv "Da forskningsdeltagernes alder varierer fra 4 til 10 år, er det utformet to informasjonsskriv. Det ene av skrivene er tilpasset de minste barna og er ment at blir lest høyt av foreldrene. Det andre er tilpasset de eldste barna og kan leses av barna selv. Informasjonsskrivet til foreldrene er utvidet med opplysning om at barna får et eget informasjonsskriv. Vedlagt ligger også en oversikt som barna kan ha ved siden av seg når de testes. På den måten har de oversikt over hvor man oppgaver som er igjen og hva de skal omhandle."

Forskningsetisk vurdering
Komiteen vurderer de innsendte informasjonsskriv i studien for å være tilstrekkelig innarbeidet av de vilkår komiteen satte for studien. Komiteen har ingen forskningsetiske innvendinger til studien slik den foreligger nå.

Vedtak
Komiteen godkjenner at prosjektet gjennomføres slik den nå foreligger med hjemmel i helseforskningsloven § 11.

Godkjenningen er gitt under forutsetning av at prosjektet gjennomføres slik det er beskrevet i søknaden, i tilbakemelding og de bestemmelser som følger av helseforskningsloven med forskrifter.

Godkjenningen gjelder til 03.12.2016

Dersom det skal gjøres endringer i prosjektet i forhold til de opplysninger som er gitt i søknaden, må prosjektleder sende endringsmelding til REK. Vi gjør oppmerksom på at hvis endringene er "vesentlige", må prosjektleder sende ny søknad, eller REK kan pålegge at det sendes ny søknad.

Forskningsprosjektets data skal oppbevares forsvarlig, se personopplysningsforskriften kapittel 2 (URL: og Helsedirektoratets veileder for Personvern og informasjonssikkerhet i forskningsprosjekter innenfor helse og omsorgssektoren (URL: http://www.helsedirektoratet.no/gamspill/informasjonssikkerhet/norm_for_informasjonssikkerhet_i_helsesektoren_232354 )


Vi ber om at alle henvendelser sendes inn via vår saksportal: http://helseforskning.etikkom.no eller på e-post til: post@helseforskning.etikkom.no
Vennligst oppgi vårt referansenummer i korrespondansen.

Med vennlig hilsen,

Stein Opjordsmoen liner (sign.)
professor dr. med
komitéleder

Katrine Ore
komitésekretær/rådgiver

Kopi til: sol.lyster@isp.uio.no
Solveig-Alma Halaas Lyster
Universitetet i Oslo

2012/1926b EEG av barn med språkvansker

**Forskningsansvarlig:** Universitetet i Oslo  
**Prosjektleder:** Solveig-Alma Halaas Lyster


**Prosjektomtale**

Formålet med studien er å belyse sammenhengen mellom språkvansker og "nattlig epileptiform aktivitet (NEA) gjennom å studere forekomst av NEA hos et utvalg barn med språkvansker. Studiens forskningsspørsmål vil vere:

- Hva er omfanget av NEA hos barn med språkvansker?
- På hvilke måter avviker språklig fungering hos gruppen barn med nattlig epileptiform aktivitet (epilepsigruppen) fra gruppen barn med forsinket språkutvikling(språkvanskegruppen)?

Noen barn med epilepsi har ikke synlige anfall, men har likevel epileptiske forstyrrelser, kalt epileptiform aktivitet. Studier har pekt på sammenhenger mellom nattlig epileptiform aktivitet og vansker med språkutvikling. Det skal rekrutteres 30 barn i alderen 4-8 år som alle er utredet ved PPT og der sakkynig vurdering beskriver "en språklig vanske." Det skal innhentes samtykke fra foreldrene, i tillegg skal det lages et eget informasjonsskriv til barna.

**Komiteens vurdering**


**Vedtak**

Med hjemmel i helseforskningsloven § 10 utsettes vedtak i påvente av tilbakemelding fra prosjektleder. Når svar foreligger vil komiteens leder ta stilling til spørsmålet om godkjenning.

Komiteens avgjørelse var enstemmig.

Vennligst benytt skjema for tilbakemelding som sendes inn via saksportalen til REK http://helseforskning.etikkom.no.
Med vennlig hilsen

Stein Opjordsmoen Ilner
professor dr. med
leder REK sør-øst B

Kopi til: sol.lyster@isp.uio.no; universitetsdirektør@uio.no

Hege Holde Andersson
Komitésekretær
Solveig-Alma H. Lyster

**2012/1926 EEG av barn med språkvansker**

**Forskningsansvarlig:** UiO; Institutt for spesialpedagogikk  
**Prosjektleder:** Solveig-Alma H. Lyster


Prosjektleders tilbakemelding ble mottatt 05.02.2013. Komiteens leder har vurdert prosjektet på delegert fullmakt

**Prosjekttomtale**

Prosjektet tar sikte på å gjennomføre EEG-registrering av barn med språkvansker. Prosjektets mål er å avklare andel av barn med språkvansker som har EEG-funnet “nattlig epileptiform aktivitet” (NEA).  

**Komiteens vurdering**

Komiteen mener prosjektleder har svart tilfredsstillende på komiteens merknader. Slik prosjektet nå foreligger har komiteen ingen innvendinger til at det gjennomføres.

**Vedtak**

Komiteen godkjenner prosjektet i henhold til helseforskningsloven § 9 og § 33

Godkjenningen er gitt under forutsetning av at prosjektet gjennomføres slik det er beskrevet i søknaden.


Forskningsprosjektets data skal oppbevares forsvarlig, se personopplysningsforskriften kapittel 2, og
Helsedirektoratets veileder "Personvern og informasjonssikkerhet i forskningsprosjekter innenfor helse- og omsorgssektoren"

Sluttmelding og søknad om prosjektendring
Prosjektleder skal sende sluttmelding til REK sør-øst på eget skjema senest 03.06.2017, jf. hfl. § 12. Prosjektleder skal sende søknad om prosjektendring til REK sør-øst dersom det skal gjøres vesentlige endringer i forhold til de opplysninger som er gitt i søknaden, jf. hfl. § 11.

Klageadgang

Med vennlig hilsen

Stein Opjordsmoen Ilner
professor dr. med
komitéleder

Hege Holde Andersson
Komitésekretær

Kopi til: sol.lyster@isp.uio.no
universitetsdirektør@uio.no
Hei!
Jeg heter Silje og lurer på hvordan det er å være deg.

Ta med mamma og/eller pappa og kom til [blank], så kan vi prate og gjøre oppgaver sammen.

Kanskje vi gjør oppgaver som dette:
Pek på ballen!

Hvis det er noe du ikke har lyst til å gjøre, så fortell meg det.

Når vi møtes kan du fortelle meg hvor gammel du er!

Jeg gleder meg til å treffe deg!
Hei!

Jeg heter Silje. Jeg syns det er spennende å lære om hvordan det er å være ... år. Da trenger jeg din hjelp!

Kom til [_____] så kan vi prate og gjøre oppgaver sammen.

Vi kan snakke sammen og se på bilder sammen.

Hvis det er noen oppgaver du ikke vil gjøre, hopper vi bare over det!

Jeg glider meg til å møte deg!
Forespørsel om deltakelse i forskningsprosjektet

"Nattlig epileptiform aktivitet og språklig fungering"

Bakgrunn og hensikt
Ved det Utdanningsvitenskapelige fakultet, Universitetet i Oslo, pågår et forskningsprosjekt om typisk og forsinket språkutvikling. I samarbeid med Solberg skole og Avdeling for kompleks epilepsi – SSE, har et av delprosjektene til hensikt å kartlegge språklig fungering hos barn med nattlig epileptiform aktivitet.

Erfaringer tilsier at barn med nattlig epileptiform aktivitet ofte har språkvansker og at språkvanskene kan opptre for nattlig epileptiform aktivitet blir konstatert. Prosjektet har til hensikten å kartlegge om det finnes typiske språkvansker for denne gruppen barn gjennom blant annet å sammenligne dem med andre grupper av barn. Gjennom økt kunnskap om språkfungering hos barn med nattlig epileptiform aktivitet, vil barna kunne fanges opp på et tidligere tidspunkt og eventuelle tiltak iverksettes.

På grunnlag av resultater fra EEG-registrering, inviteres deres barn til deltagelse i prosjektet. I alt vil rundt 30 barn bli invitert til å delta i studien.

Hva innebærer studien?

Resultatene fra kartlegging skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene og prøvene vil bli oppbevart og behandlet konfidentielt. Dersom barnet er innlagt til en tverrfaglig utredning, vil kartleggingsresultatene kunne bli benyttet i utredningen. Ved behov, og med foreldres godkjenning, vil det også være mulig å gi lokale instanser tilgang til resultatene (PPT ol) slik at dette kan brukes i utredning av barnet.

Det vil ikke være mulig å identifisere barnet i resultatene av studien når disse publiseres.

Frivillig deltakelse
Det er frivillig å delta i studien. Dere kan når som helst og uten å oppgi noen grunn trekke deres samtykke til å delta i studien ved å kontakte Silje Systad (se tlfnr og mailadresse under). Dette vil ikke få konsekvenser for barnets videre behandling.

Det legges vekt på at barnet skal kunne bestemme om de ikke ønsker å delta. Vedlagt ligger et informasjonsskriv som dere kan lese sammen med barnet.
Dersom dere ønsker at barnet skal delta, kontakter dere Solberg skole ved Christiane Sørensen (67501164) og leverer en undertegnet samtykkeerklæring. Det vil da avtales tidspunkt for kartlegging.

Med vennlig hilsen

Solveig Alma Lyster
Professor og prosjektleder,
Institutt for spesialpedagogikk
Universitet i Oslo

Silje Systad
Stipendiat, Institutt for spesialpedagogikk
Universitet i Oslo

silje.systad@isp.uio.no/ tlf.: 41147428
Samtykke til deltakelse i studien

”Nattlig epileptiform aktivitet og språklig fungering”

Som foresatt har jeg lest informasjonsbrevet og gir med dette tillatelse til at mitt barn kan delta i studien om språklig fungering hos barn med nattlig epileptiform aktivitet.

Barnets navn

Barnet er født ________ dag _______ måned ________ år

Foresattes underskrift

Telefonnummer

E-postadresse

Dato/sted __________
Informasjonsskriv

"Nattlig epileptiform aktivitet og språklig fungering"

Kjære foresatte til deltager i studien «Nattlig epileptiform aktivitet og språklig fungering»,

Takk for at dere har latt barnet deres delta i studien «Nattlig epileptiform aktivitet og språklig fungering»!

Vi sender ut dette informasjonsskrivet for å fortelle litt om studiens forløp, invitere dere til å svare på et foreldrespørreskjema, samt be dere om nytt utvidet samtykke.

Om studiens forløp
Vi har nå inkludert barn til studien i over to år og vil fremdeles fortsette med å kartlegge nye barn i en tid fremover. Siden inkluderingen ikke er avsluttet, har vi ennå ikke oppsummert resultatene.

For å repetere litt om studien: Prosjektet har til hensikt å kartlegge om det finnes typiske språkvansker for gruppen barn med nattlig epileptiform aktivitet gjennom blant annet å sammenligne dem med andre grupper av barn. Gjennom økt kunnskap om språkfungering hos barn med nattlig epileptiform aktivitet, vil barna kunne fanges opp på et tidligere tidspunkt og eventuelle tiltak iverksettes.

Om foreldrespørreskjemaet
I tillegg til den språklige kartleggingen som er foretatt, samt medisinske opplysninger hentet fra journal, ble dere forespeilet å svare på et foreldrespørreskjema. Det har beklageligvis tatt tid å få distribuert dette spørreskjemaet og det har derfor for noen av dere gått lang tid siden dere samtykket i deltagelse til studien. Da det viste seg å være vanskelig å få godkjent en elektronisk distribuering av sikkerhetsmessige grunner, har vi valgt å distribuere skjemaet pr post.


Om utvidet samtykke
I det gjeldende infoskrivet som dere fikk sammen med samtykkeerklæringen, ble det opplyst at følgende opplysninger skulle hentes fra journal: mengde og lokalitet av nattlig epileptiform aktivitet, eventuell epilepsidiagnose og eventuell medisinering.

Vi ser nå at det vil være av betydning for å nå studiens formål at vi også inkluderer eventuelle opplysninger om hørsel, samt at vi får utskrift av henvisningsskrivet til Avdeling for kompleks epilepsi – SSE og første epikrise. Vedlagt ligger derfor også et utvidet samtykke der dette er beskrevet tydeligere.
Vi minner om at det er frivillig å delta i studien. Dere kan når som helst og uten å oppgi noen grunn trekke deres samtykke til å delta i studien ved å kontakte Silje Systad (se tlfnr og mailadresse under). Dette vil ikke få konsekvenser for barnets videre behandling.

Det vil ikke være mulig å identifisere barnet i resultatene av studien når disse publiseres.

Vi håper dere har mulighet for å fylle ut vedlagt spørreskjema og skrive under utvidet samtykke. Dokumentene legges i vedlagte ferdigfrankerte og –adresserte konvolutt.

Med vennlig hilsen

Marit Bjørnvold
Medisinsk ansvarlig overlege/
overlege, Kompetansesenteret
for sjeldne epilepsirelaterte
diagnoser/ Avdeling for
kompleks epilepsi SSE

Solveig Alma H. Lyster
Professor og prosjektleder
Institutt for spesialpedagogikk
Universitet i Oslo

Silje Systad
Stipendiat
Institutt for spesialpedagogikk
Universitet i Oslo
silje.systad@isp.uio.no/
41147428
Utvidet samtykke i studien

"Nattlig epileptiform aktivitet og språklig fungering"

Som foresatt har jeg/vi lest informasjonsskrivet og gir med dette tillatelse til at prosjektet «Nattlig epileptiform aktivitet og språklig fungering» får følgende opplysninger fra journal:
- Eventuelle opplysninger om hørsel
- Henvisningsskrivet til Avdeling for kompleks epilepsi – SSE
- Første epikrise

Barnets navn

Barnet er født __________ dag __________ måned __________ år

Foresattes underskrift

Dato/sted __________
Hei!

Du vet kanskje at det er et sykehus? På det sykehuset, kommer det barn fra hele Norge. De kommer til sykehuset fordi de har epilepsi.

Vi har gjort oppgaver med noen av barna som er på sykehuset og nå ønsker vi å gjøre de samme oppgavene med noen av dere som går på  

Du er plukket ut til å få være med fordi du er akkurat like gammel som et av barna fra sykehuset!

Hvis du vil bli med, kan vi

snakke sammen og

se på bilder sammen.

Hvis det er noen oppgaver du ikke vil gjøre, hopper vi bare over det!

Når vi er ferdige, skal du få en liten gave!
Forespørsel om deltagelse i prosjekt

Sammenligningsgruppe i studien «Nattlig epileptiform aktivitet og språklig fungering»

Bakgrunn og hensikt

Det gjennomføres nå et prosjekt på Epilepisenteret - SSE som har til hensikt å undersøke språklig fungering hos en gruppe barn med en spesiell type epilepsi. For å kunne vurdere barnas ferdigheter, ønsker vi å sammenligne dem med andre barn på samme alder som ikke har epilepsi.

I den forbindelse har vi bedt [redigeres] om å plukke ut inntil 40 barn som «matches» med barna i epilepsigruppen på alder og kjønn. Barna i denne sammenligningsgruppen skal ikke ha språkvansker, være tospråklige, ha kjente diagnoser eller være hørselshemmet. De skal heller ikke være tilmeldt PPT.

Hva innebærer studien?


Frivillig deltagelse

Det er frivillig å delta i studien. Dere kan når som helst og uten å oppgi noen grunn trekke deres samtykke til å delta i studien ved å kontakte Silje Systad (se tlfnr og mailadresse under). Alle opplysninger som innhentes vil behandles konfidensielt og man vil ikke kunne identifisere barnet når resultatene presenteres.

Det legges vekt på at barnet skal kunne bestemme om de ikke ønsker å delta. Snakk derfor gjerne med barnet ditt om hva som skal foregå. Vedlagt følger et lite hefte som dere kan bruke under samtalen.

Vedlagt følger et tilbakemeldingsskriv, samt et samtykkeskjema. Vi setter pris på om dere fyller dette ut så snart som mulig og sender tilbake til læreren i barnets beskjedmappe. Læreren vil videreformidle tilbakemeldingene fra de foreldrene som samtykker i studiedeltagelse.

Med vennlig hilsen

Marit Bjørnvold  Solveig-Alma H. Lyster  Silje Systad
Medisinsk ansvarlig overlege/ Professor og prosjektleder Stipendiat
overlege Institutt for spesialpedagogikk
Kompetansesenteret for sjeldne Universitet i Oslo
epilepsirelaterte diagnoser/ silje.systad@isp.uio.no/
Avdeling for kompleks epilepsisSE 22858140
Universitet i Oslo
Tilbakemelding

Vi ønsker at vårt barn .................................................................
(barnets navn)

☐ ikke deltatt i studien.

☐ deltatt i studien (fyll også ut «Samtykke» under)

Samtykke

(fylles kun ut dersom barnet skal delta i studien)

Jeg/ vi samtykker herved i at mitt/ vårt barn deltatt i sammenligningsgruppen til prosjektet «Nattlig epileptiform aktivitet og språklig fungering».

Deltagelsen innebærer kartlegging av barnet, samt utfylling av et foreldrespørreskjema.

Barnets fødselsdato: ..................dag..................mnd.........................år

Barnets klasse: .......................  

Foresattes underskrift: ........................................................................................................

.............................................................................................................................................

Adresse:......................................................................................................................................

.............................................................................................................................................

E-post adresse / telefonnummer:..............................................................................................
Forespørsel om deltakelse i forskningsprosjektet
"EEG og barn med språkvansker"

Bakgrunn og hensikt
Ved det Utdanningsvitenskapelige fakultet, Universitetet i Oslo, pågår et forskningsprosjekt om typisk og forsinket språkutvikling. I samarbeid med Solberg skole og Avdeling for kompleks epilepsi – SSE, har et av delprosjektene til hensikt å kartlegge språklig fungering hos en gruppe barn med nattlig epileptiform aktivitet.

Som et ledd i dette delprosjektet, ønsker vi å invitere barn med språkvansker til en EEG-registrering (måle elektrisk aktivitet i hjernen).

Tidligere studier der barn med språkvansker har gjennomgått EEG-registrering, har vist at en andel av barna har hatt nattlig epileptiform aktivitet. Studiene er til dels sprikende og vi trenger mer forskning for å kunne vite mer om sammenhengen mellom språkvansker og nattlig epileptiform aktivitet.

Dette delprosjektet har til hensikten å kartlegge i hvor stor utstrekning det finnes barn med språkvansker som har nattlig epileptiform aktivitet. Videre vil vi undersøke om det er noe som kjennetegner disse barna. Gruppen barn med språkvansker vil dermed kunne deles inn i en gruppe som har nattlig epileptiform aktivitet og en gruppe som ikke har dette.

Barnet ditt/deres har gjennomgått en utredning hos PPT som viser at barnet strever med språket. På grunnlag av denne utredningen, inviteres barnet til deltagelse i prosjektet. I alt vil rundt 30 barn bli invitatert til å delta i studien.

Fordeler ved deltagelse
Dersom dere vil at barnet skal delta i studien, vil EEG-registreringen være et bidrag til en utvidet utredning til kanskje å få en bredere forståelse for barnets språkvansker. Dersom det foreligger EEG-funn av nattlig epileptiform aktivitet eller andre funn av klinisk betydning, vil dere inviteres til en samtale med lege. Som nevnt i faktaboksen Hva er nattlig epileptiform aktivitet? finnes det ingen klare retningslinjer for medikamentell behandling av tilstanden. Behandling vil vurderes på bakgrunn av blant annet mengde epileptisk aktivitet og tilleggssvansker for hvert enkelt barn.

Hva innebærer studien?

Dere kommer til Epilepsisenteret (ved Sandvika) en lørdag og barnet får satt på utstyret. Dette innebærer at barnet får små ledninger festet til hodebunnen (se bildet på den vedlagte brosjyren til barnet). Utstyret er selvfølgelig uvant for barnet, men erfaringer tilsier at barna

Dere vil også inviteres til å svare på et foreldresporreskjema (sendes elektronisk).

**Hvordan brukes opplysningene?**

I tillegg til svaret fra EEG-registreringen, vil opplysninger fra PPT-utredningen, samt informasjon fra foreldresporreskjemaet innhentes. Opplysninger fra utredningen som vil være aktuelle er resultat fra en generell ferdighetstest (WPPSI eller WISC), eventuelt også utdypende informasjon fra språktester. Vi gjør oppmerksom på at selv om det ikke gjøres funn av nattlig epileptiform aktivitet i EEG, vil opplysninger fra PPT-utredningen og foreldresporreskjemaet være viktige for prosjektet gjennom å sammenligne dataene med de andre gruppende (barn med nattlig epileptiform aktivitet og barn med språkvansker der EEG viste nattlig epileptiform aktivitet).


**Frivillig deltakelse**

Det er frivillig å delta i studien. Dere kan när som helst og uten å oppgi noen grunn trekke deres samtykke til å delta i studien ved å kontakte Silje Systad (se tlfnr og mailadresse under).

Det legges vekt på at barnet skal kunne bestemme om de ikke ønsker å delta. Vedlagt ligger derfor en liten brosjyre som dere kan lese sammen med barnet.

**Ønsker dere å delta?**

Dersom dere ønsker at barnet skal delta, fyller dere ut samtykkeerklæringene og sender dem tilbake i den vedlagte frankerte konvoluten. Den ene erklæringen (Samtykke til deltagelse i studien …) vil oppbevares hos prosjektgruppen, mens den andre erklæringen (Samtykke til utveksling av informasjon) vises til PPT for å få tilgang til opplysningene derfra.

Dere vil deretter kontaktes for at tidspunkt for EEG-registreringen kan avtales.

Med vennlig hilsen

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Marit Bjørnvold  
Medisinsk ansvarlig overlege/overlege  
Kompetansesenteret for sjeldne epilepsirelaterte diagnoser/Avdeling for kompleks epilepsiSSE

Solveig Alma H. Lyster  
Professor og prosjektleder  
Institutt for spesialpedagogikk

Silje Systad  
Stipendiat  
Institutt for spesialpedagogikk

Universitet i Oslo

silje.systad@isp.uio.no/41147428
Samtykke til deltakelse i studien

”EEG og barn med språkvansker”

Som foresatt har vi lest informasjonsbrevet og gir med dette tillatelse til at vårt barn kan delta i studien om EEG-registrering av barn med språkvansker.

Barnets navn_____________________________________________________

Barnet er født __________ dag _______ måned __________ år

Foresattes underskrift _____________________________________________

                                                                

Telefonnummer ___________________________________________________

E-postadresse _____________________________________________________

Dato/sted _________________________________________________________
Samtykke til utveksling av informasjon

Som foresatte har vi lest informasjonsbrevet og gir med dette tillatelse til at prosjektets medarbeidere kan få innsyn i PPT-utredningen.

Prosjektet vil samle inn aidentifiserte (ikke-identifiserbare) opplysninger fra en generell ferdighetstest (WPPSI eller WISC), eventuelt også utdypende informasjon fra språktester. Samtykken gjelder fra dagens dato og til prosjektets slutt (utgangen av 2016).

Dere kan når som helst og uten å oppgi noen grunn trekke deres samtykke til å delta i studien.

Foresattes underskrift ______________________________________

___________________________________________________________

Dato/sted ___________________________________________________________________
Articles I – III