

# Neuropsychological and Neuropsychiatric Features of Lyme and Other Tick Borne Diseases

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**Judith G. Leventhal, PhD**  
Private Practice, New York, NY

**Leo J. Shea III, PhD**  
Clinical Assistant Professor of Rehabilitation Medicine  
NYU-Langone Medical Center- Rusk Institute, New York, NY

# Presentation Overview

- “ Basic information about Lyme and other tick borne diseases
- “ Neuropsychology, neuropsychiatry and Lyme disease connection
- “ Functional manifestations of Lyme disease
- “ Lyme, ADHD and ASD connection
- “ Studies
- “ Our findings
- “ Case studies

## Lyme and Associated Diseases

- “ Complex mixture of several infectious agents - co-infections
- “ Caused by the bite of an infected tick
- “ *Borrelia burgdorferi* spirochete
- “ *Babesia microti* protozoa
- “ *Bartonella henselae* bacterium
- “ *Anaplasma phagocytophilum*
- “ Tularemia bacterium
- “ *Mycoplasma fermentans* bacterium

## Lyme Facts

- “ Fastest growing vector-borne disease in US
- “ Accounts for more than 95% of all vector-borne disease in US
- “ 10% cases meeting CDC surveillance criteria actually reported
- “ Maryland – 12,852 cases up to 2007 (ranked 7<sup>th</sup> in U.S. )
- “ Found in all 50 states and more than 80 countries
- “ Serious national health crisis
- “ Affects children, adolescents and adults
- “ Disproportionate number of children infected
- “ Ixodes scapularis tick attaches itself to deer, small animals and migratory birds

# Common Lyme Symptoms

- “ Flu-like symptoms
- “ Joint pain
- “ Headache
- “ Fatigue often unrelieved by rest
- “ Bell’s palsy
- “ Brain fog
- “ Sensory sensitivities
- “ Cognitive changes
- “ Word finding problems
- “ Memory problems
- “ Concentration problems
- “ Low grade fevers
- “ Frequent infections
- “ Rashes
- “ New onset anxiety and phobias
- “ Chest pains and palpitations
- “ Blurred vision and eye pain
- “ Abdominal pain, GI symptoms
- “ Vertigo
- “ Testicular/pelvic pain
- “ Arthritis
- “ Swollen glands
- “ Sleep disturbance
- “ Irritability
- “ Mood swings
- “ Night sweats
- “ Allergies
- “ Dark circles under the eyes
- “ Depression
- “ Rages

# Lyme Transmission: Human to Human

- “ Gestational – transplacental infection
  - “ can be associated with repeated miscarriages
  - “ Poor muscle tone
  - “ Developmental delays
  - “ Loss of or decline in previously acquired skills
  - “ Learning disabilities and psychiatric problems (A. Corson 2008)
  
- “ Breast milk
- “ Blood transfusion
- “ Sexually transmitted ???

# More Than An Infection

(J.J. Burrascano Jr., M.D.)

- “ Immune system compromised
- “ Neurotoxins
- “ Hormonal disturbances
- “ Tissue damage
- “ Nutritional disturbances
- “ Metabolic changes
- “ Circulation changes

# Lyme and Associated Diseases

- “ Difficult to diagnose
- “ Symptoms vague and shifting
- “ Children may not understand what is happening or how to describe
- “ Erythema migrans (EM) rash occurs less than 50% of the time
- “ Tests not definitive
- “ Organisms evade detection and hide out in the body
- “ Other “Great Imitator” – e.g., MS, ALS, AD, CFS
- “ Multi-system disease – musculoskeletal, central nervous system, cardiac/pulmonary, reproductive, gastrointestinal
- “ Difficult to treat
- “ Inadequate treatment makes future treatment more difficult
- “ Spirochetes change form – resistant to antibiotics
- “ Subspecies and numerous strains
- “ Symptoms can intensify during treatment – Jarisch-Herxheimer reaction

# Lyme and Associated Diseases

- “ Variables determining impact of exposure (J. J. Burrascano MD, Private communication, 2008)
- “ Underlying health
- “ Strength of immune system
- “ Number and quality of different bacteria, protozoa and viruses that resulted from the bite
- “ How soon after bite treatment began
- “ Type and dose of antibiotics
- “ Duration of antibiotic treatment
- “ “Infinite number of possibilities”

# The Lyme and Associated Diseases Registry <sup>TM</sup>

- “ Database – J. J. Burrascano Jr., MD, International Lyme and Associated Diseases Society, Turn the Corner Foundation
- “ Participating physicians across the U.S.
- “ First results: Neurocognitive symptoms are prominent – Lyme neuroborreliosis
- “ Impaired memory is among the most common symptoms
- “ Forgetfulness, poor short-term memory and poor attention among the symptoms most commonly rated as severe.

# Neuropsychology and Lyme Disease

- “Spirochetes have an organic tropism for the brain.” (W. Burgdorfer in P. Weintraub, 2008)
- Brain function is compromised
- Cognitive impairment is among the most frequent symptoms in children diagnosed with Lyme and associated diseases (C.R. Jones, MD, private communication, 2008)
- Neurocognitive, neuropsychiatric and neuropsychological symptoms and the resulting functional changes are among the **presenting** signs of tick-borne disease in children (C.R. Jones, MD, private communication, 2008)
- Neuropsychological and neuropsychiatric symptoms may have an infectious basis
- Neurocognitive, neuropsychological and neuropsychiatric symptoms have significant behavioral and functional consequences

# Neuropsychology and Lyme Disease

- “ Neurocognitive, neuropsychological and neuropsychiatric symptoms have a profound adverse impact on academic, social and family development and day-to-day functioning
- “ Learning is compromised
- “ Peer and family relationships disrupted
- “ Developmental milestones and stages delayed
- “ Self-confidence and self-esteem compromised
- “ Early identification and intervention

# Importance of Early Identification and Intervention

- “ History of escalating medical problems
- “ History of escalating school problems
- “ Defined by misdiagnosis
- “ Delay in appropriate interventions
- “ Abnormal as normal
- “ Situation is abnormal not the child
- “ Sense of loss
- “ Stress and trauma of medical procedures
- “ Individual and family well-being significantly compromised

# Importance of Early Identification and Intervention

- “ Need for identification and documentation of neurocognitive symptoms
- “ Establish a medical etiology for compromised functioning and behavioral problems
- “ Need psychiatric support and evaluation for psychopharmacological intervention
- “ “Psychotropic interventions are a critical component of a comprehensive treatment approach.” (R. Bransfield, 2007)
- “ Early intervention can alter the course of disease progression (R. Bransfield, 2007)

# Functional Manifestations of Lyme Symptoms

- “Lyme undulation” (Shea 2001) – fluctuating abilities
- Waxing and waning of symptoms
- Reduced stamina
- “Crashing”
- Inconsistent and unpredictable from day to day
- Difficulty organizing and expressing thoughts
- Easily overwhelmed by too much information and too much sensory stimulation (schoolyard, lunchroom, parties)

# Functional Manifestations of Lyme Symptoms

- “ School work takes longer with greater effort
- “ Last one to finish
- “ Forget to hand in homework
- “ Forget information for tests
- “ Child exhausted by extra effort
- “ Fatigue, reduced stamina and other physical symptoms limit ability to participate in activities
- “ Brief gaps in attention and awareness
- “ Easily confused

# Functional Manifestations of Lyme Symptoms

- “ Get lost in the middle of a conversation
- “ Difficulty communicating thoughts
- “ Need more time to process information
- “ Difficulty following multistep directions
- “ Irritability, mood swings
- “ Difficulty meeting responsibilities

# Functional Manifestations of Lyme Symptoms

- “ Miss subtle social cues
- “ Feel isolated and alone
- “ Sense of loss
- “ Disrupted friendships and relationships
- “ Require repetition of information
- “ Difficulty while driving

# Diagnostic Considerations

- “ ADD/ADHD
- “ Sensorimotor Integration Disorder
- “ Auditory Processing Disorder
- “ Learning Disability
- “ Language Disorder
- “ ASD/PDD/Asperger’s
- “ Traumatic Brain Injury/Concussion
- “ Oppositional Defiant Disorder
- “ Mood Disorder
- “ Anxiety Disorder
- “ Obsessive-Compulsive Disorder
- “ Tourette’s
- “ Autoimmune disorder

## Lyme/ASD/ADHD

- “ Subset of children diagnosed with ASD have evidence of Bb infections.
- “ Lyme may produce a vulnerability during fetal development and infancy that may lead to “increased vulnerability for developing autism spectrum disorders.” (R. Bransfield et. al., 2007)
- “ Children with gestational Lyme diagnosed with ASD and ADHD (C.R. Jones, et al., 2005)
- “Autism is an inflammatory encephalitis caused by a pathogen such as Bartonella or Mycoplasma.” (J. Burrascano, R. Bransfield quote, 2008)

## Lyme/ASD/ADD

- “ Children diagnosed with Lyme may have ASD/ADHD symptoms
- “ Diagnoses may represent Lyme symptoms rather than end diagnoses
- “ Responsive, attentive and focused during a neuropsychological evaluation
- “ Interactive and show good eye contact during a neuropsychological evaluation

# Lyme/ASD/ADHD

## Overlapping Symptoms and Behavioral Similarities

- “ Attention/concentration
- “ Social interaction
- “ Emotional
- “ Delayed or disrupted language development
- “ Communication skills
- “ Sensory disturbances and sensitivities
- “ Academic performance

## Neuropsychological Study

- “ Westervelt and McCaffrey (2002): Impairments in:
  - “ Verbal fluency
  - “ Mental flexibility
  - “ Fine motor dexterity
  - “ Speed of information processing
  - “ Language
  - “ Oro–motor functioning
  - “ Memory especially free recall list learning tasks.
  - “ Frontal and sub-cortical abnormalities on neuro-imaging.

# Neuropsychological Study

- “ Tager and Fallon et. al. (2001): Study of children 8-16 with chronic neurological Lyme. Deficits in:
  - “ Auditory and visual processing
  - “ Attention
  - “ Working memory
  - “ Mental tracking
  - “ Perception and Organization

# Neuropsychological Study

- “ Rissenberg and Chambers (1998): Adult study. Impairments in:
  - “ Memory
  - “ Receptive and expressive language
  - “ Visual-spatial processing
  - “ Abstract reasoning
  - “ Speed of information processing

# Neuropsychological Study

- “ Keilp et. al (2006): Adult study. Impairments in:
  - “ Processing speed
  - “ Auditory and visual memory
  
- “ McAuliffe et. al. (2008): Adolescent study. Previously treated. Impairments in:
  - “ Visual and verbal memory and recognition memory
  - “ Visual recognition memory more impaired than verbal recognition memory
  - “ Long-term problems in cognition and school functioning

# Neuropsychiatric Study

- “ Fallon and Nields (1994): Adult study. Found psychiatric reactions associated with Lyme disease:
  - “ Paranoia
  - “ Dementia
  - “ Schizophrenia
  - “ Bi-polar disorder
  - “ Panic attacks
  - “ Major depression
  - “ Anorexia Nervosa
  - “ Obsessive compulsive disorder

# Qualitative Study

- “ Drew and Hewitt (2006): Qualitative study of becoming diagnosed with Lyme disease. Themes:
  - “
  - “ Frustration: Diagnostic process
  - “ Exhaustion: Diagnostic process is lengthy and exhausting
  - “ Stress: Financial stress and the impact on family
  - “ Need for self-validation

## Neuropsychological Evaluation and Treatment Services, PC and Review of Medical Records

- “ 53 children
- “ Ages 6 to 15:
  - “ 6-10 (10), 9-11 (18), 12-14 (19), 15-16 (6)
- “ Nationwide: East-West, North-South
  - “ NY, CT, NJ, VA, MD, PA, MA, TN, AZ, CA, FL, MN, NV, RI, NH
- “ Lyme diagnosis – 100%
- “ Other TBD’s – 45%
- “ Tick attachment – 32%
- “ Gestational exposure – 24%
- “ EM rash – 7% (A. Corson – 12%)

## **Neuropsychological Evaluation and Treatment Services, PC** **and Review of Medical Records**

- “ Lyme and associated diseases in family members – 60%
- “ History of chronic medical problems
- “ History of developmental problems
- “ Chronic ear infections – 39%
- “ Previous diagnoses – symptoms not seen within a systemic perspective
- “ Symptom onset to diagnosis – up to 14 years
- “ Return of symptoms after previous treatment
- “ School attendance and performance fluctuating
- “ Participation in extracurricular and social activities limited

## Presenting Problems

“ Attention/Concentration	92%
“ Impulsivity	58%
“ Memory and forgetfulness	75%
“ Multi-tasking	40%
“ Visual	36%
“ Speech/Writing	34%

# Presenting Problems

“ Auditory processing	62%
“ Word-finding	34%
“ Sensory Sensitivities	57%
“ ADHD/ADD	22%
“ Sleep	75%
“ Fatigue	79%

# Presenting Problems

- “ Neuropsychiatric and Behavioral Problems - 98%
- “ Anxiety, panic attacks
- “ Irritability and anger
- “ Mood swings
- “ Depression
- “ Sadness
- “ Suicidal thoughts and gestures
- “ Explosive behavior and rages
- “ Self harming thoughts and behaviors
- “ Harm to others - thoughts and behaviors
- “ Obsessive – compulsive behaviors

# Neuropsychological Patterns: Strengths

- “ Intellectual (WISC-IV):
  - “ Similarities
  - “ Vocabulary
  - “ Comprehension
  - “ Information
  - “ Word Reasoning
  - “ Matrix Reasoning

# Neuropsychological Patterns: Strengths

- “ Academic (WIAT-II):
  - “ Oral Expression
  - “ Listening Comprehension

# Neuropsychological Patterns: Weaknesses

- “ Intellectual (WISC-IV):
  - “ Working memory – Digit Span
  - “ Processing speed – Coding, Cancellation, Symbol Search
  - “ Discrimination of visual detail – Picture Completion

# Neuropsychological Patterns: Weaknesses

- “ Academic (WIAT-II):
  - “ Word decoding (Word Reading)
  - “ Phonetic decoding (Pseudoword Decoding)
  - “ Spelling
  - “ Reading rate (Reading Speed)
  - “ Reading Comprehension

# Neuropsychological Patterns: Weaknesses

- “ Memory (WRAML2):
  - “ Visual and verbal memory
  - “ Visual and verbal recognition memory
  
- “ Visual attention (D-KEFS):
  - “ Visual scanning
  - “ Divided attention

# Neuropsychological Patterns: Weaknesses

- “ Verbal Fluency (D-KEFS and WIAT-II)
- “ Graphomotor Speed (D-KEFS Motor Speed)
- “ Fine Motor coordination (Purdue Peg Board)

# Neuropsychological Findings: Weaknesses

- “ Processing speed
- “ Working memory
- “ Discrimination of fine detail
- “ Visual scanning
- “ Phonetic decoding
- “ Fine motor skills
- “ Reading
- “ Mathematics

# Neuropsychological Findings: Weaknesses

- “ Visual immediate recall and recognition memory
- “ Auditory verbal immediate recall and recognition memory
- “ Auditory memory scores < verbal cognitive skills
- “ Visual memory scores < visual perceptual reasoning skills
- “ Visual recognition memory < auditory verbal recognition memory

# Behavioral Observations

- “ Hard working
- “ Focused
- “ Well-related
- “ Variability in performance – intra-test and intra-skill domain
- “ Limited stamina
- “ Brief moments of unresponsiveness
- “ Sensitive to ambient conditions
- “ Repetition of information required
- “ Spontaneous language richer than on-demand
- “ Frequent refocusing – get lost in the middle of a task

## Key Points

- “ Takes longer to do everything
- “ Effort can be exhausting
- “ Able to maintain grade level scores because of effort and intelligence (cognitive reserve)
- “ Fears and anxieties about health
- “ Concerns about being misunderstood
- “ Thrown into the adult world
- “ Language to talk about illness
- “ Innate intellectual ability preserved
- “ Significant disruption in family life
- “ Must rule out infection underlying symptoms

# Pediatric Case Study 1

- “ 10 year-old male diagnosed with Lyme
- “ Evaluations at age 10-2 and 11-10
- “ Full term uncomplicated pregnancy
- “ Motor milestones WNL
- “ Low tone
- “ Delayed speech development
- “ Small for age
- “ Special education preschool
- “ Speech therapy and occupational therapy

# Pediatric Case Study 1

- “ ADD
- “ Auditory Processing Disorder
- “ Sensory sensitivities
- “ PDD/ASD
- “ 2005 - Mother diagnosed with Lyme (chronic)
- “ Child diagnosed with Lyme
- “ Younger sister diagnosed with Lyme

# Pediatric Case Study 1

- “ Fatigue
- “ GI symptoms
- “ Poor social skills but longs for friendships
- “ Anxiety
- “ Mood swings

# Pediatric Case Study 1

## “ 2006 Neuropsychological Evaluation:

“ Range - 2<sup>nd</sup> %ile - 96<sup>th</sup> %ile

“ WISC-IV VCI – 23<sup>rd</sup> %ile

“ WISC-IV PRI - 66<sup>th</sup> %ile

“ WISC-IV WMI - 61<sup>st</sup> %ile

“ WISC-IV PSI - 13<sup>th</sup> %ile

“ Full Scale IQ – 34<sup>th</sup> %ile

“ Similarities – 91<sup>st</sup> %ile

## “ 2008 Neuropsychological Evaluation:

“ Range - 1<sup>st</sup> %ile - 96<sup>th</sup> %ile

“ WISC-IV VCI – 66<sup>th</sup> %ile

“ WISC-IV PRI - 90<sup>th</sup> %ile

“ WISC-IV WMI – 86<sup>th</sup> %ile

“ WISC-IV PSI - 16<sup>th</sup> %ile

“ Full Scale IQ – 75<sup>th</sup> %ile

“ Similarities – 91<sup>st</sup> %ile

# Pediatric Case Study 1

Wechsler Intelligence Scale for Children 6 Fourth Edition (WISC-IV)

	<b>2006</b>		<b>2008</b>	
<b>Verbal Comprehension Subtests</b>	<b>SS</b>	<b>%</b>	<b>SS</b>	<b>%</b>
Similarities	14	91 <sup>st</sup>	14	91 <sup>st</sup>
Vocabulary	06	09 <sup>th</sup>	09	37 <sup>th</sup>
Comprehension	04	02 <sup>nd</sup>	11	63 <sup>rd</sup>
Information	09	37 <sup>th</sup>	12	75 <sup>th</sup>
Word Reasoning	10	50 <sup>th</sup>	12	75 <sup>th</sup>
<b>Perceptual Reasoning Subtests</b>				
Block Design	09	37 <sup>th</sup>	11	63 <sup>rd</sup>
Picture Concepts	13	84 <sup>th</sup>	12	75 <sup>th</sup>
Matrix Reasoning	11	63 <sup>rd</sup>	16	98 <sup>th</sup>
Picture Completion	05	05 <sup>th</sup>	06	09 <sup>th</sup>
<b>Working Memory Subtests</b>				
Digit Span	12	75 <sup>th</sup>	14	91 <sup>st</sup>
Letter Number Seq.	10	50 <sup>th</sup>	12	75 <sup>th</sup>
Arithmetic	11	63 <sup>rd</sup>	13	84 <sup>th</sup>
<b>Processing Speed Subtests</b>				
Coding	05	05 <sup>th</sup>	05	05 <sup>th</sup>
Symbol Search	09	37 <sup>th</sup>	10	50 <sup>th</sup>
Cancellation	09	37 <sup>th</sup>	05	05 <sup>th</sup>
<b>Composite Scores Summary</b>				
	<b>COM</b>	<b>%</b>	<b>COM</b>	<b>%</b>
Verbal Comprehension Index	89	23 <sup>rd</sup>	106	66 <sup>th</sup>
Perceptual Reasoning Index	106	66 <sup>th</sup>	119	90 <sup>th</sup>
Working Memory Index	104	61 <sup>st</sup>	116	86 <sup>th</sup>
Processing Speed Index	83	13 <sup>th</sup>	85	16 <sup>th</sup>
Full Scale	94	34 <sup>th</sup>	110	75 <sup>th</sup>

# Pediatric Case Study 1

- “ Comprehension – SS 4 to 11
- “ Information – SS 9 to 12
- “ Matrix Reasoning – SS 11 to 16
- “ Working Memory subtests – up 2 SS points
- “ Cancellation – SS 9 to 5

## Pediatric Case Study 2

- “ Ten year old male diagnosed with Lyme
- “ Mother, father and younger brother all diagnosed with Lyme
- “ Five weeks premature
- “ Colicky
- “ Motor milestones WNL
- “ Numerous ear infections beginning at 6 months
- “ Began talking at 17 months
- “ 18-19 months unable to repeat words and speech was “gibberish”

## Pediatric Case Study 2

- “ Pediatrician – wait
- “ Age three diagnosed with dyspraxia of speech, sensory integration dysfunction with vestibular weakness, motor dyspraxia
- “ Speech therapy and occupational therapy
- “ Age six and a half – Auditory Processing Disorder
- “ Visual focusing problems – vision therapy

## Pediatric Case Study 2

- “ Age eight – lethargy, joint pain, circles under his eyes
- “ Diagnosed with Lyme and treated with three weeks of antibiotics
- “ Remained symptomatic
- “ Nine and a half – positive for mycoplasma, pneumonia and mononucleosis
- “ Then seen by Charles Ray Jones, MD

## Pediatric Case Study 2

- “ Positive WB, HLA-DR2 positive
- “ Fatigue, insomnia, numbness in feet, joint pain, clumsiness, shortness of breath, stabbing chest pains
- “ Depression, anxiety, crying, quick to anger, obsesses over small issues, difficulty “moving on,” obsessive hand washing, lines up objects
- “ Impulsive, easily frustrated, explosive

## Pediatric Case Study 2

- “ Sensory hypersensitivity
- “ Sensitive to food textures and tastes
- “ Hand flapping
- “ Cognitive difficulties – reduced speed of information processing, short-term memory and planning and organization

## Pediatric Case Study 2

- “ Difficulty interpreting social cues
- “ Interpersonal difficulties
- “ Doesn't remember names
- “ Evaluated for Asperger's but did not meet criteria
- “ Classified as Speech/Language Impaired
- “ Age 7-10 – changed to Specific Learning Disability

## Pediatric Case Study 2

- “ 2005 Neuropsychological Evaluation – age 10
  - “ Range – 5<sup>th</sup> %ile – 99.9<sup>th</sup> %ile
  
  - “ WISC-IV VCI – 97<sup>th</sup> %ile
  - “ WISC-IV PRI – 99<sup>th</sup> %ile
  - “ WISC-IV WMI – 27<sup>th</sup> %ile
  - “ WISC-IV PSI - 13<sup>th</sup> %ile
  - “ Full Scale IQ – 86<sup>th</sup> %ile
  
  - “ WIAT-II Written Expression - 19<sup>th</sup> %ile
  - “ WIAT-II Oral Expression – 96<sup>th</sup> %ile
  - “ WIAT-II Spelling – 5<sup>th</sup> %ile
  - “ NEPSY Phonological Processing – 5<sup>th</sup> %ile

## Adult Case Study

- “ Female: Evaluations at age 44 and 45-7
- “ Master’s degree
- “ High level executive position
- “ Tick bite in 1/92
- “ Symptoms in 2/92
- “ Treated and symptoms under control until 1/03
- “ Babesia, Mycoplasma, Bartonella, Tularemia and Chlamydia

## Adult Case Study

### “ 2006 Neuropsychological Evaluation:

- “ Range - 1<sup>st</sup> %ile - 99<sup>th</sup> %ile
- “ WAIS-III VCI - 97<sup>th</sup> %ile
- “ WAIS-III PRI - 68<sup>th</sup> %ile
- “ WAIS-III WMI - 66<sup>th</sup> %ile
- “ WAIS-III PSI - 27<sup>th</sup> %ile

### “ 2008 Neuropsychological Evaluation:

- “ Range - 1<sup>st</sup> %ile - 99<sup>th</sup> %ile
- “ WAIS-III VCI - 99<sup>th</sup> %ile
- “ WAIS-III PRI - 73<sup>rd</sup> %ile
- “ WAIS-III WMI - 61<sup>st</sup> %ile
- “ WAIS-III PSI - 47<sup>th</sup> %ile

# Adult Case Study

Wechsler Adult Intelligence Scale 3<sup>rd</sup> Edition (WAIS-III)

	2006		2008	
	SS	%	SS	%
<b>Verbal Comprehension</b>				
Vocabulary	17	99 <sup>th</sup>	17	99 <sup>th</sup>
Similarities	15	95 <sup>th</sup>	17	99 <sup>th</sup>
Information	13	84 <sup>th</sup>	14	91 <sup>st</sup>
Comprehension	14	91 <sup>st</sup>	17	99 <sup>th</sup>
<b>Perceptual Organization</b>				
Picture Completion	15	95 <sup>th</sup>	10	50 <sup>th</sup>
Block Design	08	25 <sup>th</sup>	10	50 <sup>th</sup>
Matrix Reasoning	11	63 <sup>rd</sup>	15	95 <sup>th</sup>
Picture Arrangement	13	84 <sup>th</sup>	14	91 <sup>st</sup>
<b>Working Memory</b>				
Arithmetic	10	50 <sup>th</sup>	09	37 <sup>th</sup>
Digit Span	08	25 <sup>th</sup>	10	50 <sup>th</sup>
Letter Number Sequencing	15	95 <sup>th</sup>	13	84 <sup>th</sup>
<b>Processing Speed</b>				
Digit Symbol/Coding	08	25 <sup>th</sup>	09	37 <sup>th</sup>
Symbol Search	07	16 <sup>th</sup>	11	63 <sup>rd</sup>

<b>Results</b>	<b>I.Q.</b>	<b>%</b>	<b>I.Q.</b>	<b>%</b>
Verbal IQ	117	87 <sup>th</sup>	125	95 <sup>th</sup>
Performance IQ	106	66 <sup>th</sup>	110	75 <sup>th</sup>
Full Scale IQ	113	81 <sup>st</sup>	120	91 <sup>st</sup>
<b>Index Scores</b>				
Verbal Comprehension	129	97 <sup>th</sup>	136	99 <sup>th</sup>
Perceptual Organization	107	68 <sup>th</sup>	109	73 <sup>rd</sup>
Working Memory	106	66 <sup>th</sup>	104	61 <sup>st</sup>
Processing Speed	91	27 <sup>th</sup>	99	47 <sup>th</sup>

# Adult Case Study

- “ Comprehension – SS 14 to 17
- “ Matrix Reasoning – SS 11 to 15
- “ Picture Completion – SS 15 to 10
- “ Symbol Search – SS 7 to 11

# Resources

- “ [www.ilads.org](http://www.ilads.org)
- “ [www.lymedisease.org](http://www.lymedisease.org)
- “ [www.lymediseaseassociation.org](http://www.lymediseaseassociation.org)
- “ [www.lymenet.org](http://www.lymenet.org)
- “ [www.lymepa.org](http://www.lymepa.org)
- “ [www.n-e-t-s.org](http://www.n-e-t-s.org)
- “ [www.nrftd.org](http://www.nrftd.org)
- “ [www.timeforlyme.org](http://www.timeforlyme.org)
- “ [www.turnthecorner.org](http://www.turnthecorner.org)