

A Correlation Between Autism Spectrum Disorders and Lyme Disease.

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Autism is a developmental disorder that appears in the first 3 years of life; it is a physical condition linked to abnormal biology and chemistry that affects the brain's normal development of social and communication skills (National Institute of Mental Health, 2008, p.3). Over the last twenty years the prevalence of Autism has increased over 600% (Autism Speaks, 2010). The increased awareness has led to a classification of Autism Spectrum Disorders [ASDs]. ASDs are a group of developmental disorders including, Autism Disorder, Aspergers Syndrome, and Persuasive Developmental Disorder – Not Otherwise Specified [PDD-NOS] (Centers for Disease Control, 2010a).

There have been many hypotheses to why the rate of ASDs have increased at such a high rate, this paper will investigate a possible contributor; a correlation between ASDs and Lyme disease. Four children who have a diagnosis of an ASD and one who displayed behaviors consistent with an ASD, were assessed using the SCERTS SAP Observation [SAP-O] form. All five children tested positive for Lyme disease and their SAP O score was evaluated before and after antibiotic therapy. Both the parents and the teachers of the children in the study were interviewed and asked to complete the observation form before the child started antibiotic therapy and after. The mean score of the parents and teachers were calculated in an attempt to negate any potential bias. All five children displayed an increase in joint attention and communication skills. Three of the five children in the study were observed five days a week and additional data was collected before and during their antibiotic therapy, including functional points, verbal communication, shared attention, and frequency of repetitive behaviors. The other two students in the study live in different states and data was collected through interviews with parents and teachers and data submitted by their parents.

If more research is done to investigate the potential correlation between Lyme disease and ASDs the benefits could be considerable. Published studies in peer reviewed medical journals have shown that a number of individuals who are diagnosed with an ASD test positive for Lyme disease. A study of was conducted by Dr. Garth Nicolson in 2003 where 20% of the children (n=48) diagnosed with an ASD came back positive for Lyme disease (Bransfeld et al., 2008, p.978). A similar study was conducted by Dr. Aristo Vojdani (2007) and 22% of the ASD patients (n=54) he tested came back positive. In a personal interview with an assistant of Dr. Charles Ray Jones, the only pediatric physician in the world who exclusively treats Lyme disease, she claimed that 50% of his patients who have been diagnosed with an ASD have come back positive for Lyme disease. She also claimed that all of his patients' symptoms improve with antibiotic therapy.

Lyme disease has been called "The Great Imitator" because infected individuals often present neurological and physical symptoms that are similar to other disorders (Bransfeld, 2007, p.29). Late stage Lyme disease is commonly misdiagnosed because it mimics many better known disorders (Pachner, 1989). There is debate to whether or not Lyme disease can be cured, but in nearly all cases patients' symptoms improve with antibiotics and/or other antimicrobial and herbal therapies (International Lyme and Associated Diseases Society, 2009).

If the small sample studies are any indication of the number of children who have a diagnosis of an ASD and are infected with Lyme disease there could be a large population of people who could improve their physical and mental health with proper treatment. An estimated 750,000 individuals in the United States are affected by autism

(Centers for Disease Control, 2010a). If 20% of those individuals test positive for Lyme disease potentially 152,000 people could improve their overall health with antibiotic therapy.

Curing or treating Lyme disease will not cure ASDs, but it may be the difference between an individual's ability to live independently or with assistance. Harvard University's School of Public Health (2006) estimated that the cost to care for an individual with an ASD over their lifetime is 3.2 million dollars. They also estimate that the annual cost to parents and health care providers is between \$39,000 and \$130,000. If a large number of children can alleviate some of their symptoms with antibiotic therapy to treat their Lyme disease the financial impact could also be significant.

Lyme Disease

Lyme disease is a multisystemic illness caused by the spirochete bacteria *Borrelia burgdorferi* [Bb]; it is the most common vector born disease in the United States (Centers for Disease Control, 2010c). The most common mode of transmission of Lyme disease is through the bite of an infected *Ixodes Scapularis* tick (also known as a deer tick); but Bb has been found in the autopsies of miscarried fetuses (McDonald, 1989, p. 657), breast milk (Schmidt et al, 1995, p.122), and placenta's of infected mothers (Brandt et al, 1990, p.985). The mothers of the five children in the study all tested positive for Lyme disease and some of their physicians suspect that the Bb bacteria was transmitted congenitally. Misdiagnosis of initial symptoms of Lyme disease and delayed treatment can lead to debilitating chronic illnesses with musculoskeletal, cognitive, and neuropsychiatric impairments (Cameron, 2003). Children who have gone undiagnosed and later been found to have Lyme disease have displayed decreased reading comprehension and

handwriting skills, impaired speech fluency, attention deficit behavior, hyperactivity, withdrawal from activities with peers, inability to perform at grade level, obsessive compulsive behavior, anxiety, mood swings, dyslexic-like behaviors, sensitivity to light and sound, and inability to manage frustration (Hamlen & Kilman, 2007, p.34).

Lyme and Autism: A Statistical Increase.

Over the last twenty years the number of individuals diagnosed with an ASD and Lyme disease has increased (Centers of Disease Control, 2010e; Thoughtful House for Children, 2010). The fact that the disorder and the disease have increased during the same time period does not mean they are related, there are many other issues that could contribute to the increase of ASDs. Even the fact that ASDs prevalence is four to five times higher for boys than for girls (Centers for Disease Control, 2007, p.576) and the age and gender group that reported the most cases of Lyme disease in the United States from 2003 – 2005 was males age 5 -9 (Centers for Disease Control, 2007, p.576) does not definitively make them linked. But, a factor that could potentially show that Lyme disease and ASDs are more than a coincidental correlation is geographic incidence. Populations of infected ticks are predominantly found in north eastern and upper mid west regions of the United States (Centers for Disease Control, 2007, p.576). Rosner and Duncan (2008, p.146) studied the reported cases of Lyme disease and Autism Disorder and found that the majority of the states with the highest prevalence of Lyme disease also had the highest prevalence of Autism Disorder. After searching the Centers for Disease Control's data for reported cases of Lyme disease, by state, for 2009 and comparing it to the number of reported cases of Autism, by state, according to the Thoughtful House for Children, comparable results were found.

Similar to Rosner and Duncan's findings in 2007, a strong correlation was found between the states that reported the highest prevalence of Autism Disorder and Lyme disease. Of the twenty states that reported the highest occurrence of Autism Disorder per 10,000 people; fifteen reported a higher than average number of Lyme disease cases (figure 2). Conversely, of the twenty states that reported the lowest incidence of Autism Disorder per 10,000 people; zero reported a higher than average number of Lyme disease cases (figure 1). The average number of reported individuals with Lyme disease per state per 100,000 people in 2009 was 13.69 (Centers for Disease Control, 2010e).

The data presented in figure 1 and 2 shows that Lyme disease, which is known to cause numerous cognitive impairments, is more prevalent in areas of the United States that also reported a higher prevalence of ASDs. This data alone should raise questions about a potential relationship between the two.

Autism and Lyme Disease: Similar Biological Abnormalities

At the present time the origin of ASD's are largely unknown, but genetic environmental, immunological, and neurological factors are thought to play a role in the development of ASDs (Ashwood et al, 2006, p.1). The increase in the number of individuals diagnosed with an ASD has created a debate in the academic community. Some believe that the high rate is due to an increase in awareness. Frith (2003, p.67) claimed that in the state of California from 1987-1994 the increase in rate of individuals diagnosed with Autism Disorder rose in perfect correlation with the decline in rate with individuals diagnosed with mental retardation. The increase in awareness does offer a hypothesis to why the rates of ASDs have increased, but it does not explain why many

individuals diagnosed with an ASD have biological differences from their neurotypical peers.

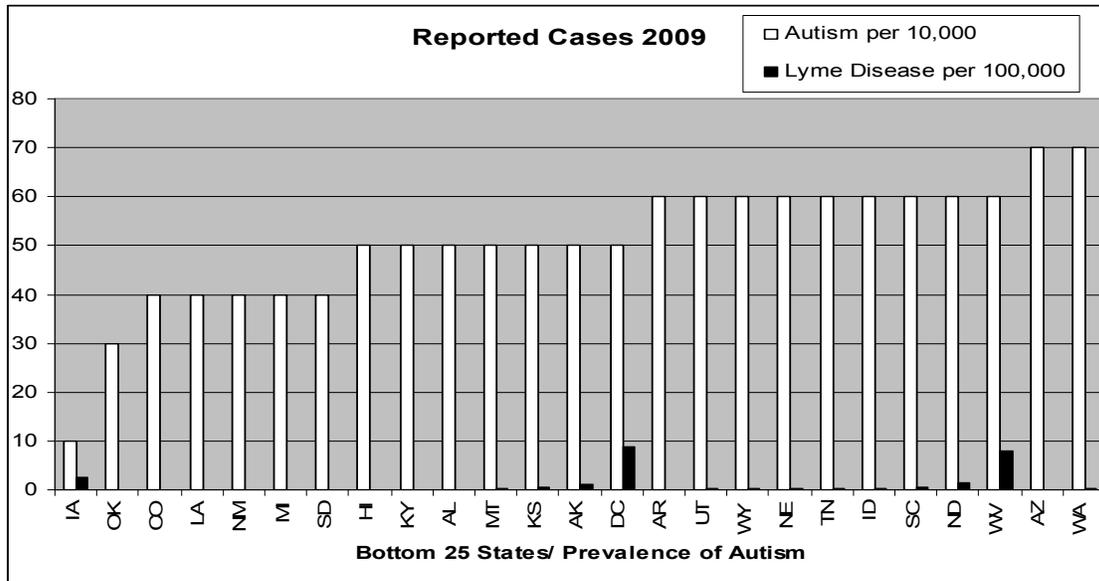


Figure 1 Bottom twenty five states for prevalence of Autism Disorder and prevalence of Lyme disease in those states in 2009.(Centers for Disease Control, 2011; Thoughtful House for Children, 2010).

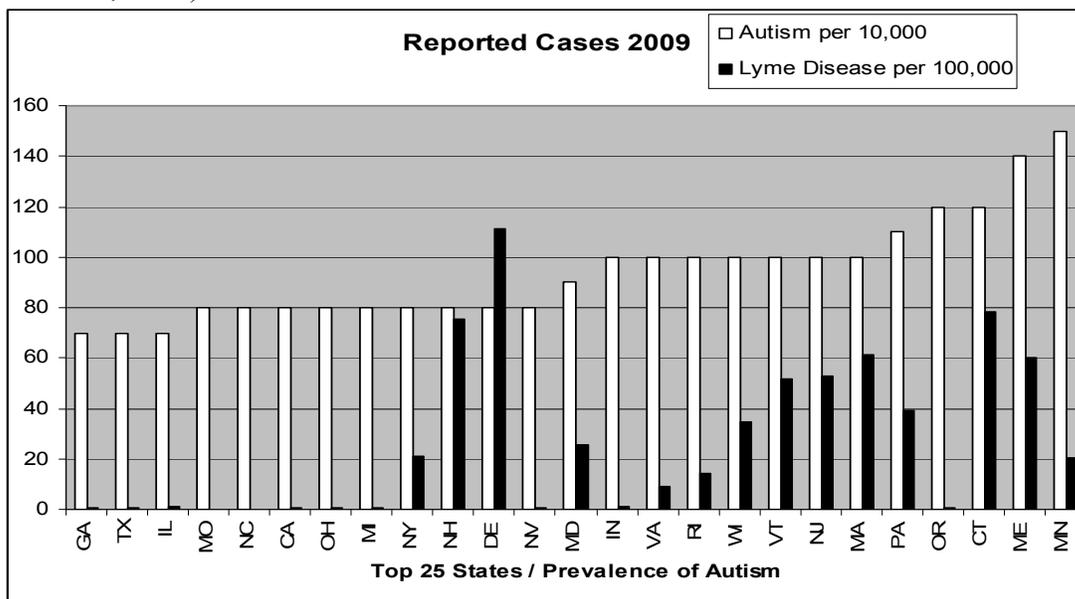


Figure 2 Top twenty five states for prevalence of Autism Disorder and prevalence of Lyme disease in those states in 2009. (Centers for Disease Control, 2011; Thoughtful House for Children, 2010).

Over the last decade medical researchers have attempted to understand the genetic abnormalities in children with ASDs. A study by researchers at the University of California, Davis, the MIND Institute (2005) and the National Institute of Environmental Health Sciences Center for Children's Environmental Health demonstrated that children with Autism Disorder have different immune system responses than children who do not have the disorder. When blood samples of the patients with Autism Disorder were provoked with bacteria the immune system did not attack the bacteria the same way that the immune system of neurotypical peers did (The University of California Davis, 2005). If individuals with Autism Disorder have an immune system that responds differently to bacterial infection it may make them more susceptible to the harmful effects of environmental agents, like Lyme disease.

ASDs have also been linked to autoimmune disorders (Ashwood et al. 2006). An autoimmune disorder is a condition that occurs when the immune system mistakenly attacks and destroys healthy body tissue (National Institute of Health, 2010). Currently, there is no known cause of autoimmune disorders (American Autoimmune and Related Disease Association, 2011) but, research is showing that the body's immune system is not simply attacking healthy tissue but in some cases is instead attacking a type of elusive bacteria, like Lyme disease (Duncan & Rosner, 2008, p.75). Lyme disease patients who do not respond to initial antibiotic treatment and present physical and neurological symptoms can attribute the continuing symptoms to persistent infection or pathogen-induced autoimmunity (Alaedini & Latov 2005, p. 192).

Dr. Anne Comi et al (1999, p.388) studied the immune history of families of sixty one patients with Autism Disorder and compared their results to the immune history of

the families of a group of forty six control patients with no history of Autism. They found that the number of autoimmune disorders was greater in families with a history of ASDs, and as the number of autoimmune disorders increased from one to three, the risk of ASD was greater (Comi et al, 1999, p.394). There is potential that irregular immune activity during vulnerable and critical periods of neurodevelopment could participate in the generation of neurological dysfunction in ASDs (Ashwood et al, 2006, p.2).

Below is a list of common symptoms for autoimmune disorders and Lyme disease; the similarities are quite obvious, but patients with autoimmune diseases are not commonly tested for Lyme disease.

<p>Symptoms of Autoimmune Disorders</p> <ul style="list-style-type: none"> - Dizziness - Fatigue - Flu-like symptoms - Fever - Joint pain 	<p>Symptoms of Lyme Disease</p> <ul style="list-style-type: none"> - Dizziness - Fatigue - Flu-like symptoms - Fever - Joint Pain - Rash
<p><i>Fig. 3 a.</i> Symptoms of Autoimmune Disorders (National Institute of Health, 2011)</p>	<p><i>Fig. 3 b.</i> Symptoms of Lyme disease (Mayo Clinic, 2011)</p>

Immune system irregularities are not the only similarities that Lyme disease patients and individuals diagnosed with an ASD share. Magnetic resonance imaging [MRI] studies have been conducted, independently, on both subgroups and a common atypical structure, white matter hyperintensities, has been observed. White matter hyperintensities are unusual white patches that show up in patient's MRIs that indicate injury to the brain (University of California Davis, 2007) and have been associated with cognitive decline and dementia (Debette & Markus, 2010). One study observed a significant association of progression of white matter hyperintensities with decline in

conceptualization, or ability to think in abstract terms, and spatial relationship skills (Schmidt et al., 2005, p.610). Studies of children with Autism Disorder have shown an inability to conceptualize size comparison and spatial relationships (Ohta, 1987, p.45). The inability to conceptualize can also be associated with the lack of a Theory of Mind (Frith & Happé, 1999). Lack of Theory of Mind, or mind blindness, can be described as an inability to develop an awareness of what is in the mind of another human and is a core deficit of individuals diagnosed with Autism Disorder (Frith, 2001).

Other studies of white matter hyperintensities found an association of a faster decline of executive functions, or processing speed (DeBette & Markus, 2010). A longitudinal study conducted by Ozonoff & McEvoy (1994) indicated that both executive function and theory of mind abilities are seriously deficient in individuals with Autism Disorder.

Boddaert et al. (2009) compared the MRI findings of seventy seven children with a diagnosis of Autism Disorder with seventy seven control subjects and found a high rate (48%) of white matter hyperintensities in the group of children diagnosed with Autism Disorder (Figure 3).

Lyme disease patients who present cognitive impairments have demonstrated white matter hyperintensities on MRI results (Fallon et al., 2009). In some cases antibiotic therapy has resulted in a disappearance of the white matter hyperintensities (Columbia University, 2010).

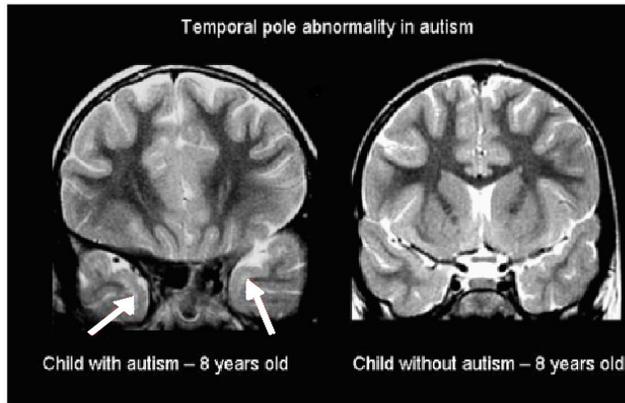


Figure 3
MRI results of a child diagnosed with Autism Disorder compared to a healthy control subject. The arrows point out the white matter hyperintensities (Boddaert et al., 2009, p 5).

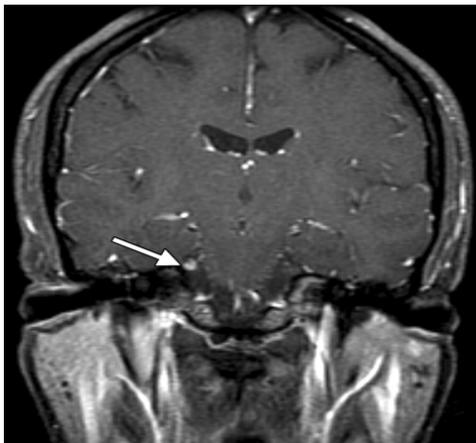


Figure 4
MRI result of a Lyme disease patient with neurological symptoms and facial numbness showing a white matter abnormality as indicated by the white arrow (Agarwal & Sze, 2009, p. 169).

The fact that a number of individuals diagnosed with Lyme disease and numerous individuals diagnosed with Autism Disorder have displayed white matter hyperintensities on their MRI exams; and the fact that white matter hyperintensities have shown to be present in the exams of individuals with cognitive decline further raises the possibility that Lyme disease could be related in the cases of some people diagnosed with an ASD.

Another potentially significant brain abnormality that Lyme disease patients and individuals diagnosed with an ASD share is hypoperfusion. Hypoperfusion occurs when

there is decreased blood flow through an organ; if prolonged, it may result in permanent cellular dysfunction (Dorland's Medical Dictionary for Health, 2007).

Two common tools used to measure blood flow through the brain and typical brain activities are the positron emission tomography [PET] and Single Photon Emission Computerized Tomography [SPECT] (Columbia University, 2010).

According to the Mayo Clinic (2009b):

A single-photon emission computerized tomography (SPECT) scan lets a doctor analyze the function of some of your internal organs. While imaging tests such as X-rays can show what the structures inside your body look like, a SPECT scan produces images that show how your organs work. For instance, a SPECT scan can show how blood flows to your heart or what areas of your brain are more active or less active.

The Mayo Clinic (2009a) describes a PET scan as:

An imaging test that can help reveal how your tissues and organs are functioning. To show this chemical activity, a small amount of radioactive material must enter your body. More radioactive material accumulates in areas that have higher levels of chemical activity. This often corresponds to areas of disease and shows up as brighter spots on the PET scan. A PET scan is useful in evaluating a variety of conditions — including neurological problems, heart disease and cancer.

Approximately 70% of patients with chronic Lyme disease will have multiple areas of hypoperfusion, when treated with antibiotics many of those areas of hypoperfusion have shown to decrease (Columbia University, 2010). A study conducted by Logigian et al (1997) examined the SPECT scans of thirteen individuals who had a

diagnosis of Lyme disease. The SPECT scans showed multiple areas of hypoperfusion in the temporal lobes of the patients (figure 6). Some of the patients in the study were diagnosed with anxiety and depression. When those individuals began antibiotic treatment they showed improvements in neuropsychiatric symptoms and the areas of hypoperfusion decreased (Logigian et al 1997, p. 1661).

Dr. Monica Zilbovicius et al. (2000) compared the PET scans of twenty one children diagnosed with Autism Disorder with ten children diagnosed with mental retardation. In the study they found the group of children diagnosed with Autism Disorder had significant hypoperfusion in the temporal lobes (figure 5) and the left and right superior temporal gyrus (Zilbovicius et al, 2000, p. 1991). The team of doctors did not find any hypoperfusion in the comparison group of individuals diagnosed with mental retardation.

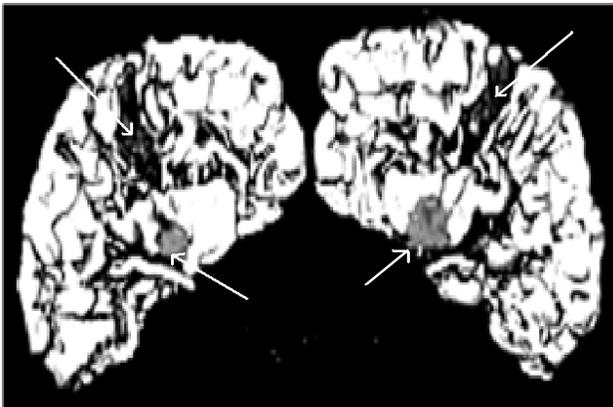


Figure 5
Areas of brain hypoperfusion (in black and grey - arrows) on a PET scan of a child diagnosed with Autism Disorder (Zilbovicius et al, 2000, p.1991).

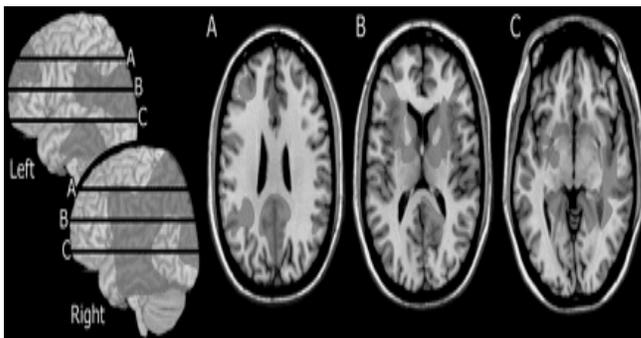


Figure 6
Areas of brain hypoperfusion (Grey) on the SPECT of a patient diagnosed with Lyme disease (Hurley & Taber, 2008, p.1).

In both studies (Zilbovicius et al., 2000; Hurley & Taber, 2008) the exams of the patients diagnosed with Lyme disease and Autism Disorder displayed hypoperfusion in the temporal lobe region of the brain. Kolb & Wishaw (1990) have identified eight principle symptoms of temporal lobe damage: 1) disturbance of auditory sensation and perception, 2) disturbance of selective attention of auditory and visual input, 3) disorders of visual perception, 4) impaired organization and categorization of verbal material, 5) disturbance of language comprehension, 6) impaired long-term memory, 7) altered personality and affective behavior, 8) altered sexual behavior. Damage to the temporal lobe can also have dramatic effects on an individual's personality. Temporal lobe epilepsy can cause perseverative behavior and speech, paranoia, and aggressive rages (Blumer & Benson, 1975).

Nearly all of the symptoms of temporal lobe damage listed by Kolb & Wishaw could be identified as criterion for Autism Disorder. Blumer & Benson's identification of perseverative behaviors in individuals with temporal lobe injury could also be considered a characteristic frequently observed in individuals diagnosed with Autism Disorder. Perseverative behaviors are defined as continual involuntary repetition of a mental act usually exhibited by speech or by some other form of overt behavior (Merriam Websters Medical Dictionary, 2007). A diagnostic criterion for Autism Disorder is stereotyped and repetitive use of language or idiosyncratic language or echolalia (American Psychiatric Association, 2000). Other behaviors, listed as diagnostic criterion for Autism Disorder, that are similar to Kolb & Wishaw's and Blumer & Benson's behavior due to a damaged temporal lobe are: delay in, or total lack of, the development of spoken

language, apparently inflexible adherence to specific, nonfunctional routines or rituals, and lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level (American Psychiatric Association, 2000).

Gendry Meresse et al. (2005), investigated the relationship between hypoperfusion in the brain and its effects on an individual's severity of their autistic symptoms. In the study a brain analysis was performed on forty five children diagnosed with Autism Disorder. Then, each individual's level of hypoperfusion was compared to their score on the Autism Diagnostic Interview-Revised [ADI-R]. The ADI-R is a structured interview conducted with the parents of individuals who have been referred for the evaluation of possible autism or autism spectrum disorders; it measures behavior in the areas of reciprocal social interaction, communication and language, and patterns of behavior (Le Couteur et al., 2003). The researchers found that the more the hypoperfusion that was present, the lower the individual's ADI-R score was; suggesting that temporal hypoperfusion is related to the severity of the individual's autistic behavior (Gendry Meresse et al., 2005).

Self Stimulating Behavior

A common behavior pattern and early detection sign for Autism Disorder are stereotyped and repetitive motor mannerisms (American Psychiatric Association, 2000). One mannerism, which is specifically listed for Autism Disorder is hand flapping (American Psychiatric Association, 2000). At present time self stimulating behavior and sensory irregulation are the only explanations researchers have provided for the behavior. Hand flapping and other patterns of repetitive behavior occur randomly and seem to serve no purpose (Kogel & Wilhelm, 1973).

A clue to why some individuals diagnosed with an ASD display repetitive behaviors, like hand flapping, may lie in a medical condition that many Lyme disease patients experience called paresthesia. Paresthesia is a tingling sensation, often in the fingers or toes (National Institute of Neurological Disorders and Stroke, 2010). The sensation, which happens without warning, is usually painless and described as tingling or numbness, skin crawling, or itching (National Institute of Neurological Disorders and Stroke, 2010). Researchers have identified paresthesia as a neurological and cognitive symptom in children with undiagnosed Lyme disease (Adams et al. 1994, p.185). In a poll conducted by a Lyme disease Physician 73.6% of the patients asked (n=644) claimed that they experience paresthesia. Of those patients 25.1% (n=123) reported that their symptoms resolved after antibiotic therapy and 42.3% (n=207) reported that their symptoms improved with antibiotic therapy (personal communication April 1, 2011). In an interview with a few of the Lyme disease patients who responded yes in the survey the most common responses to the question: “How do you alleviate the symptoms of paresthesia?” were: “Wiggle your fingers,” and “Shake your hand” (personal communication April 5, 2011).

In an interview with the mother of a child named Kyle diagnosed with an ASD and Lyme disease Duncan & Rosner (2008) claimed she said:

Kyle periodically “pumps” his arms with fists downward. When I ask Kyle why he does this, he explained that this was his way of coping with the pins and needles sensations and partial numbness in his arms. I find that Kyle periodically “picks” at his fingers during a relapse (p. 245 -246).

If a significant portion of patients with Lyme disease experience a tingling sensation in their extremities (fingers and toes) and a percentage of children who are diagnosed with an ASD also, unknowingly, are infected with Lyme disease it could explain why so many children diagnosed with an ASD present these restrictive and repetitive behaviors (hand flapping and toe walking).

The self stimulating behavior of one of the children in the study (Child A) was closely monitored before and after antibiotic therapy began. The parents of Child A were concerned with what appeared to be irritation due to sensory dysfunction. Child A became dysregulated when he was in the presence of loud noises, when he touched certain textures, and when anyone tried to hold him. To help with these issues he was enrolled in occupational therapy with a sensory integration emphasis. The father of Child A kept data on escape behavior and self stimulation behavior (hand flapping) to determine if the occupational therapy was effective. Data was collected by carefully observing the child once a week, and recording the number of times he flapped his hands throughout the day. They then took the mean score of those four data collection periods and multiplied that number by seven to obtain the approximate number of times he hand flapped during the month. The parents reported that after three months of occupational therapy they did not see any improvement. They continued the therapy but also added Audio Integration Therapy. Auditory Integration Training [AIT] is an 'alternative' therapy aimed at individuals with hypersensitive hearing; it involves listening to electronically-processed music through headphones (Link, 1997, p. 106). The parents did not observe any changes in Child A when AIT was added. But, when antibiotic therapy began, to treat Child A's Lyme disease, they observed an immediate decrease in self

stimulation behavior and after a month the behavior completely resolved (figure 7). The parents of Child A also reported that he allowed them to give him hugs without displaying an escape behavior, and he didn't become dysregulated in over stimulating environments. In an interview with the pre-school teacher of Child A, she claimed that the data presented by the parents is consistent to what she has observed in the classroom, in regards to self simulation behavior (personal communication December 10, 2010).

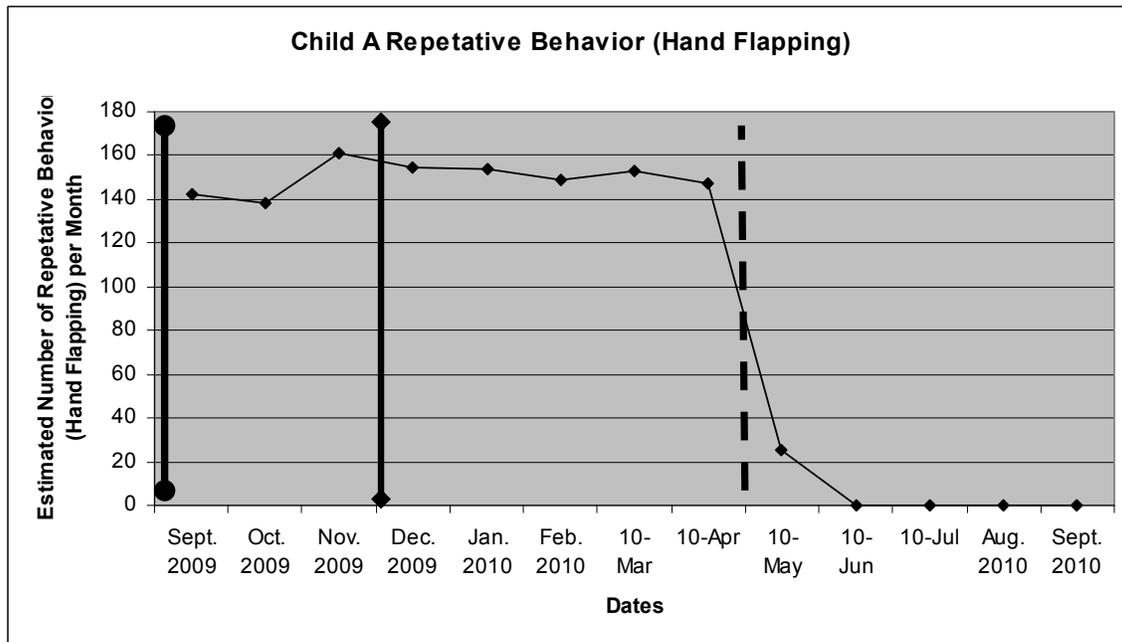


Figure 7 Intervention Key

- Occupational Therapy / Sensory Integration Therapy
- ◆——◆ Audio Integration Therapy
- - - - - Antibiotic Therapy

Controversy in Lyme Disease Treatment and Studies of Children Diagnosed with ASD and Lyme Who Have Improved.

Doctors and researchers have conflicting views on how to treat Lyme disease. In 2006 the Infectious Disease Society of America [IDSA] presented it's guidelines on how Lyme disease should be treated. The panel of fourteen doctors claimed that infected

patients typically need only fourteen to twenty eight days of the antibiotics to effectively treat Lyme disease (Worsmer et al, 2006, p.1106). The panel recognized that some patients continued to present symptoms associated with Lyme disease (cognitive dysfunction, joint and muscle pain, and fatigue), but concluded that post treatment symptoms appear to be more related to the aches and pains of daily living rather than to either Lyme disease or a tick borne coinfection (Worsmer et al, 2006, p.1115).

The other side of the argument on how to treat Lyme disease is presented by International Lyme and Associated Diseases Society [ILADS]. ILADS is a nonprofit, international, multi-disciplinary medical society, dedicated to the diagnosis and appropriate treatment of Lyme and its associated diseases (ILADS, 2009). ILADS released a set of guidelines in 2004 and Dr. Daniel Cameron et al. suggested that the management of chronic Lyme disease must be individualized, since patients will vary according to severity of presentation and antibiotic treatment may take months or years. The parents of all five children in the study chose to treat their child's infection using the more aggressive ILADS guidelines.

The use of antibiotics to treat ASDs is not a recommended treatment option so the amount of literature on this subject is very limited, but there have been a few studies where children diagnosed with an ASD benefited from antibiotics. It should be noted that in these studies the children had not been tested for Lyme disease, but they did present physical symptoms that were similar to the symptoms of Lyme disease.

Dr. Richard Sandler et al (2000, p.425) treated 10 children with "regressive" Autism Disorder with an antibiotic (vancomycin). "Regressive" Autism is an unofficial term describing children who didn't show any signs of an ASD early in life and then

suddenly began to regress. Eight of the ten children scored higher on neurological testing after the use of the drug (Sandler et al 2000, p.435). In a follow up, the progress of those eight children regressed back to baseline levels after the study, and the antibiotics, concluded. This regression of symptoms is a characteristic of chronic Lyme disease; many chronic Lyme patients find that if the Bb bacteria are not eradicated after the initial course of antibiotic their symptoms return (Stricker, 2007, p.149).

In another study twelve children with a diagnosis of Autism Disorder were given an antibiotic (d-Cycloserine) and over an eight week period they were observed using the Aberrant Behavior Checklist [ABC] to determine if the drug had any effects on social withdrawal. The ABC is a symptom checklist for assessing problem behaviors of children and adults with mental retardation at home, in residential facilities, and work training centers (Aman & Singh, 1986). After a two week placebo lead in, all of the children showed reduced social withdrawal and increased social responsiveness on the ABC exam when treated with the antibiotics (Posey, et al, 2004, p.2115).

Case Study of Five Children Diagnosed with an ASD (Or ASD like behavior) and Lyme Disease and Their Measurable Progress Before and After Antibiotics.

The parents of five children diagnosed with an ASD (or ASD like behavior) had their children tested for Lyme disease and all five came back positive. All of the children were prescribed the antibiotic amoxicillin to treat their infection. To determine if the antibiotic had any effect on the children's impairments the parents and the teachers of the children were interviewed using the observation form of the Social Communication, Emotional Regulation, and Transactional Support Model or SCERTS Model. The SCERTS model is a comprehensive, multidisciplinary approach to enhancing

communication and social-emotional abilities of individuals with an ASD and related disabilities (Prizant, Wetherby, Rubin, & Laurent, 2003). Prizant, et al (2003) describes the SCERTS Assessment Process Observation (SAP-O) as:

There are three domains on the SCERTS model – Social Communication, Emotional Regulation, and Transactional Support. Each domain is divided into two core components: Joint Attention and Symbol Use are the core components of the Social Communication domain; Mutual Regulation and Self-Regulation are the core components of the Emotional Regulation domain; Interpersonal Support and Learning Support are the core components of the Transactional Support domain (p. 165).

The SAP-O form was completed by the parents and teachers of the child before they started antibiotics and again six months later. The mean score from the parents and teachers was calculated in an attempt to eliminate any bias and to get more than one perspective on the child's behavior since some children act different at home then they do at school. It should be noted that at the time of publication of this paper all of the children are still taking antibiotics and they did not all start antibiotic therapy at the same time. Some of the children have been observed for over twelve months but the shortest amount of time that one of the children had been administered antibiotics was six months so all of the children had their pre-antibiotic SAP-O score compared to their SAP-O score after six months of antibiotics for consistency reasons.

The two domains that were studied for this project were Social Communication and Emotional Regulation because they are the domains that focus on the child's ability to focus and communicate; two areas where children have shown

improvement in the limited studies conducted with children diagnosed with Lyme disease and an ASD.

Child A

As of 4/15/2011 Child A is three years, ten months old. The parents reported a normal child birth with no complications. They also reported fairly typical development for the first eighteen months of life. Child A sat up at six months, walked at fourteen months, said his first word at twelve months, and had good grip and fine motor skills. The parents of Child A did notice a few peculiar behaviors early in his life like rocking to sleep, hand flapping, walking on toes, and spinning the wheels of toy cars repeatedly. Child A developed verbal communication from age twelve months to eighteen months when he independently spoke fifteen words. At eighteen months the parents reported a difference in his demeanor. They reported that Child A's language regressed from fifteen words to just a few words, that he frequently repeated, to no speaking at all when he was twenty months old. The parents also reported that he frequently became dysregulated, most noticeably when his routine changed (personal communication, March 1, 2011).

After the initial regression of spoken words Child A did not speak for fourteen months. In that time period the parents had him diagnosed by a team of professionals at the University of Iowa. The doctors gave Child A a diagnosis of PDD-NOS at age twenty six months. Following the suggestions from the team at the University the parents had him enrolled in Early Intervention Services. Child A received in home instruction from a trained professional who used the Treatment and Education of Autistic and Communication related handicapped Children, or TEACHH, approach.

The parents of Child A were very concerned about his regression in verbal communication so they helped the professional who worked with their son design a program that focused on communication. They used the Picture Exchange Communication System [PECS], visual schedules, and highly structured work sessions to try to elicit verbal responses. In a further attempt to promote verbal communication Child A was presented with vocabulary picture cards that had the ninety five nouns listed on the Dolch most frequently used noun word list. The picture card was held close to the teacher's mouth and the name of the noun on the card was said while Child A sat across from the table. The ninety five cards were presented to Child A nearly every day for eight months, but Child A did not speak any words during the work sessions or any other time in that eight month period (personal communication March 1, 2011).

In April of 2010 Child A was diagnosed with Lyme disease after his mother had a positive blood test and the family's doctor suggested getting him tested. Child A's blood was evaluated using the Western Blot [WB] method. The Western Blot looks for antibodies that the patient's blood produces and reacts with the Bb antigens (Brenner, 2011). Child A tested positive for bands 23, 31, 34, 39, 41, 45, and 83 on his WB IgM. On his WB IgG he tested positive for bands 23, 41, and 83. Child A also tested positive for Babesiosis and was vitamin D deficient. The Centers for Disease Control (2010d) defines Babesiosis as:

A disease caused by microscopic parasites that infect red blood cells that can cause low blood pressure, anemia, blood clots, organ failure, and flu-like symptoms, such as fever, chills, sweats, headache, body aches, loss of appetite,

nausea, or fatigue . Babesiosis is transmitted in nature by Ixodes scapularis ticks, the same ticks that spread Lyme disease.

Child A began taking the antibiotic amoxicillin three times a day in April of 2010.

The parents and teachers of Child A reported that they observed an immediate change in him after he began the antibiotic. After fourteen months of not speaking any words (Age twenty months to thirty four months) Child A spoke his first word, post regression, after ten days of being on the antibiotic. The teachers and parents continued to present the vocabulary picture cards with the ninety five most frequently used sight nouns from the Dolch word list and they reported a steady increase in Child A’s verbal identification. The parents and teachers reported that they would sit across the table from Child A and present the card to him and ask “What’s this?” They would then wait five seconds and listen for a verbal response. If he did not give them a response they would say the name of the noun on the card and move on. Five months later Child A could verbally identify all ninety five vocabulary cards (Figure 8).

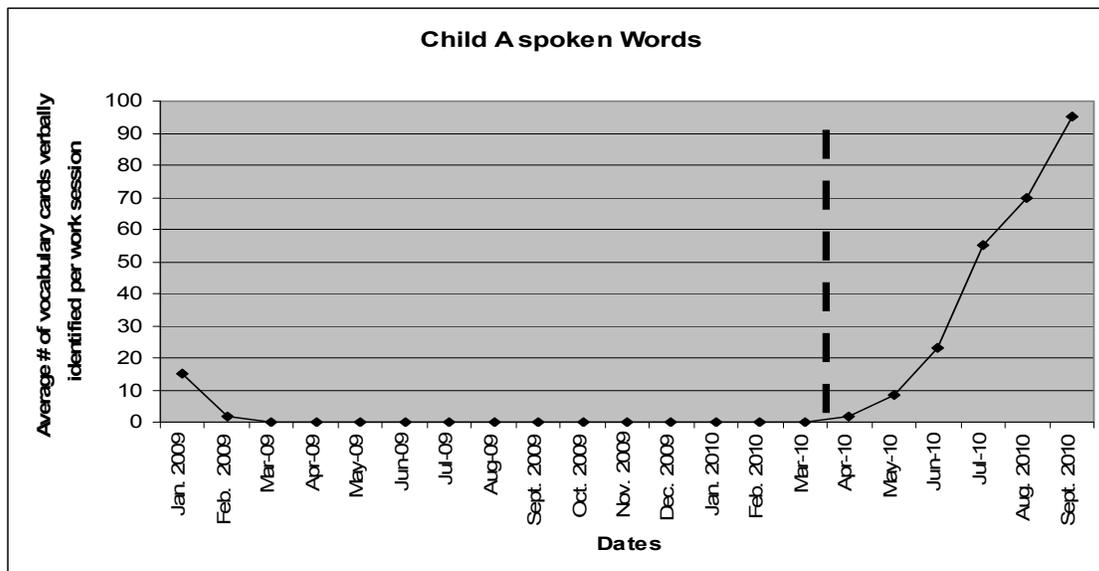


Figure 8 – Parents and teachers collected data of the number of times Child A verbally identified a picture vocabulary card. The data point for each month represents the average for each work session (total correct responses for the month / the number of work sessions). The vertical dotted line represents when antibiotic therapy began.

During the five month period both the parents and teachers claimed that the only intervention that changed in Child A's routine was the antibiotics, he still received Early Intervention services and the team used the same TEACHH approach that they did before he began treatment for his Lyme disease. Currently Child A can say almost any word he is asked to repeat verbally, but both parents and teachers report that he uses a lot of echolalia, the repeating the same word or phrase over and over, and delayed echolalia, describing something that happened in the past and is not in context. The parents and teachers did report that since Child A began antibiotic therapy his dysregulation has significantly decreased and he verbally requests his wants and needs.

Verbal communication is not the only area where the teachers and parents of Child A observed improvement after antibiotic therapy began. Child A demonstrated more joint attention with both adults and peers after he began treatment of his Lyme disease. Joint attention is the process by which one alerts another to a stimulus via nonverbal means, such as gazing or pointing (Center for Early Literacy Learning, 2009). Studies have shown that problems with joint attention are associated with developmental processes that are important in the etiology of autism (Mundy et al. 2009). Both teachers and parents reported that Child A gave good eye contact before his regression period, but his ability to focus on tasks, share positive emotions with parents, and sustain eye contact decreased during the time his verbal communication diminished. Parents and teachers noticed that Child A would become fixated on certain television shows or games that made music and lit up. He would become excited when these antecedents were presented to him, but he would not share his excitement with others; instead he would smile, hand

flap, and ignore everyone around him. The parents of Child A were very concerned with this behavior so the teachers and parents created an intervention where they presented Child A with an antecedent that provoked a pleasurable response (A preferred television show, a toy that lit up and played music, taking him to see the river flow over the local dam, or taking him to the park and letting him swing or slide), when Child A began to self stimulate they attempted to join by clapping, calling his name, and trying to share eye contact with him. The parents and teachers collected data on their attempts (n=20 attempts per month) and reported that during the regression period Child A very rarely shared any joint attention with them and frequently became dysregulated when they persisted in intruding in his self stimulation. After antibiotic therapy began, the parents and teachers noticed a change in Child A's ability to achieve joint attention with adults and peers. He transitioned from a self stimulation behavior, when he was presented with the antecedents, to seeking out others to share his enjoyment of the experience. Parents and teachers recorded joint attention when Child A was presented with one of the antecedents that stimulated a pleasurable response and he gave the adult eye contact and/or he looked in the direction of the adult and said the name of the antecedent (figure 8).

In another attempt to increase joint attention parents and teachers presented Child A with a picture book, pointed to various pictures in the book and observed his eye gaze to determine if he was engaged in joint attention. During the regression period Child A's gaze very rarely followed the point of the teacher and he only randomly pointed to the picture that the teacher or parent requested (personal communication, February, 10 2011).

After antibiotic therapy began Child A notably increased his ability to follow the point of his teacher and identify items in the picture books presented to him (Figure 9).

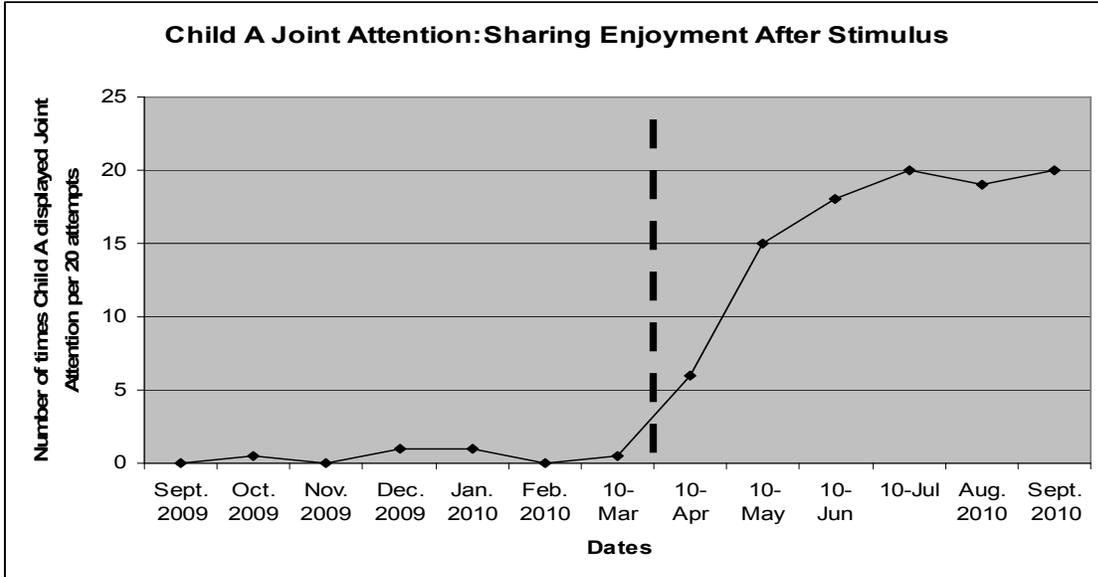


Figure 8 – Parents and teachers observed how many times Child A shifted his eye contact from a stimulus to a social partner. Data was recorded twenty times per month. The vertical dotted line represents when antibiotic therapy began.

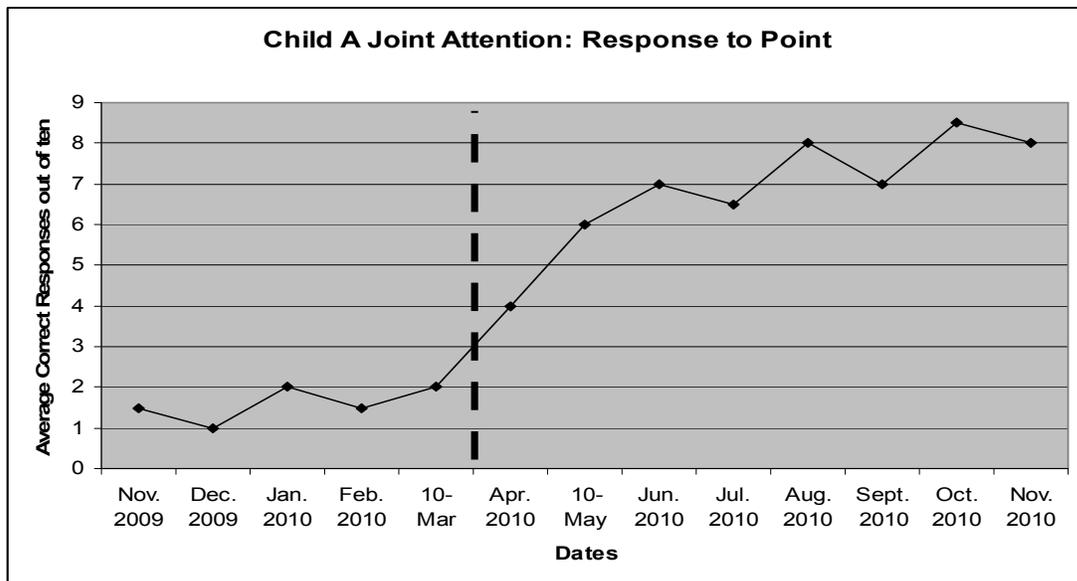


Figure 9 – Teachers and parents showed Child A a picture book and asked him to identify ten items in the book. During the pre-antibiotic period they counted a response to point when his eye gaze followed the teachers or parents point. After antibiotic therapy began teachers and parents counted a response to point when Child A’s eye gaze followed their point and when he independently identified the item after a verbal prompt. The data points are the average correct responses per month (Total correct responses / total work sessions). The vertical dotted line represents when antibiotic therapy began.

The parents and teachers of Child A were interviewed after they observed Child A in a typical school and home setting using the SAP-O form. The group agreed that Child A belonged in the Language Partner stage since he was able to use at least one hundred different words or phrases regularly, but not always with communicative intent. The group met again six months later, observed Child A again, and filled out the SAO-O questionnaire a second time to establish a comparative score to his pre-antibiotic data. Both teachers and parents noted that the only intervention that changed during the six month period was the antibiotics. The teachers continued to use the TEACHH method and the parents continued their in home interventions the same as before Child A started antibiotics. Everyone involved in the assessment process agreed that Child A showed improvement in all areas assessed and he showed the largest gain in joint attention (figure 10). At the time of publication of this paper Child A is still taking antibiotics. Teachers and parents of Child A reported that he continues to show positive progress, but he still meets the criteria for an ASD.

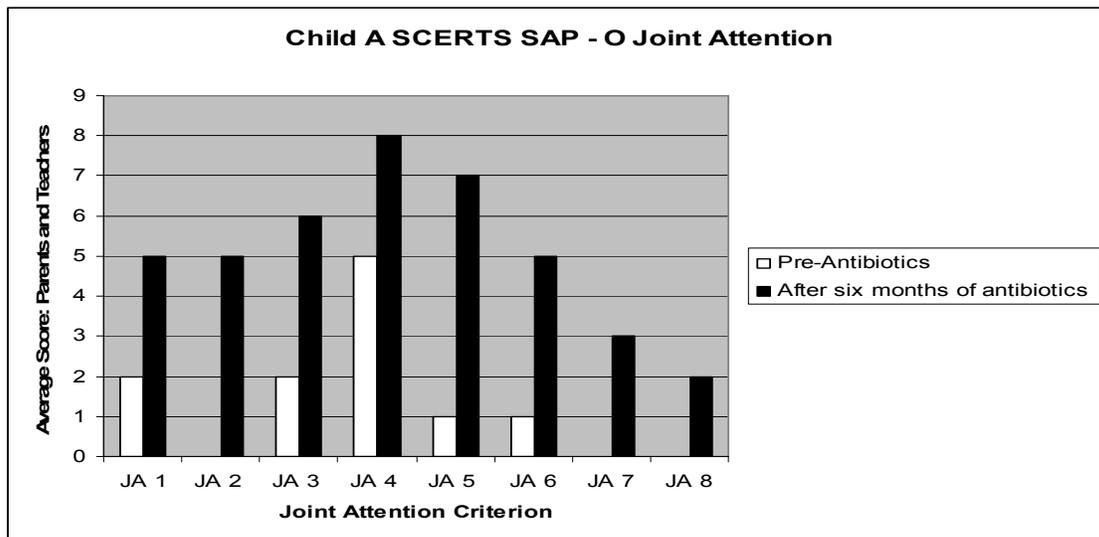


Figure 10 –Key: JA 1 – Engages in reciprocal interaction (total possible 6 points) JA 2 Shares Attention (total possible 8 points) JA 3 – Shares Emotion (total possible 8 points) JA 4 –Shares intentions to regulate the behavior of others (total possible 8 points) JA 5 Shares Intentions for Social Interaction (total possible 14 points) JA 6 Shares Intentions for Joint Attention (total possible 6 points) JA 7 Persists and Repairs Communication Breakdowns (total possible 6 points) JA 8 Shares Experiences in Reciprocal Interaction (total possible 6 points).

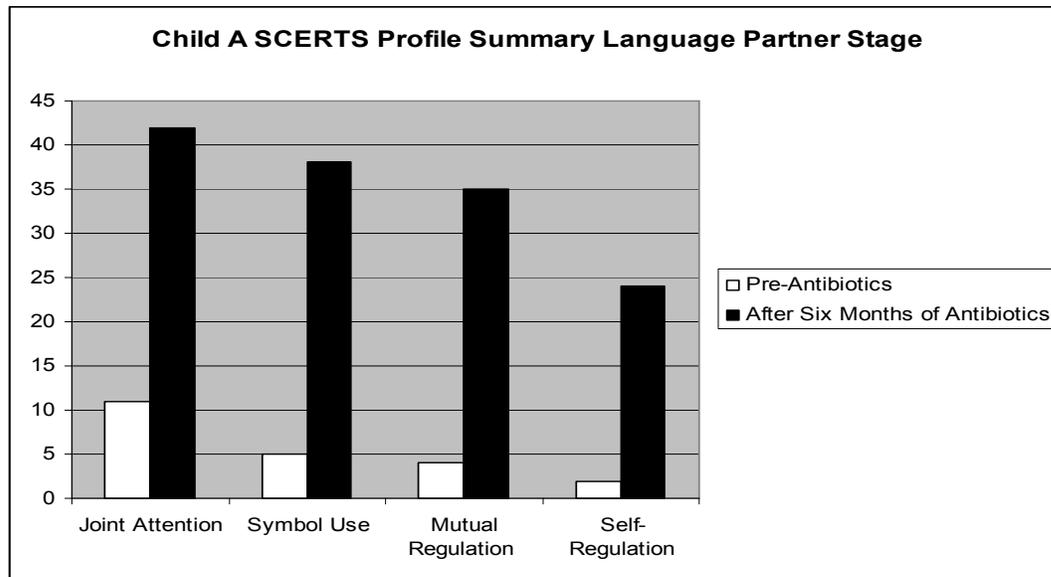


Figure 11-SCERTS Profile Summary scores for Child A before antibiotic therapy began and six months into antibiotic therapy.

Child B

As of 4/15/2011 Child B is four years and six months old. The parents reported a normal child birth with no complications. Early in life Child B achieved many typical developmental milestones; he smiled and gave eye contact at one month, sat up at four months, crawled at eight months, and walked at eight months. The parents became concerned about Child B's development when he began toe walking and hand flapping, refused to eat certain foods, displayed no signs of pretend play, stopped interacting with peers, and had not displayed any form of verbal communication around the age of eighteen months. At age thirty months Child B was formally diagnosed with PDD-NOS

at the University of Iowa. He began special education pre-school shortly after he was diagnosed. His teachers use an approach based around the TEACCH method (personal communication January 18, 2011).

In July 2010 Child B tested positive for Lyme disease. His WB IgM came back positive for band 39 and 41 and his WB IgG came back positive for band 39 and 41. His doctor prescribed the antibiotic amoxicillin, and he has been taking it every day since his diagnosis.

The parents of child B were very concerned that he did not follow instructions and that he was not engaged in activities with adults and peers. They asked Child B's teachers to design a work session to help him follow one word prompts with the goal of him eventually completing independent activities. One of the work sessions the teachers designed was to have Child B sit at his table and point to various items around the room when he was prompted verbally. The teacher would say "Child B look at the lamp," they would then wait five seconds and observe if he would look or point at the item. If he did not respond after five seconds they gave him a second verbal prompt and pointed to the item themselves. A positive response was credited when Child B's eye gaze followed the point or when he pointed to the object. The teachers would repeat this activity with five items per work session. Child B's deficit in joint attention caused him to produce very few desired responses, but after he began antibiotic therapy his teachers reported a desired response over ninety percent of the time (Figure 12).

Another area of concern for the parents of Child B was his inability to share emotions with adults and his peers. When presented with a pleasurable stimulus Child B would engage in self stimulating behavior like hand flapping and jumping but his focus

would stay on the stimulus. Child B's teachers designed a work session where they presented him with a stimulus that elicited a positive response and then they tried to engage his attention by calling his name, and clapping. Before antibiotic therapy began the teachers reported almost no joint attention from Child B after the stimulus was presented, but after he began taking antibiotics they reported a positive response almost ninety percent of the time (Figure 13)

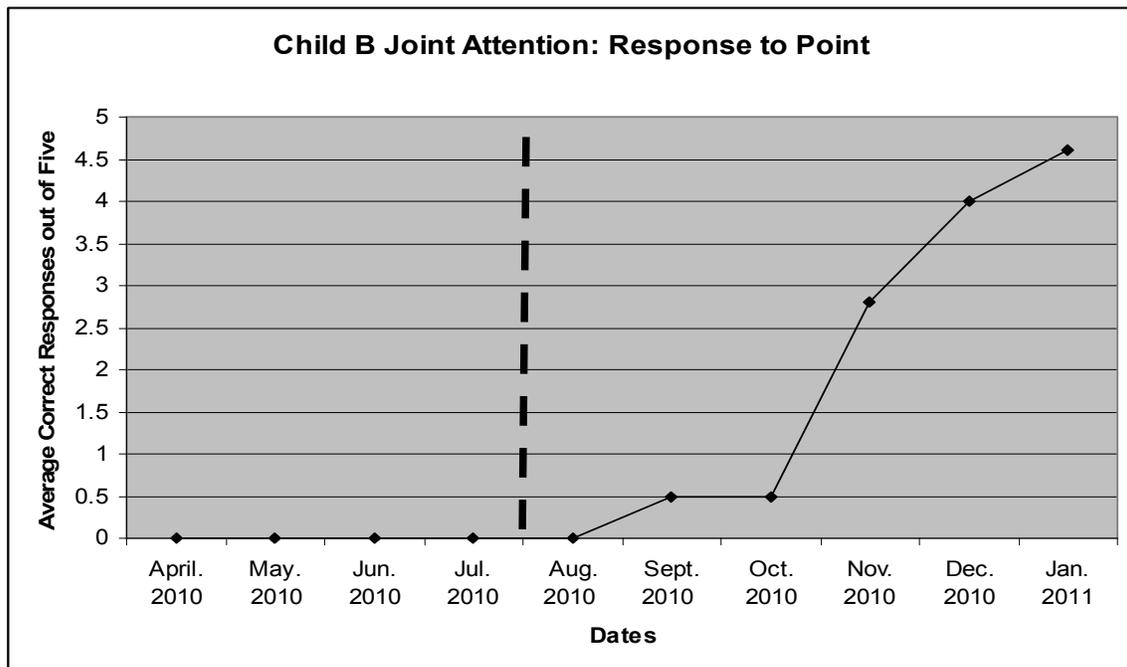


Figure 12 – Teachers pointed to items in the classroom and asked Child B to “look” at the item. When Child B’s eye gaze followed the point it was recorded as a correct response. During each work session Child B was asked to follow the teacher’s point five times. The data points are the average correct responses per work session per month (total correct responses / number of work sessions). The vertical dotted line represents when antibiotic therapy began.

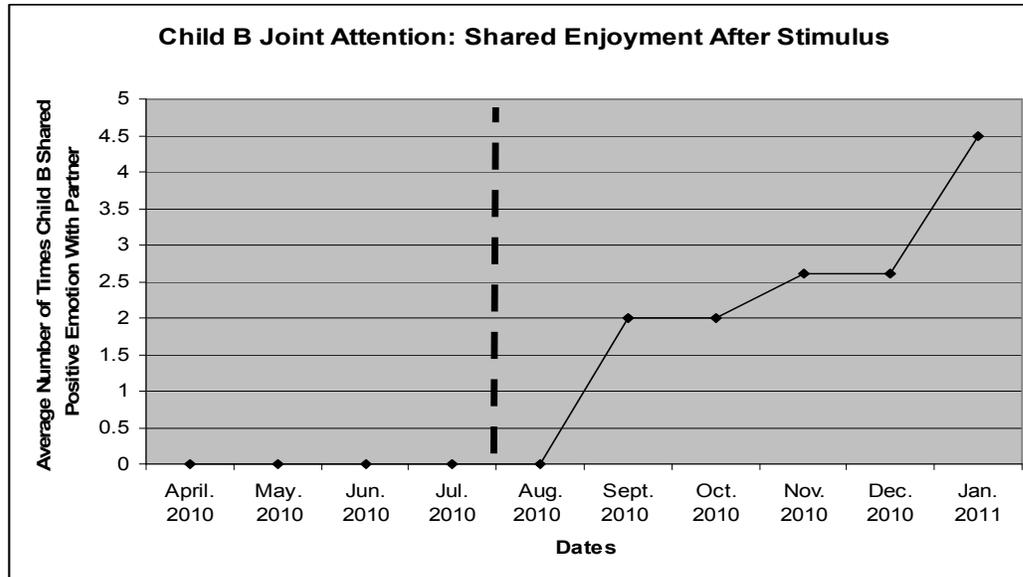


Figure 13 - Teachers observed how many times Child B shifted his eye contact from a stimulus to a social partner. In each work session Child B was presented with five pleasurable stimulus situations. Data points are the average number of times Child B shifted his eye contact per work session per month (total desired outcomes / number of work sessions). The vertical dotted line represents when antibiotic therapy began.

The parents and teachers of Child B were interviewed after they observed Child B in a typical school and home setting using the SAP-O form. The group agreed that Child B belonged in the Social Partner stage because he has not developed verbal communication. The group met again six months later, observed Child B again, and filled out the SAO-O questionnaire a second time to establish a comparative score to his pre-antibiotic data. Both teachers and parents noted that the only intervention that changed during the six month period was the antibiotics. The teachers continued to use the TEACHH method and the parents continued their in home interventions the same as before Child B started antibiotics. Everyone involved in the assessment process agreed that Child B showed improvement in all areas assessed. Parents and teachers could only provide anecdotal data, but they claimed that Child B's hand flapping and toe walking has almost completely resolved. At the time of publication of this paper Child B is still

taking antibiotics. Teachers and parents of Child B reported that he continues to show positive progress, but he still meets the criteria for an ASD.

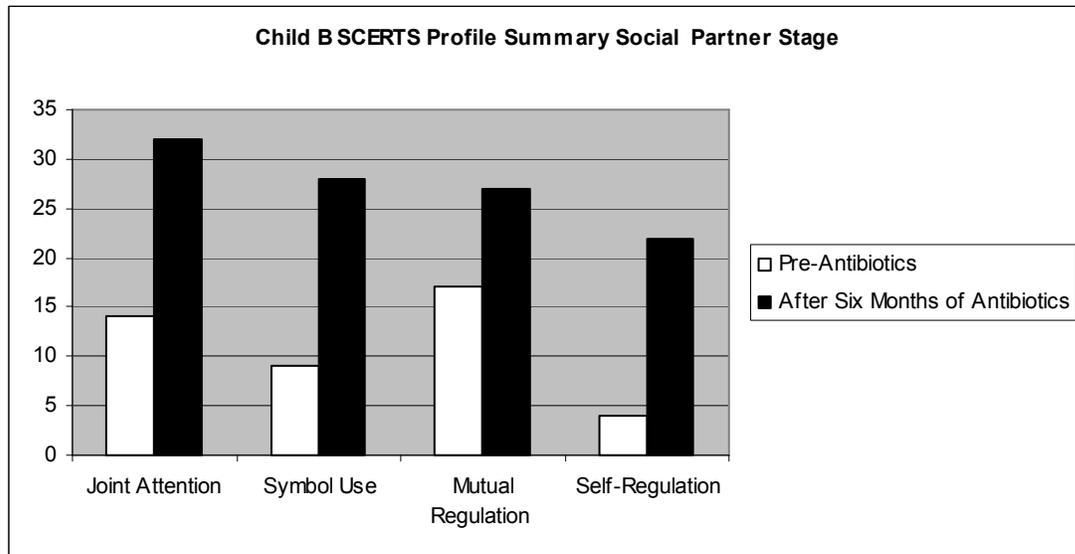


Figure 14 – SCERTS Profile Summary scores for Child B before antibiotic therapy began and six months into antibiotic therapy.

Child C

As of 4/15/2011 Child C is nine years and nine months old. The parents of Child C reported a normal child birth with no complications. They claimed that he met all of his developmental milestones, but at age twenty four months they noticed strange patterns in his speech. During that same time they noticed that Child C began to regress socially, commonly displayed restrictive and repetitive behaviors (hand flapping and toe walking) and he became dysregulated frequently. Child C was diagnosed with an ASD (PDD-NOS) at the University of Iowa in February 2005 when he was four years and seven months old (personal communication August 5, 2010).

Since kindergarten, Child C has attended school with his neurotypical peers. He has a full time aid in the classroom, but his teacher reported that he performs at an above average level with very few modifications.

Child C tested positive for Lyme disease in November 2010. On his WB IgM he tested positive for band 41 and on his WB IgG he tested positive for bands 18, 31, 34, 39,41, 58. His doctor prescribed the antibiotic amoxicillin and he has been taking it daily since the diagnosis.

Parents and teachers reported that one of the features that make Child C stand out from his neurotypical peers is his persistent toe walking and skipping when the class walks in the hallway. The teachers collaborated and created a Power Card Strategy in an attempt to make Child C think about his actions and possibly reduce the behavior. Power Card Strategy involves including special interests with visual aids to teach and reinforce academic, behavioral and social skills to individuals with Autism Spectrum Disorders (Miles et al., 2006). Teachers created a card with a character from a movie that is of high interest to Child C and typed a message from the character reminding him to walk like his friends and not skip in the hallway. Teachers began the Power Card Strategy in October 2010 and recorded data to determine if the strategy was effective. When Child C lined up to transition to other classes he was presented with his Power Card and was allowed to carry it with him while he walked. While walking in the hallway his teacher monitored his gait and recorded if he walked on his toes or skipped. If Child C walked to his destination similar to his neurotypical peers the teacher recorded a desired response. A week of baseline data was collected, then data was recorded daily and every week it was compared to the baseline data to determine if the Power Card Strategy was effective.

After an initial increase in desired response Child C regressed to baseline levels (figure 15), but after antibiotic therapy began the Child C's teacher reported an increase in desired responses (walking without toe walking or skipping). The Power Card Strategy continued during antibiotic therapy and Child C's teacher reported that they did not attempt any other intervention to address toe walking and skipping during this time.

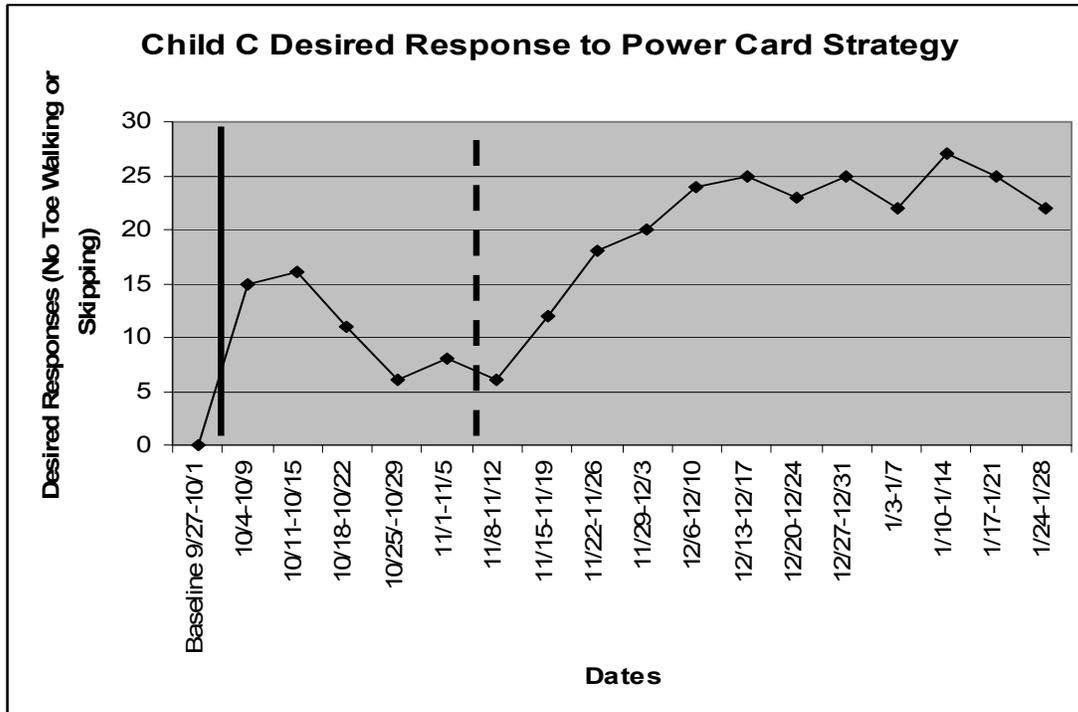


Figure 15 – Number of Child C's desired responses when walking in the hallway during school. Child C was given credit for a desired response if he walked from his classroom to the requested destination without walking on his toes or skipping. Data was collected daily and was cut off at thirty observations per week for consistency. The solid vertical line indicates when the Power Card Strategy began. The dotted vertical line represents when antibiotic therapy began. Note – Power Card Strategy continued during antibiotic therapy.

Another noticeable difference in Child C and his neurotypical peers is his inability to sustain eye contact when speaking to another individual. Child C's teachers reported that he can give eye contact if he is listening to you and participates in classroom discussions but he has a difficult time giving an audience member eye contact when talking to them (personal communication March 19, 2011). Previous data collected in this study showed that joint attention and eye contact increased with Child A and B when they started antibiotics, so similar data was collected with Child C. When Child C's blood test came back positive for Lyme disease his parents had to wait three weeks before they could get an appointment with their doctor and start antibiotics. During this three week period baseline data was established to determine how many times he established eye contact with his teacher when he gave a verbal response in the classroom. The teacher recorded twenty trials during the three week baseline period where he called on Child C to answer a question in class and Child C gave a verbal response. Each time Child C established eye contact with the teacher when he answered the question he was given credit for a desired response. During the baseline period Child C gave very few desired responses, but after antibiotic therapy began his number of desired responses increased (figure 16). Parents and teachers also reported that Child C has been much more regulated at home and school. His teacher reported that he has only had to be removed from his classroom once this school year where last year he was removed frequently when an expected routine unexpectedly changed. Child C has been more social with peers, more attuned to other people's interests, and has had an overall more happy and

pleasant demeanor since he started antibiotic therapy to treat his Lyme disease (Personal Communication April 10, 2011).

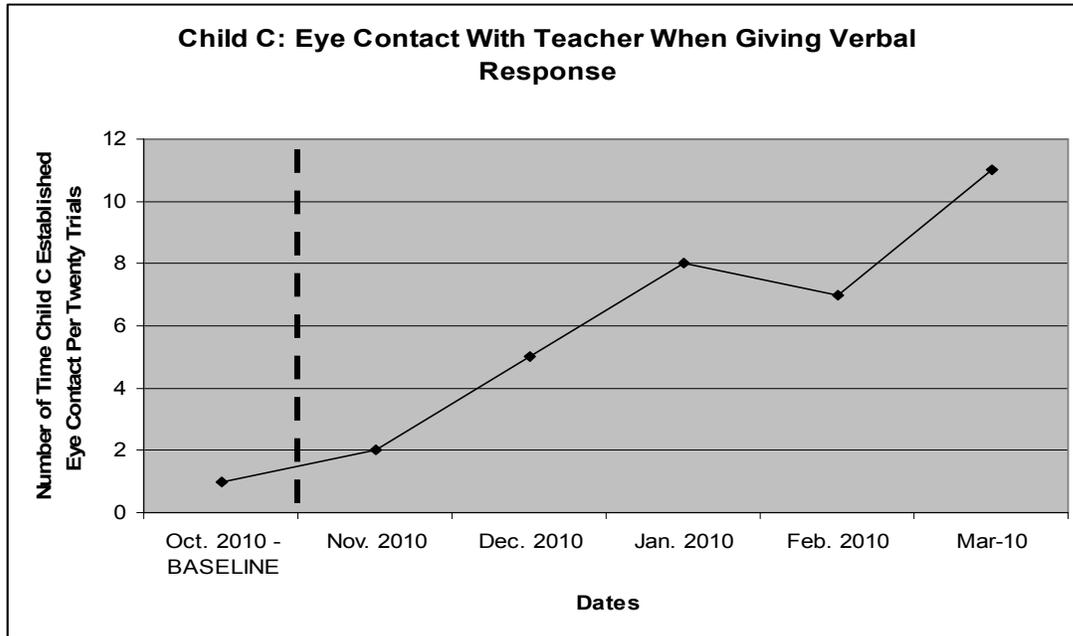


Figure 16 – Number of times Child C gave his teacher eye contact when he responded verbally to a question in his classroom. Twenty trials were collected during the baseline period so for consistency twenty trials were collected during the following months. The vertical dotted line represents when antibiotic therapy began.

The parents and teachers of Child C were interviewed after they observed Child C in a typical school and home setting using the SAP-O form. The group agreed that Child C belonged in the Conversational Partner stage since he was able to use at least one hundred different words or phrases regularly, and with communicative intent. The group met again six months later, observed Child C again, and filled out the SAP-O questionnaire a second time to establish a comparative score to his pre-antibiotic data. Both teachers and parents noted that the only intervention that changed during the six month period was the antibiotics. Everyone involved in the assessment process agreed that Child C showed improvement in all areas assessed (figure 17). At the time of publication of this paper Child C is still taking antibiotics. Teachers and parents of Child

C reported that he continues to show positive progress, but he still meets the criteria for an ASD.

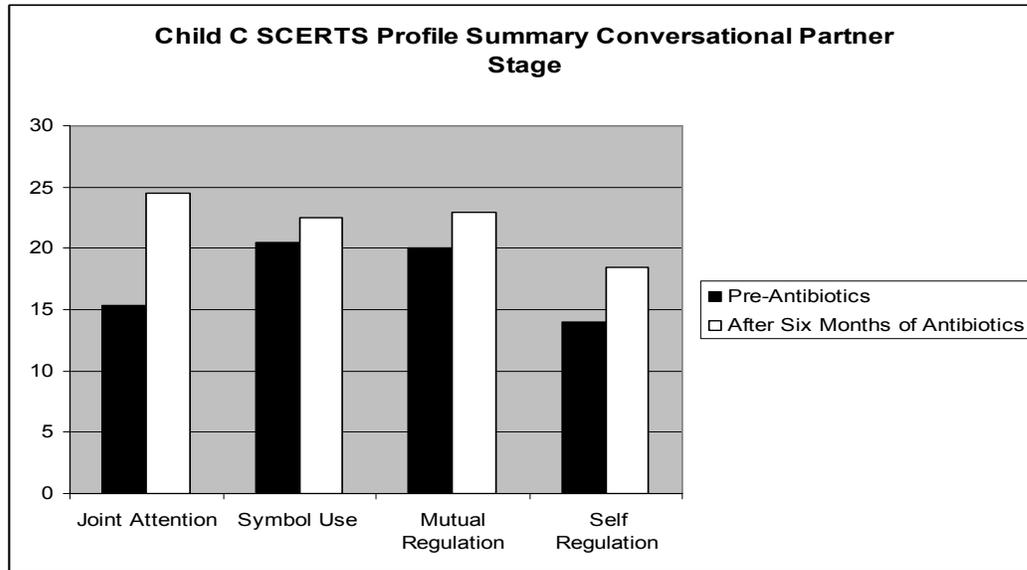


Figure 17 - SCERTS Profile Summary scores for Child C before antibiotic therapy began and six months into antibiotic therapy.

Child D

As of 4/15/2011 Child D is seven years old. The parents of Child D reported no complications with child birth and claimed that he achieved all of his early developmental milestones. Child D sat up at four months, crawled at seven months, walked at twelve months, and said a few words at eighteen months. The parents of Child D first became concerned with his development when he was eighteen months old because he was not talking and he has an older sibling who also has a diagnosis of an ASD. At eighteen months Child D qualified for early intervention services, but was not formally diagnosed with an ASD until the age of three. At that time he began special education pre-school full time.

In October 2010 Child D was diagnosed with Lyme disease. On his WB IgM he tested positive for bands 31, 34, 41 and 45 and on his WB IgG he tested positive for 31 and 41. He began taking the antibiotic amoxicillin daily (personal communication February 16, 2011). Child D also tested positive for Babesiosis.

Interviews with Child D's parents were completed over the phone and the SAP – O form was filled out by his teachers and mailed back before and after antibiotic therapy began. It was agreed upon that Child D belonged in the Language Partner Stage because he used between fifty and eighty words but did not use those words with communicative intent consistently. A follow up interview was done six months later, both parents and teachers filled out the SAP – O form and mailed it back after observing his behaviors and noting any changes. The two scores were averaged to get a perspective of Child D's behavior at home and school. Everyone who assessed Child D agreed that he improved in all areas assessed on the SAP-O form during the six month period (Figure 18). The parents of Child D also reported an increase in verbal communication, a decrease in the repetitive behaviors (humming), and an increase in interactions with siblings and peers. At the time of publication of this paper Child D was still taking antibiotics. He continues to show positive progress but still meets the criteria for an ASD.

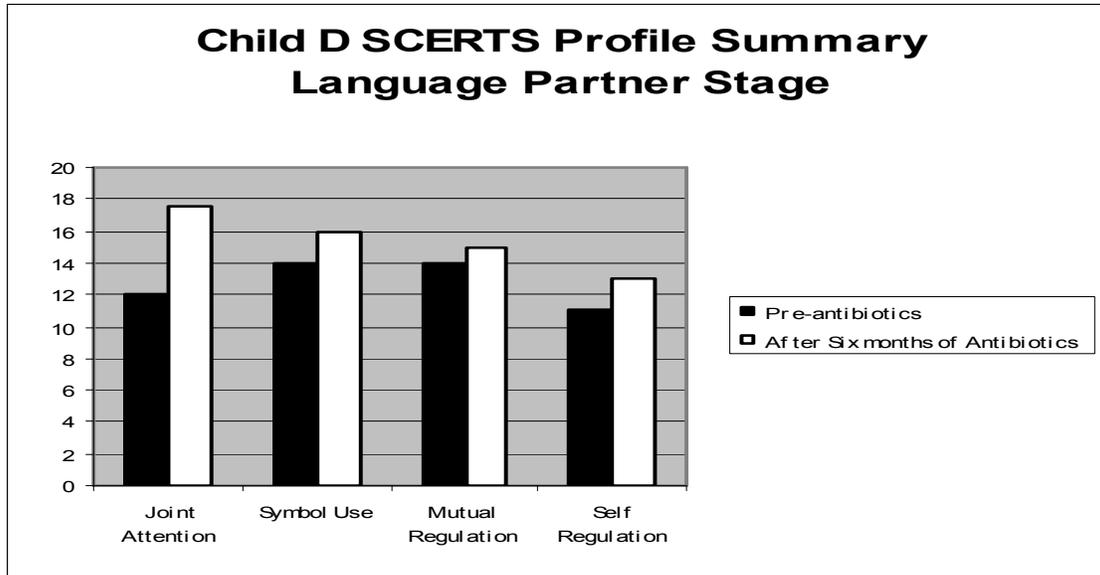


Figure 18 - SCERTS Profile Summary scores for Child D before antibiotic therapy began and six months into antibiotic therapy.

Child E

As of 4/15/2011 Child E is four years six months old. The parents of Child E reported a normal child birth with no complications. He met all of his developmental milestones and showed no signs of any mental disorders. Unlike the other children in the study the parents of Child E can recall when he was infected with Lyme disease. In an interview with the parents of Child E they claimed that the entire family took a vacation to Maine when he was nine months old. After the trip all five members of the family became very ill. Their family doctor tested the family for a variety of illnesses and infections, but did not test the family for Lyme disease or other tick borne diseases. According to the parents of Child E he did not think it was necessary to test the family when they inquired about potentially having Lyme disease. After months of going untreated and declining mental and physical health, the family found a doctor who tested them for Lyme disease and all five members of the family came back positive. During the

regression period Child E rejected breastfeeding, did not want to be touched, became dysregulated in the presence of bright lights and loud sounds, displayed repetitive and restrictive behaviors (spinning), and his sleep patterns changed. All of these symptoms were not present before the family went on the trip to Maine (personal communication February 5, 2011).

During that same period the two older siblings of Child E also displayed physical and mental regression. According to the parents of Child E his four year old brother, who showed no signs of cognitive impairment before being infected with Lyme disease, lost bladder control, displayed repetitive behaviors (hand flapping and finger wagging), and he stopped giving his parents eye contact. His parents had a SPECT scan performed and according to documents acquired from the family, Child E's brother displayed hypoperfusion in his right temporal lobe, frontal lobe, and left occipital lobe. Child E's older sister also had a SPECT scan performed and hypoperfusion was present in her right temporal lobe, and right occipital lobe. During the months when the family went untreated the parents reported that Child E's sister lost her previously acquired ability to speak German, had difficulty finishing school work, and she complained of fatigue and joint pain. According to the family Child E's siblings were prescribed the antibiotic amoxicillin daily for nearly four years and during that time their mental and physical symptoms improved. Child E's older brother no longer displayed repetitive behaviors, regained bladder control, and began to give eye contact with his parents and peers again. Child E's sister reacquired her ability to speak German, and her grade point average increased and is now in a gifted and talented program (personal communication April 10, 2011).

Child E was never officially diagnosed for an ASD because his parents were convinced his developmental issues were caused by his infection. But, they claimed that there is a chance he would have been diagnosed with an ASD because he displayed: deficits in developing and maintaining relationships appropriate to developmental level, echolalia, repetitive motor movements, an adherence to routine, and hypersensitivity to light. When Child E was eighteen months old he was diagnosed with Lyme disease. His WB IgM was positive for bands 23,34,39,41 and his WB IgG was positive for bands 39,41, and 58. He also tested positive for Babesiosis and Bartonellosis. Bartonellosis is a disease caused by the bacteria *Bartonella henselae*, it can cause fever, fatigue, headaches, malaise, and lost of appetite (National Institute of Health, 2009).

Child E's parents reported that at eighteen months he had not displayed any verbal communication, but after two weeks of being on antibiotics he spoke his first word. Child E continued antibiotic therapy for nearly four years and according to his teachers he attends a general education classroom setting with his neurotypical developing peers with no aid. They also reported that he shows little to no signs of an ASD.

Interviews with Child E's parents were completed over the phone. Since Child E has been on antibiotics for a longer period than the other children in the study, his parents filled out the SAP-O form out based on his behaviors before he started antibiotics and after he completed therapy. Note – only Child E's mother completed the SAP-O form for his before antibiotic therapy because Child E was only eighteen months old when he started antibiotics and had not been enrolled in any type of school or daycare program. Child E's mother agreed that he belonged in the Social Partner Stage because he had not

acquired verbal communication at eighteen months. Child E’s mother filled out the SAP-O form to assess his post-antibiotic behavior four years later. She agreed that Child E showed incredible growth in all areas assessed by the SAP-O form (figure 19). When asked to score Child E’s post-antibiotic behavior the parents agreed that Child E no longer belonged in the Social partner Stage because he can now use over one hundred words with communicative intent. Child E’s scores were not included with the other four children when the mean score for the study group was calculated because his antibiotic therapy was much longer (6 months vs. 4 years).

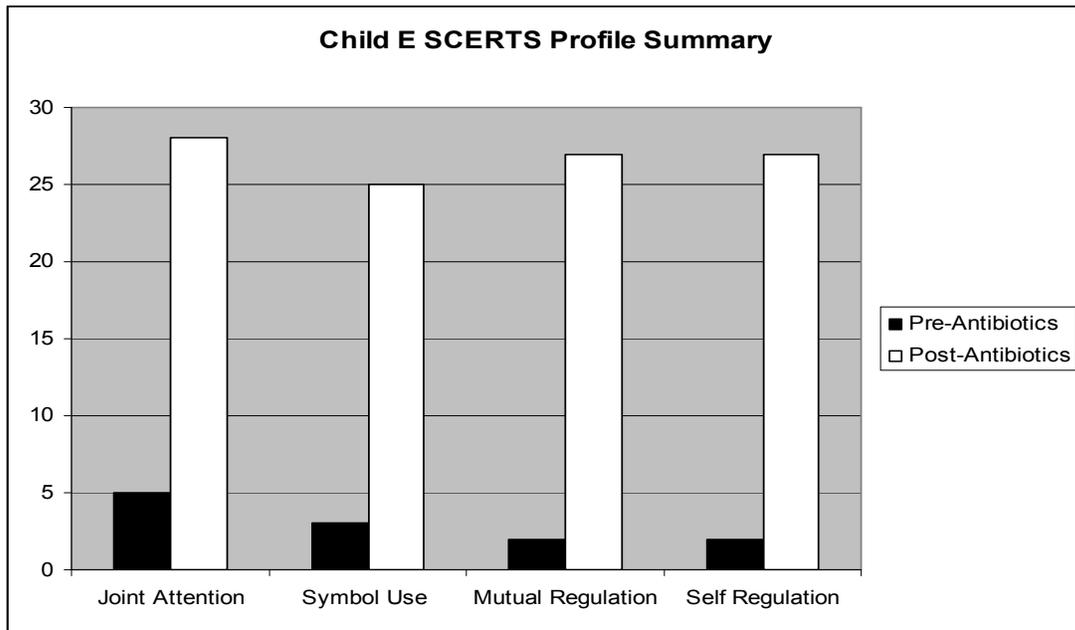


Figure 19 - SCERTS Profile Summary scores for Child E before antibiotic therapy began and after antibiotic therapy concluded.

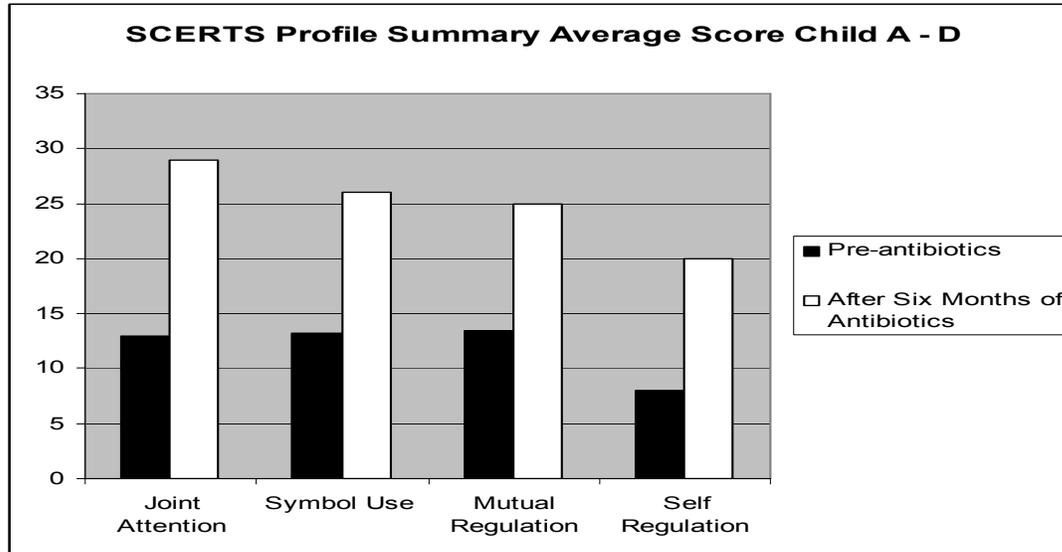


Figure 20 - The average SCERTS profile summary score for Child A – D before they started antibiotics and six months later. Child E’s scores were not included because his pre-antibiotic score was compared to his score four years later after he completed antibiotic therapy.

Conclusions

More research needs to be conducted to determine if there is a correlation between Lyme disease and Autism Spectrum Disorders. If enough evidence can be presented to back the claim that there is a connection between the disease and the disorder it could lead to more medical research that could determine if Lyme disease is a causative factor for some children diagnosed with an ASD.

All five children in the study showed improvement when assessed using the SAP-O form of the SCERTS model. The area that parents and teachers observed the most improvement was in joint attention with an average increase of 15.5 points after antibiotic therapy (figure 20). At the time of publication four of the five children in the study were still taking antibiotics, so it is not possible to determine if the gains that the children have experienced will regress once they stop taking antibiotics.

A characteristic that four of the children in the study share are their initial diagnosis of PDD-NOS. Co-morbid disorders occur very frequently in children diagnosed

with PDD-NOS (Bruin et al, 2006, p.877). Many of these disorders that occur co-morbid with PDD-NOS have symptoms similar to the neurological impairments that Lyme disease has been known to present. American Psychiatric Association (2000) defines PDD-NOS as:

This category should be used when there is a severe and pervasive impairment in the development of reciprocal social interaction associated with impairment in either verbal and nonverbal communication skills, or with the presence of stereotyped behavior, interests, and activities, but the criteria are not met for a specific Pervasive Developmental Disorder, Schizophrenia, Schizotypal Personality Disorder, or Avoidant Personality Disorder.

Autism Speaks (2011) defines PDD-NOS as:

Pervasive Developmental Disorder - Not Otherwise Specified, or PDD-NOS, for short, is a condition on the spectrum that has those with it exhibiting some, but not all, of the symptoms associated with classic autism. That can include difficulty socializing with others, repetitive behaviors, and heightened sensitivities to certain stimuli.

Lyme disease has been called “The Great Imitator” because infected individuals often present neurological and physical symptoms that are similar to other disorders, including Autism Spectrum Disorders (Bransfeld, 2007, p.29). More research needs to be conducted to determine if a percentage of children diagnosed with PDD-NOS are actually presenting the neurological symptoms of Lyme disease and not an atypical form of autism.

Early screening for Lyme disease could potentially be an important factor in determining how well an individual will recover from the infection. The three youngest children in the study (Child A, B, and E) showed the most positive progress on their SAP-O form during the period they were on antibiotics. If the family's doctors are correct with their hypothesis that the mother transmitted the Bb bacteria congenitally then Child C and D could have been infected for a longer period of time and it could be the reason they did not show as much progress as Child A, B and E. The parents of Child E began antibiotic therapy at eighteen months, the youngest age of any of the children in the study, and he showed the most amount of progress after antibiotic therapy concluded.

Helt et al. (2011) reviewed evidence that between 3% and 25% of children reportedly lose their ASD diagnosis and enter the normal range of cognitive, adaptive and social skills. Earlier age of diagnosis and treatment, and a diagnosis of Pervasive Developmental Disorder-Not Otherwise Specified were reported as favorable signs for recovery (Helt et al., 2011). The question should be raised, why do a small percentage of children diagnosed with an ASD lose their diagnosis and what caused them to present behaviors similar to an ASD?

If an individual is diagnosed with an ASD and they are found to have Lyme disease, treating the Lyme disease will most likely not result in the individual losing their ASD diagnosis, but it could significantly improve their physical and mental health. If a child presents signs of an ASD it should be worth inquiring to a Lyme Literate Medical Doctor [LLMD] because they could be infected with a debilitating neurological disease and antibiotic therapy could improve their symptoms.

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