AUTISM AND DRIVING

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In the United States and other developed countries, motor vehicle crashes are the leading cause of death and acquired disability for adolescents.

Drivers younger than age 25 years only comprise one-tenth of the population but account for more than a quarter of fatally injured drivers -(OECD, 2006).
Within just a year of their first driving experience, most teens are licensed as independent drivers.

(Requires) successful development of driving skills, expertise, and competencies, including psychomotor, cognitive, and perceptual proficiencies.

DEVELOPMENTAL, BIOLOGICAL, AND COGNITIVE FACTORS

- Novice teen drivers are not "defective" or "deficient" adult drivers.
- Habits and patterns of driving are being sculpted and embedded.

Potential exists for promoting adoption of safe, rather than unsafe driving patterns.

80% of Americans recalling having heard or seen the public service announcement and nearly 80% of Americans reporting that they took action to prevent a friend from driving drunk.
For interventions directed at teens, teens should be partners in intervention development (Brown, 2004; Gecelik & Steinberg, 2006; Jacobson, 2007; Steinberg & Monahan, 2007).

Content and messaging as well as implementation strategies must be salient to the teens.

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So what about youngsters with autism? Can they learn to drive?

- According to the U.S. Centers for Disease Control and Prevention, about 1 in every 68 children has autism.

*CDC estimate is from researchers checking health and school records for more than 47,000 children*
A growing segment of the autism population has been increasingly recognized with at least average overall intelligence.

Many are integrated into typical life but experience deficits in social interaction, communication, and motor/coordination skills that, if untreated, can impair aspects of daily living.

(Fombonne & Tidmarsh, 2003; Ghaziuddin, 2008; Gillberg, 1998; Paul, Orlovski, Marcinko, & Volkmar,

Physicians, whom parents may consult regarding driving decisions, do not have any evidence-based guidelines to offer families regarding whether it is safe for their teens with developmental disabilities to learn to drive.

Understanding how individuals with ASD might differ from other driving students is important …

How general driver’s education should account for needs of teens with developmental disabilities

How educational interventions should be tailored
SO, WHAT IS AUTISM?

- A syndrome with a wide spectrum of symptoms
- A neurobiological disorder
- Behaviorally diagnosed
- Is apparent early in life
- Lasts for the lifetime of the individual

What is Autism?

- Primarily a disorder of communication, social relating, and sensory processing
- Genetic influences are evident
- Can occur in conjunction with any other disability
- A disorder of higher level processing

“Autism spectrum disorders affect essential human behaviors such as social interaction, the ability to communicate ideas and feelings, imagination and the establishment of relationships with others.”

- Educating Children With Autism
Autism is not:
• Anyone’s fault
• A mental illness
• A behavioral disorder
• An emotional disorder
• A hopeless condition

- Barbara Doyle, MS

Myths about Autism
• No eye contact
• No speech
• Behavioral etiology
• Post natal onset
• Mental retardation in most
• Rare
• A-social
• Dismal prognosis

There is no single behavior that is always typical of autism or any of the autism spectrum disorders and no behavior that would automatically exclude an individual child from a diagnosis of ASD.

- Educating Children With Autism
Diagnostic and Statistical Manual of Mental Disorders Criteria

- Referred to as DSM-V
- Definition of autism recently revised in 2013
- Child must meet specified criteria organized into 4 categories: A, B, C, and D

DSM-V Criteria

Criteria A: Persistent deficits in social communication and social interaction across contexts, not accounted for by general developmental delays.

Manifested by all 3 of the following:
- Deficits in social-emotional reciprocity
- Deficits in nonverbal communicative behaviors
- Deficits in developing and maintaining relationships

New DSM-V Guidelines

1. Deficits in social-emotional reciprocity
   - Abnormal social approach
   - Failure of normal back and forth conversation through reduced sharing of interests, emotions, and affect and response
   - Lack of initiation of social interaction
New DSM-V Guidelines

2. Deficits in nonverbal communicative behaviors used for social interaction
   - Poorly integrated verbal and nonverbal communication
   - Abnormalities in eye contact and body language
   - Deficits in understanding and use of nonverbal communication
   - Lack of facial expression or gestures

New DSM-V Guidelines

3. Deficits in developing and maintaining relationships, appropriate to developmental level (beyond those with caregivers)
   - Difficulties adjusting behavior to suit different social contexts
   - Difficulties in sharing imaginative play and in making friends

New DSM-V Guidelines

Criteria B: Restricted, repetitive patterns of behavior, interests, or activities

Manifested by at least two of the following four criteria:
   - Stereotyped or repetitive actions
   - Excessive adherence to routines
   - Highly restricted fixated interests
   - Hyper- or hypo-reactivity to sensory input
New DSM-V Guidelines
Criteria C and Criteria D

Criteria C: Symptoms must be present in early childhood though may not fully manifest until social demands exceed limited capacities

Criteria D: Symptoms together limit and impair everyday functioning

Executive functioning—Problems with:

- Anger management
- Conflict resolution
- Understanding rules especially unwritten rules
- Modulating reactions
- Selective attention
- Theory of mind
Neurons, connections and normal brain development

• The adult brain has an estimated twenty billion neurons
• Each neuron has an average of ten thousand connections that directly link itself to other neurons
• So we have about one million billion of these connections in our brains

Source: The Developing Mind: How Relationships and the Brain Interact to Shape Who We Are, Daniel J. Siegel

Brain Connections

• The activation of nerves in the brain directly influences the way connections are made in the brain.
• More activations means more connections

Source: The Developing Mind: How Relationships and the Brain Interact to Shape Who We Are, Daniel J. Siegel

The Brain

• Neurons that fire together at one time will tend to fire again in the future
• "Neurons that fire together, wire together"
Neural Structure and Function

- Experiences that involve little emotional intensity seem to do little to arouse attention and vice versa.
- A positive emotional context is helpful.
- A negative emotional context can be harmful.
- Memories are based on the binding together of various aspects of neuronal activation patterns.
- Context helps us learn.

Source: The Developing Mind: How Relationships and the Brain Interact to Shape Who We Are, Daniel J. Siegel

Mechanisms Behind Autism

With functional MRI, a dramatic reduction of connectivity in the brain was noted in individuals with autism.

The Profile of Intact & Impaired Abilities in High Functioning Autistic Individuals

Intact or Enhanced
Attention
Sensory Perception
Elementary Motor
Simple Memory
Formal Language
Rule-Learning
Visuospatial processing

Cognitive Weaknesses
Complex Sensory
Complex Motor
Complex Memory
Complex Language
Concept-formation
Face recognition

Source: May 2007 Presentation by Nancy Minshew, MD, Autism Center of Excellence-University of Pittsburgh
Findings:
- Neurological Function and Neural Circuitry

- Simpler processing & abilities are intact/enhanced
- Information processing capacity is limited
- Integrative processing & higher order cognitive abilities are disproportionately impacted
- Inference: Higher order circuitry is under developed
- Individuals with autism are reliant on lower order circuitry & basic cognitive abilities to function

Source: May 2007 Presentation by Nancy Minshew, MD, Autism Center of Excellence-University of Pittsburgh

Mechanisms Behind Autism

- Some brain regions in individuals with autism do not communicate with each other as effectively as those without autism.

Mechanisms Behind Autism

2012 Study:

Functional MRI Scans were done on 31 adolescents with ASD and 29 without the disorder, while they were at rest, not engaged in any task.

Autism and Learning

• Individuals with autism learn differently

• What are the differences in the way children with autism learn compared to those without ASD?

Source: Gasgeb, Strauss, & Minshew. Child Dev 2006

The Adolescent Brain

Teens may be physically mature but brain development is not at a mature level.

The Adolescent Brain

• The cerebellum develops earlier than the pre-frontal cortex.
  • The cerebellum controls muscle coordination and balance.

So beginning drivers learn basic operational skills quickly, which may give false confidence in driving abilities.
The Adolescent Brain

- The pre-frontal cortex is among last parts of brain to develop, around the age of 25-29.
  - Emotional regulation, inhibition, and decision-making are influenced by pre-frontal cortex.

  Therefore, emotions and rewards have more influence in younger drivers

The Profile of Intact & Impaired Abilities in High Functioning Autistic Individuals

<table>
<thead>
<tr>
<th>Intact or Enhanced</th>
<th>Cognitive Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>Complex Sensory</td>
</tr>
<tr>
<td>Sensory Perception</td>
<td>Complex Motor</td>
</tr>
<tr>
<td>Elementary Motor</td>
<td>Complex Memory</td>
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Findings:

Disruptions in connectivity in Autism are concentrated in social centers of the brain.

-a circuit that is normally in sync with the rest of the social brain has become decoupled

Lack of connectivity in the brain seems to correspond with the following symptoms of autism:

- Difficulty processing sensory information
- Apraxia
- Difficulty understanding complex language and complex facial expressions and gestures
- Difficulty understanding social contexts

Connectivity Issues

Consistency, consistency, consistency!

- Slow down while speaking
- Use short simple sentences

- When addressing inappropriate behaviors:
  - Use few words
  - Remain neutral and calm
  - Positive emotional context

Communication Tips

Medications that can be helpful:

- Medications for sleep
  - Melatonin
  - Clonazepam
  - Lunesta
  - Restoril
  - Trazadone

- Medications for irritability
  - Risperidone
  - Seroquel
  - Abilify
  - Geodon

- Medications for attention
  - Strattera
  - Adderal
  - Quilreliavant
  - Ritalin

- Medications for anxiety
  - Clonazepam
  - Sertrale
  - Lexapro
  - Paxil
  - Buspar
Autism and driving

High Functioning Autism Spectrum Disorder (HFASD)

- HFASD represents a high-functioning disability with subtle cognitive deficits that may directly impact automobile driving.

Motor Differences

- Many individuals with HFASD are described as “clumsy,” or demonstrate specific impairments in movement preparation, planning, inhibition, and execution.

**ASD and ADHD**

Up to half of children and adolescents with Autism Spectrum Disorders have attention difficulties that meet criteria for ADHD

Sintig, Bruning, Morsch, & Lehmkuhl, 2008.

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**Differences in Higher Order Cognitive Processes**

Differences in 

mental flexibility (the ability to shift to a different thought or action based on the environment),

self-monitoring,

correction

Hill, 2004; Pijnacker et al., 2009).

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**Visual Perceptual Differences**

- Individuals with HFASD tend to engage in local processing (focusing on details) rather than focusing on the global or larger meaning of the presented visual stimuli

- As a result, an individual may become "lost in the details" of what he or she sees in the road, affecting both operational and strategic competencies of driving.

Sheppard, Ripar, Underwood, & van Loon, 2010).
• A greater proportion of individuals with autism spectrum disorders are at risk for a co-occurring mood disorder, including anxiety. *(Hofvander et al., 2009)*.

• In addition, difficulties with emotional regulation (self-calming) are common and may result in unsafe driving behaviors. *(Patil et al., 2006)*.

**Emotional Regulation Difficulties**

**Strengths Among Individuals with HFASD**

• Attention to detail

• “Rule Bound” and may be more likely to follow the law carefully (e.g., follow street signs, wear their safety belt, and not talk on cell phones) than to act recklessly.

Source: Patty Huang* and Flaura Koplin Winston*, Center for Injury Research and Prevention and Division of Child Development and Rehabilitation Medicine at The Children’s Hospital of Philadelphia, Philadelphia, PA.
CURRENT RESEARCH ON ASD/ADHD TEENS AND DRIVING

Blog from the Children's Hospital of Philadelphia

Driving is conceptualized into three main aspects:

1. A set of skills
2. Events prior to a crash
3. Adolescent brain

https://injury.research.chop.edu/blog/posts/developmental-disabilities-and-driving

Driving as a set of skills:

Russell Barkley’s hierarchical model of driving:
1. Operational competency
   Basic skills of driving, such as scanning for hazards, breaking, motor coordination, and reaction time
2. Tactical competency
   Decisions such as yielding, speed regulation, passing
3. Strategic competency
   Decisions about the best time of day to drive, weather conditions, alertness

Inattentiveness, impulsivity, decreased self-awareness, and emotional problems all affect skill sets.
REVIEW OF INTERVENTIONS AND DETERMINANTS OF DRIVING PERFORMANCE IN TEENS WITH ADHD OR AUTISM

Meta-analysis: Ten studies were appraised

Three Groups:
1. On-road studies
2. Driving simulator or virtual reality studies
3. Self-report/proxy report

In drivers with ADHD (9 Studies):
• Positive effect found for instrumented vehicle, simulator training, and parent involvement
• Psychotropic stimulants not associated with poorer on-road driving compared to placebo
• Driving possibly improved by prescribed stimulants
• Driving without stimulants may predict worse performance
• Self-report/proxy produced inadequate data

"Inadequate data about perception of driving hazards via video clips"


For teens with ADHD:
• Multimodal approach using instrumented vehicles, simulator, and parent involvement seems to improve driving.
• Training of awareness of environmental stimuli and hazard perception also provide benefits.
• Stimulant medication is helpful; therefore “drug holidays” may not be safe.
• Different subtypes of ADHD may have different driving outcomes.
  • i.e. inattention versus impulsivity
• Young male ADHD drivers had more risky driving behavior, traffic violations, and citations.

Discussion of Results

In ASD, only one study was found in the literature review.

The specific mechanics of driving errors were not found.

Proposed difficulties include motor-visual integration, situational awareness, or a combination of problems.

Future studies should be conducted by trained occupational therapists.
Indicators of Simulated Driving Skill in Adolescents with ASD

- Prospective two group study of 7 teens with ASD and 22 healthy controls
- Utilized comprehensive driving evaluation by OT-CDRS
- Ages were between 14 and 18 years
- Did not have learner’s permit or driver’s license

Source: Classen, S., and Monahan, M., Indicator of Simulated Driving Skills in Adolescents with Autism Spectrum Disorder, The Open Journal of Occupational Therapy, Vol. 1, Iss. 4, Summer 2013, Article 2

Method

- Visual acuity, peripheral field, and depth perception assessed with Optec 2500 Visual Analyzer Visual Tests
- Visual attention, processing speed, and divided/selective attention with the Comprehensive Trail Making Test
- Visual motor integration with the Beery Visual Motor Integration test
- Attention shifting and scanning speed with the Symbol Digit Modalities Test
- Motor performance with Bruininks-Oseretsky Test

Six driving errors were assessed:

1. Lane maintenance
2. Gap acceptance
3. Adjustment to stimuli
4. Visual scanning
5. Vehicle positioning
6. Signaling

Results:

Clinical Tests
ASD group had significantly poorer acuity of the right eye, took longer to complete the CTMT Trail 2, and performed more poorly on the Beery VMI and the BOT2.
Simulator:

- ASD group performed worse on all simulator operational skills.
- In driving errors, more difficulty with visual scanning, speed regulation, lane maintenance, signaling, adjustment to stimuli, and total number of driving errors.
- Significantly greater number of total traffic light tickets.

Discussion

- Poorer visual acuity of right eye was unexpected. However, only 7 subjects were studied.
- This result is supported in research by Simmon et al., 2009, who found that ASD teens have poorer visual acuity than normal controls.
- Poorer visual acuity was significantly and inversely correlated with lane maintenance and total driving errors.
- Another reason for differences is that Trail 2 is more complex than Trail 1 and has more distractors.

Errors of visual scanning, speed regulation, lane maintenance, signaling, adjustment to stimuli, and total number of driving errors can be explained by previously reported problems in ASD.

- Shifting attention and prioritization of visual information
- Perception of environment, interpretation, and motor response maintaining speed limit and controlling brake and accelerator
- Spatial awareness and visual motor integration
  - lane maintenance-lane position
• Understand and interpret social cues
  • signaling errors (on-road communication)

• Adjusting to stimuli
  • slow down for red light
  • observe surroundings before left turn

• Visual motor integration problems
  • coordination of vision with motor skills
  • press the brake when they see a red light

• Total number of driving errors
  • motor skill impairment and visual motor integration

Discussion, Cont.

Driving Characteristics of Teens with Attention Deficit Hyperactivity and Autism Spectrum Disorder

Subjects:
  • 22 Teens with ADHD and ASD
  • 22 Healthy Controls

Measures:
  • Clinical battery of tests
  • Optec 2500 Visual Analyzer
  • Useful Field of View
  • Visual-motor integration
  • Baer VMI
  • Cognitive abilities
    • Comprehensive Trail Making Test
    • Symbol Digit Modalities Test
  • Motor performance
    • Bruininks-Oseretsky Test of Motor Proficiency-2


Driving Performance

Discussion:
  • Impaired visual-motor integration is associated with errors in basic maneuvers necessary for adequate vehicle control.
  • In cognition, teens with both ASD and ADHD performed more poorly on planning, attention, set shifting, and sequencing.
  • Motor performance deficits included lack of inhibition of non-goal directed motor actions, sensitivity and timing of motor response, and postural instability.
  • Teens with ASD ineffectively prioritize information and have delay in attention shifting to recognize multiple stimuli on roadway.
  • Limitation
    • Simulator data may not be adequately sensitive to detect driving deficits.
Driving Hazard Perception in Autism

Subjects:
23 adult males with ASD
21 adult male healthy controls
Only non-drivers were used
They did not have comorbid diagnoses, such as ADHD

Method:
Subjects viewed 10 video clips with driving hazards.
In half of the clips, the hazard was a visible person.
In the other half, the hazard was a car, which is non-social.
Participants were asked to press response key as soon as they saw a hazard.
The video was stopped when the hazard key was pressed so that the subjects
could identify source of hazard.

Results
Subjects with ASD identified fewer hazard than controls.
Also, subjects with ASD identified fewer social hazards.
However, there was no difference between the number of non-social hazards identified.
ASD group was slower to respond to hazards.

Slower responding was demonstrated by the ASD group.
They may not have been aware of the hazard until a later stage of the action.
If this explanation is true, difficulty with slow responding decreases decision making time.
Alternately, the ASD group may have perceived the hazard at the same time but were slower to respond
due to motor control or planning difficulties.

Independent predictors of learning to drive included:
- measures of functioning at school and outside of the home,
- support from the school,
- and parent experience with teaching other teens to drive.

Patty Huang* and Flaura K. Winston*. * Center for Injury Research and Prevention and Division of Child Development and Rehabilitation Medicine at The Children’s Hospital of Philadelphia, Philadelphia, PA.

Summary of Driving in Teens with ADHD, Autism, and Intellectual Disabilities
- ADHD, autism, and intellectual disabilities all represent common neurocognitive disabilities associated with deficits that may impact the operational, tactical, and strategic competencies of driving.
- Because individuals with autism spectrum disorders and intellectual disabilities are at higher risk for ADHD-like behaviors, it would not be surprising if they had similar risky driving patterns.

Teaching adolescents with ASD to drive
Pre-driving Interventions

Have driving goals in the teen’s Individual Education Plan.

Teach new vocabulary words

“Commentary driving” is helpful before the teen is driving age. Teen sits in the passenger seat and practices visual scanning while parent drives.

One item to be scanned is selected, i.e. brake lights. When teen has mastered one task, another can be added such as finding stop signs.

Turn taking can be practiced with Hot Wheel cars, especially four way stop signs.

Visual aids can demonstrate the size of objects on the road.

Use graphics to show where problems may develop.

Practice prediction of what comes next in a situation, what is missing, and possible unexpected outcomes.

Sequence actual route before leaving. Use maps and actual pictures.

Practice an emergency phone call before the emergency occurs.

During BTW instruction

Controlled stages of driving

Much slower instructional rate: approximately two times longer than for average peers.

Shorter driving sessions

Fewer instructions per session
During BTW instruction

Begin in familiar neighborhoods. Teens with ASD should only drive one or two routes near their homes.

After they are proficient with these routes, new driving areas can be added slowly.

Drive with an adult other than their parents.

Only one novel technique per session so that teens are not overwhelmed with new information.

A positive emotional atmosphere during all driving and feedback is essential.

Give feedback when the car is stopped or at the end of the session.

“Neurons that fire together wire together”

CONSISTENCY
REPETITION
Positive Emotional Context

CONSISTENCY
REPETITION
Positive Emotional Context
The State Farm/CHOP suggests in their report three levels of independence

- Level one (0 to 6 months):
  Drive only during daytime.
- Level two (6 to 12 months):
  Extends driving time through the evening hours.
- Level three (12 to 18 months):
  Drive freely while following agreed upon rules.

Everyday Rules:

- Take medication as prescribed.
- Fill out the log every trip.
- While driving:
  - Keep music low
  - Use preset radio stations only
  - No eating
  - No texting or mobile phone use
  - No other teens in the car
  - Absolutely NO alcohol or other intoxicants

Key Takeaways

- Issues with reading, visual processing, impulsivity and motor skills can all impact driving.
- Poor problem-solving skills can make it harder to handle accidents or other roadside problems.
- Kids with learning and attention issues may take longer to learn to drive, and need more practice than other kids.
Perhaps, specialized driving programs will be necessary to improve hazard perception in some people with ASD.

CONCLUSIONS

Autism Spectrum Disorder is common.

Teens with ASD have additional challenges when learning to drive.

Among the challenges are difficulties with:
- Sensory processing
- Visual-motor integration
- Executive functioning
- Attention
- Anxiety
- Social communication

In the Future

Many more research studies done by OT-CDRS in collaboration with teens and parents are needed.

END