

Table A:
Summary Comparison of Characteristics
of Autism & Mercury Poisoning

Mercury Poisoning	Autism
<i>Psychiatric Disturbances</i>	
Social deficits, shyness, social withdrawal	Social deficits, social withdrawal, shyness
Depression, mood swings; mask face	Depressive traits, mood swings; flat affect
Anxiety	Anxiety
Schizoid tendencies, OCD traits	Schizophrenic & OCD traits; repetitiveness
Lacks eye contact, hesitant to engage others	Lack of eye contact, avoids conversation
Irrational fears	Irrational fears
Irritability, aggression, temper tantrums	Irritability, aggression, temper tantrums
Impaired face recognition	Impaired face recognition
<i>Speech, Language & Hearing Deficits</i>	
Loss of speech, failure to develop speech	Delayed language, failure to develop speech
Dysarthria; articulation problems	Dysarthria; articulation problems
Speech comprehension deficits	Speech comprehension deficits
Verbalizing & word retrieval problems	Echolalia; word use & pragmatic errors
Sound sensitivity	Sound sensitivity
Hearing loss; deafness in very high doses	Mild to profound hearing loss
Poor performance on language IQ tests	Poor performance on verbal IQ tests
<i>Sensory Abnormalities</i>	
Abnormal sensation in mouth & extremities	Abnormal sensation in mouth & extremities
Sound sensitivity	Sound sensitivity
Abnormal touch sensations; touch aversion	Abnormal touch sensations; touch aversion
Vestibular abnormalities	Vestibular abnormalities
Motor Disorders	
Involuntary jerking movements - arm flapping, ankle jerks, myoclonal jerks, choreiform movements, circling, rocking	Stereotyped movements - arm flapping, jumping, circling, spinning, rocking; myoclonal jerks; choreiform movements
Deficits in eye-hand coordination; limb apraxia; intention tremors	Poor eye-hand coordination; limb apraxia; problems with intentional movements

Gait impairment; ataxia - from incoordination & clumsiness to inability to walk, stand, or sit; loss of motor control	Abnormal gait and posture, clumsiness and incoordination; difficulties sitting, lying, crawling, and walking
Difficulty in chewing or swallowing	Difficulty chewing or swallowing
Unusual postures; toe walking	Unusual postures; toe walking
<i>Cognitive Impairments</i>	
Borderline intelligence, mental retardation - some cases reversible	Borderline intelligence, mental retardation - sometimes "recovered"
Poor concentration, attention, response inhibition	Poor concentration, attention, shifting attention
Uneven performance on IQ subtests	Uneven performance on IQ subtests
Verbal IQ higher than performance IQ	Verbal IQ higher than performance IQ
Poor short term, verbal, & auditory memory	Poor short term, auditory & verbal memory
Poor visual and perceptual motor skills, impairment in simple reaction time	Poor visual and perceptual motor skills, lower performance on timed tests
Difficulty carrying out complex commands	Difficulty carrying out multiple commands
Word-comprehension difficulties	Word-comprehension difficulties
Deficits in understanding abstract ideas & symbolism; degeneration of higher mental powers	Deficits in abstract thinking & symbolism, understanding other's mental states, sequencing, planning & organizing
<i>Unusual Behaviors</i>	
Stereotyped sniffing (rats)	Stereotyped, repetitive behaviors
ADHD traits	ADHD traits
Agitation, unprovoked crying, grimacing, staring spells	Agitation, unprovoked crying, grimacing, staring spells
Sleep difficulties	Sleep difficulties
Eating disorders, feeding problems	Eating disorders, feeding problems
Self injurious behavior, e.g. head banging	Self injurious behavior, e.g. head banging
<i>Visual Impairments</i>	
Poor eye contact, impaired visual fixation	Poor eye contact, problems in joint attention
"Visual impairments," blindness, near-sightedness, decreased visual acuity	"Visual impairments"; inaccurate/slow saccades; decreased rod functioning
Light sensitivity, photophobia	Over-sensitivity to light
Blurred or hazy vision	Blurred vision
Constricted visual fields	Not described
<i>Physical Disturbances</i>	

Increase in cerebral palsy; hyper- or hypo-tonia; abnormal reflexes; decreased muscle strength, especially upper body; incontinence; problems chewing, swallowing, salivating	Increase in cerebral palsy; hyper- or hypotonia; decreased muscle strength, especially upper body; incontinence; problems chewing and swallowing
Rashes, dermatitis/dry skin, itching; burning	Rashes, dermatitis, eczema, itching
Autonomic disturbance: excessive sweating, poor circulation, elevated heart rate	Autonomic disturbance: unusual sweating, poor circulation, elevated heart rate
<i>Gastro-intestinal Disturbances</i>	
Gastroenteritis, diarrhea; abdominal pain, constipation, “colitis”	Diarrhea, constipation, gaseousness, abdominal discomfort, colitis
Anorexia, weight loss, nausea, poor appetite	Anorexia; feeding problems/vomiting
Lesions of ileum & colon; increased gut permeability	Leaky gut syndrome
Inhibits dipeptidyl peptidase IV, which cleaves casomorphin	Inadequate endopeptidase enzymes needed for breakdown of casein & gluten
<i>Abnormal Biochemistry</i>	
Binds -SH groups; blocks sulfate transporter in intestines, kidneys	Low sulfate levels
Has special affinity for purines & pyrimidines	Purine & pyrimidine metabolism errors lead to autistic features
Reduces availability of glutathione, needed in neurons, cells & liver to detoxify heavy metals	Low levels of glutathione; decreased ability of liver to detoxify heavy metals
Causes significant reduction in glutathione peroxidase and glutathione reductase	Abnormal glutathione peroxidase activities in erythrocytes
Disrupts mitochondrial activities, especially in brain	Mitochondrial dysfunction, especially in brain
<i>Immune Dysfunction</i>	
Sensitivity due to allergic or autoimmune reactions; sensitive individuals more likely to have allergies, asthma, autoimmune-like symptoms, especially rheumatoid-like ones	More likely to have allergies and asthma; familial presence of autoimmune diseases, especially rheumatoid arthritis; IgA deficiencies
Can produce an immune response in CNS	On-going immune response in CNS
Causes brain/MBP autoantibodies	Brain/MBP autoantibodies present
Causes overproduction of Th2 subset; kills/inhibits lymphocytes, T-cells, and monocytes; decreases NK T-cell activity; induces or suppresses IFN γ & IL-2	Skewed immune-cell subset in the Th2 direction; decreased responses to T-cell mitogens; reduced NK T-cell function; increased IFN γ & IL-12
<i>CNS Structural Pathology</i>	

Selectively targets brain areas unable to detoxify or reduce Hg-induced oxidative stress	Specific areas of brain pathology; many functions spared
Damage to Purkinje and granular cells	Damage to Purkinje and granular cells
Accumulates in amygdala and hippocampus	Pathology in amygdala and hippocampus
Causes abnormal neuronal cytoarchitecture; disrupts neuronal migration & cell division; reduces NCAMs	Neuronal disorganization; increased neuronal cell replication, increased glial cells; depressed expression of NCAMs
Progressive microcephaly	Progressive microcephaly and macrocephaly
Brain stem defects in some cases	Brain stem defects in some cases
<i>Abnormalities in Neuro-chemistry</i>	
Prevents presynaptic serotonin release & inhibits serotonin transport; causes calcium disruptions	Decreased serotonin synthesis in children; abnormal calcium metabolism
Alters dopamine systems; peroxidase deficiency in rats resembles mercurialism in humans	Possibly high or low dopamine levels; positive response to peroxidase (lowers dopamine levels)
Elevates epinephrine & norepinephrine levels by blocking enzyme that degrades epinephrine	Elevated norepinephrine and epinephrine
Elevates glutamate	Elevated glutamate and aspartate
Leads to cortical acetylcholine deficiency; increases muscarinic receptor density in hippocampus & cerebellum	Cortical acetylcholine deficiency; reduced muscarinic receptor binding in hippocampus
Causes demyelinating neuropathy	Demyelination in brain
<i>EEG Abnormalities / Epilepsy</i>	
Causes abnormal EEGs, epileptiform activity	Abnormal EEGs, epileptiform activity
Causes seizures, convulsions	Seizures; epilepsy
Causes subtle, low amplitude seizure activity	Subtle, low amplitude seizure activities
<i>Population Characteristics</i>	
Effects more males than females	Male:female ratio estimated at 4:1
At low doses, only affects those genetically susceptible	High heritability - concordance for MZ twins is 90%
First added to childhood vaccines in 1930s	First "discovered" among children born in 1930s
Exposure levels steadily increased since 1930s with rate of vaccination, number of vaccines	Prevalence of autism has steadily increased from 1 in 2000 (pre1970) to 1 in 500 (early 1990s), higher in 2000.
Exposure occurs at 0 - 15 months; clinical silent stage means symptom emergence delayed;	Symptoms emerge from 4 months to 2 years old; symptoms emerge gradually, starting with movement & sensation

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**Table II: Summary of Psychiatric Disturbances
Found in Autism & Mercury Poisoning**

Mercury Poisoning	Autism
Extreme shyness, social withdrawal, feeling overly sensitive, introversion	Social deficits, social withdrawal, self reports of extreme shyness, aloofness
Mood swings; flat affect; mask face; laughing or crying without provocation; episodes of hysteria	Mood swings; flat affect in some; no facial expression; laughing or crying without reason
Anxiety; nervousness; tremulousness; somatization of anxious feelings	Anxiety, nervousness; anxiety disorder
Schizoid tendencies, neurosis, obsessive-compulsive traits, repetitive dreams	Schizophrenic traits; OCD traits; repetitive behaviors and thoughts
Lack of eye contact; being less talkative; hesitancy to engage others	Lack of eye contact, gaze avoidance; avoids conversation
Depression, lack of interest in life, lassitude, fatigue, apathy; feelings of hopelessness; melancholy	Association with depression; lack of initiative, diminished outward emotions
On the one hand, less overtly active, unwilling to go outside or be with others; on the other hand, increased restlessness	Tendency to withdraw, especially to own rooms, prefer to be alone; hyperactivity
Irrational fears	Irrational fears
Irritability, anger, and aggression; in children this may manifest as frequent and severe temper tantrums	Irritability and aggression; severe temper tantrums in children
Psychotic episodes; hallucinations, hearing voices; paranoid thoughts	Psychotic talk, paranoid thoughts
Impaired face recognition	Impaired face recognition

**Table III: Summary of Speech, Language
& Hearing Deficits in Autism & Mercury Poisoning**

Mercury Poisoning	Autism
Complete loss of speech in adults or children; failure to develop speech in infants	Delayed language onset; failure to develop speech
Dysarthria; speech difficulties from intention tremor; slow and slurred speech	Dysarthria; dyspraxia and oral-motor planning difficulties; unintelligible speech

Aphasia, the inability to use or understand words, inability to comprehend speech although ability to hear sound is intact

Speech comprehension deficits, although ability to hear sound is intact

Difficulties verbalizing; word retrieval problems

Echolalia; pronoun reversals, word meaning and pragmatic errors; limited speech production

Auditory disturbance; difficulties differentiating voices in a crowd

Difficulties following conversational speech with background noise

Sound sensitivity

Sound sensitivity

Hearing loss; deafness in very high doses

Mild to profound hearing loss

Poor performance on standardized language tests

Poor performance on verbal IQ tests

Table IV: Summary of Sensory Abnormalities in Mercury Poisoning & Autism

Mercury Poisoning	Autism
Abnormal sensation or numbness around mouth and extremities (paresthesia); burning feet	Abnormal sensation in mouth and extremities; excessive mouthing of objects (infants); toe walking; difficulty grasping objects
Sound sensitivity	Sound sensitivity
Excessive pain when bumping; abnormal touch sensations; touch aversion	Insensitivity or overreaction to pain and touch; touch aversion; stiff to hold
Loss of position in space	Vestibular system abnormalities; difficulty orienting self in space
Normal pinprick tests	Normal pinprick tests

Table V: Summary of Motor Disorder Behaviors in Mercury Poisoning & Autism

Mercury Poisoning	Autism
Involuntary jerking movements, e.g., arm flapping, ankle jerks, myoclonal jerks; choreiform movements; circling (cats); rocking; purposeless movement of extremities; twitching, shaking; muscular spasticity	Stereotyped movements such as arm flapping, jumping, circling, spinning, rocking; myoclonal jerks; choreiform movements
Unsteadiness in handwriting or an inability to hold a pen; deficits in eye-hand coordination; limb apraxia; intention tremors; loss of fine motor skills	Difficulty in writing with or holding a pen; poor eye-hand coordination; limb apraxia; problems carrying out intentional movements (praxia)
Ataxia: gait impairment; severity ranging from mild incoordination, clumsiness to complete inability to walk, stand, or sit; staggering, stumbling; loss of motor control	Abnormal gait and posture, clumsiness and incoordination; difficulties sitting, lying, crawling, and walking in infants and toddlers

Toe walking
 Difficulty in chewing or swallowing
 Unusual postures
 Areflexia

Tremors in general, tremors of the face and tongue,
 hand tremors

Toe walking
 Difficulty chewing or swallowing
 Unusual postures
 None described

None described

**Table VI: Summary of Areas of Mental Impairment
 in Mercury Poisoning & Autism**

Mercury Poisoning	Autism
Some aspect of mental impairment in all symptomatic cases	Some aspect of mental impairment in all cases
Borderline intelligence on testing among previously normal individuals; mental retardation occurring in severe cases of pre-/postnatal exposure; some cases of MR reversible; primate studies indicate core intelligence spared with low exposures	Borderline intelligence or mental retardation on standard tests among previously normally appearing infants; some cases of MR "reversible"; indications that normal IQ might be present in MR-labeled individuals
Uneven performance on subtests of intelligence	Uneven performance on subtests of intelligence
Verbal IQ higher than performance IQ; compromised language/verbal expression and comprehension	Verbal IQ higher than performance IQ; compromised language/verbal expression and comprehension
Poor concentration, shortened attention span, general lack of attention; poor response inhibition	Lack of concentration, short attention span, lack of attention, difficulty shifting attention
Forgetfulness, loss of memory, particularly short term, verbal and auditory memory; mental confusion	Poor short term/working memory; poor auditory and verbal memory; lower verbal encoding abilities
Poor visual and perceptual motor skills, poor eye-hand coordination; impairment in simple reaction time	Poor visual and perceptual motor skills, poor eye-hand coordination; lowered performance on timed tests
Not reported as being tested	Difficulty processing multiple stimuli
Difficulty carrying out complex commands	Difficulty carrying out multiple commands
Alexia (inability to comprehend the meaning of written words)	Hyperlexia (ability to decode words while lacking word comprehension)
Deficits in constructional skills, conceptual abstraction, understanding abstract ideas and symbolism; degeneration of higher mental powers	Deficits in abstract/conceptual thinking, symbolism, understanding other's mental states; impairment in sequencing, planning, organizing
Lack of understanding of object permanence (primates)	Deficient understanding of object permanence (children)

**Table VII: Summary of Unusual Behaviors
in Mercury-Poisoned Animals and Humans & in Autism**

Mercury Poisoning	Autism
Stereotyped sniffing (rats)	Stereotyped, repetitive behaviors
Hyperactivity (rats); poor response inhibition (humans), restlessness	Hyperactivity; ADHD-traits
Agitation (humans)	Agitation
Insomnia; difficulty falling asleep (humans)	Insomnia; difficulty falling or staying asleep
Eating disorders: anorexia, poor appetite, food aversion, narrow food preferences, decided food preferences (salty food) (humans)	Eating disorders: anorexia; restricted diet/narrow food preferences; feeding and suckling problems
Masturbation, priapism (children)	Masturbatory tendencies
Unintelligible cries; continuous crying; unprovoked crying (infants and children)	Unprovoked crying
Self injurious behavior, including head banging and hitting the head (toddlers and children)	Self injurious behavior, including head banging and hitting the head
Grimacing (children)	Grimacing
Staring spells (infants and children)	Staring spells

**Table VIII: Summary of Visual Impairments
Seen in Mercury Poisoning & Autism**

Mercury Poisoning	Autism
Lack of eye contact; difficulties with visual fixation	Lack of eye contact; gaze abnormalities; problems in joint attention
"Visual impairments," blindness, near-sightedness, decreased visual acuity	"Visual impairments"; inaccurate or slow saccades; decreased functioning of the rods; retinal sheen
Light sensitivity, photophobia	Over-sensitivity to light
Blurred or hazy vision	Blurred vision
Constricted visual fields	Not described

**Table IX: Physical Disturbances
in Mercury Poisoning & Autism**

Mercury Poisoning	Autism
Increase in cerebral palsy; hyper- or hypotonia; paralysis, abnormal reflexes; spasticity; decreased muscle strength and motor power, especially in the upper body; incontinence; problems chewing, swallowing, and salivating	Increase in cerebral palsy; hyper- or hypotonia; decreased muscle strength, especially in the upper body; incontinence/toilet training difficulties; problems chewing and swallowing
Rashes, dermatitis, dry skin, itching; burning sensation	Rashes, dermatitis, eczema; itching

Autonomic disturbances: excessive sweating; poor circulation; elevated heart rate

Autonomic disturbances: sweating abnormalities; poor circulation; elevated heart rate

Table X: Summary of Gastrointestinal Problems in Mercury Poisoning & Autism

Mercury Poisoning	Autism
Gastroenteritis, diarrhea; abdominal pain, rectal itching, constipation, "colitis"	Diarrhea, constipation, gaseousness, abdominal discomfort, colitis
Anorexia, weight loss, nausea, poor appetite	Anorexia; feeding difficulties, vomiting as infants
Lesions of the ileum and colon; increased intestinal permeability	Leaky gut syndrome from sulfur deficiency
Inhibits dipeptidyl peptidase IV, which cleaves casomorphin	Inadequate endopeptidase enzymes responsible for breakdown of casein and gluten

Table XI: Abnormalities in Biochemistry Arising from Hg Exposure & Present in Autism

Mercury Poisoning	Autism
Ties up sulfur groups; prevents sulfate absorption	Low sulfate levels
Has special affinity for purines and pyrimidines	Errors in purine and pyrimidine metabolism can lead to autistic features
Depletes cellular tyrosine in yeast	PKU, arising from disruption in tyrosine production, results in autism
Reduces bioavailability of glutathione, necessary in cells and liver for heavy metal detoxification	Low levels of glutathione; decreased ability of liver to detoxify heavy metals
Can cause significant reduction in glutathione peroxidase and glutathione reductase	Abnormal glutathione peroxidase activities in erythrocytes
Disrupts mitochondrial activities, especially in brain	Mitochondrial dysfunction, especially in brain

Table XII: Summary of Immune System Abnormalities in Mercury Exposure & Autism

Mercury Poisoning	Autism
Individual sensitivity due to allergic or autoimmune reactions; sensitive individuals more likely to have allergies and asthma, autoimmune-like symptoms, especially rheumatoid-like ones	More likely to have allergies and asthma; familial presence of autoimmune diseases, especially rheumatoid arthritis; IgA deficiencies
Can produce an immune response, even at low levels; can remain in CNS for years	Indications of on-going immune response in CNS
Presence of autoantibodies (IgG) to neuronal cytoskeletal proteins, neurofilaments, and myelin basic protein; astrogliosis; transient ANA and AnolA	Presence of autoantibodies (IgG and IgM) to cerebellar cells, myelin basis protein

Causes overproduction of Th2 subset; diminishes capacity to produce TNF(alpha) and IL-1; kills lymphocytes, T-cells, and monocytes; inhibits lymphocyte production; decreases NK T-cell activity; may induce or suppress IFN(gamma) and IL-2 production

Skewed immune-cell subset in the Th2 direction and abnormal CD4/CD8 ratios; decreased responses to T-cell mitogens; increased neopterin; reduced NK T-cell function; increased IFN(gamma) and IL-12

**Table XIII: CNS Lesions
in Mercury Poisoning & Autism**

Mercury Poisoning	Autism
Primarily impacts CNS	Neurological impairments primary
Selectively targets brain areas - those unable to detoxify heavy metals or reduce Hg-induced oxidative stress	Specific areas of brain pathology; many functions spared
Damage to Purkinje and granular cells	Damage to Purkinje and granular cells
Accumulates in amygdala and hippocampus	Pathology in amygdala and hippocampus
Causes abnormal neuronal cytoarchitecture; interferes with neuronal migration and depresses cell division in developing brains; reduces NCAMs	Neuronal disorganization; increased neuronal cell replication, small glia to neuron ration, increased glial cells; depressed expression of NCAMs
Head size differences: progressive microcephaly	Head size differences: progressive microcephaly and macrocephaly
Brain stem defects in some cases	Brain stem defects in some cases

**Table XIV: Abnormalities in Neurons & Neurochemicals
from Mercury & in Autism**

Mercury Poisoning	Autism
Can increase tissue concentration of serotonin in newborn rats; causes calcium disruptions in neurons, preventing presynaptic serotonin release and inhibiting serotonin transport activities	Serotonin abnormalities: decreased serotonin synthesis in children; over-synthesis in adults; elevated serotonin in platelets; positive response to SSRIs; calcium metabolism abnormalities present
Alters dopamine systems; disrupts calcium and increases synaptosome membrane permeability, which affect dopamine activities; peroxidine deficiency in rats results in acrodynia	Indications of either high or low dopamine levels; positive response to peroxidine by lowering dopamine levels; positive response to dopamine antagonists
Increases epinephrine and norepinephrine levels by blocking the enzyme which degrades epinephrine	Elevated norepinephrine and epinephrine; positive response to norepinephrine reuptake inhibitors
Elevates glutamate; decreases glutamate uptake; reduces functional activity of glutamatergic system	Elevated glutamate and aspartate
Alters choline acetyltransferase, leading to acetylcholine deficiency; inhibits acetylcholine neurotransmitter release via impact on calcium	Abnormalities in cholinergic neurotransmitter system: cortical acetylcholine deficiency and reduced

homeostasis; causes cortical acetylcholine deficiency; increases muscarinic receptor density in hippocampus and cerebellum

muscarinic receptor binding in hippocampus

Causes demyelating neuropathy

Demyelation in brain

**Table XV: EEG Activity & Epilepsy
in Mercury Poisoning & Autism**

Mercury Poisoning

Autism

Causes abnormal EEGs and unusual epileptiform activity

Abnormal EEG activity; epileptiform activity

Causes seizures, convulsions

Seizures; epilepsy

Causes subtle, low amplitude seizure activity

Subtle, low amplitude seizure activities