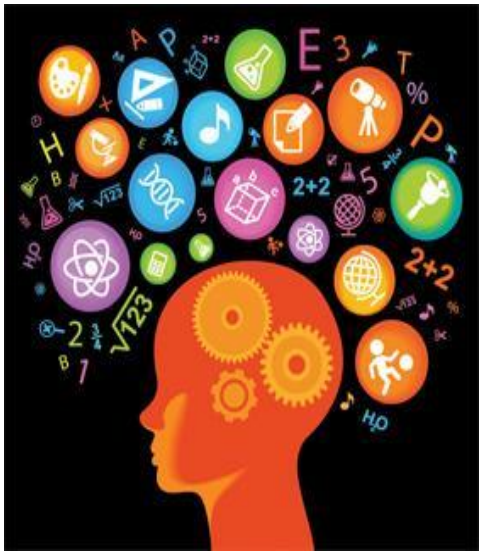
MASSACHUSETTS GENERAL HOSPITAL
PSYCHIATRY ACADEMY

Driving and Working Impairments in ADHD and ASD



Ronna Fried, Ed.D.

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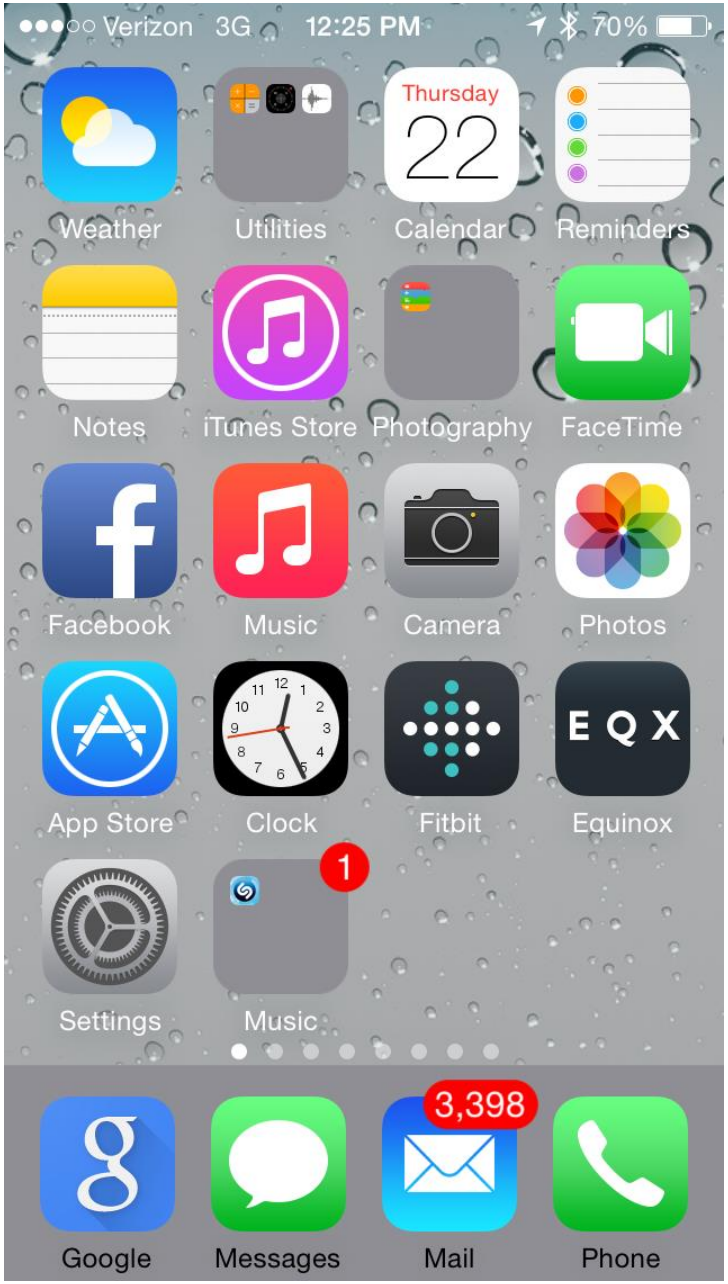
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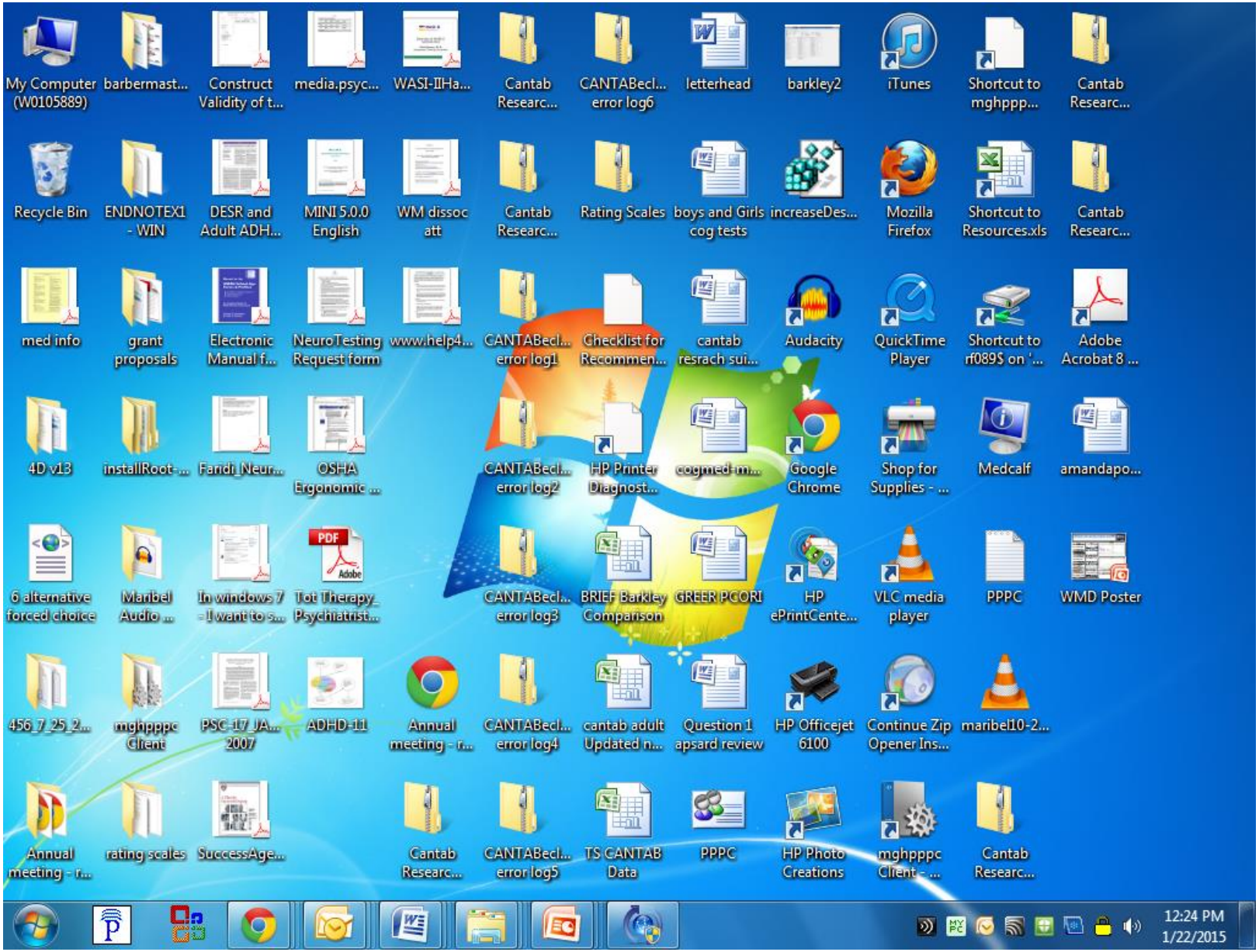
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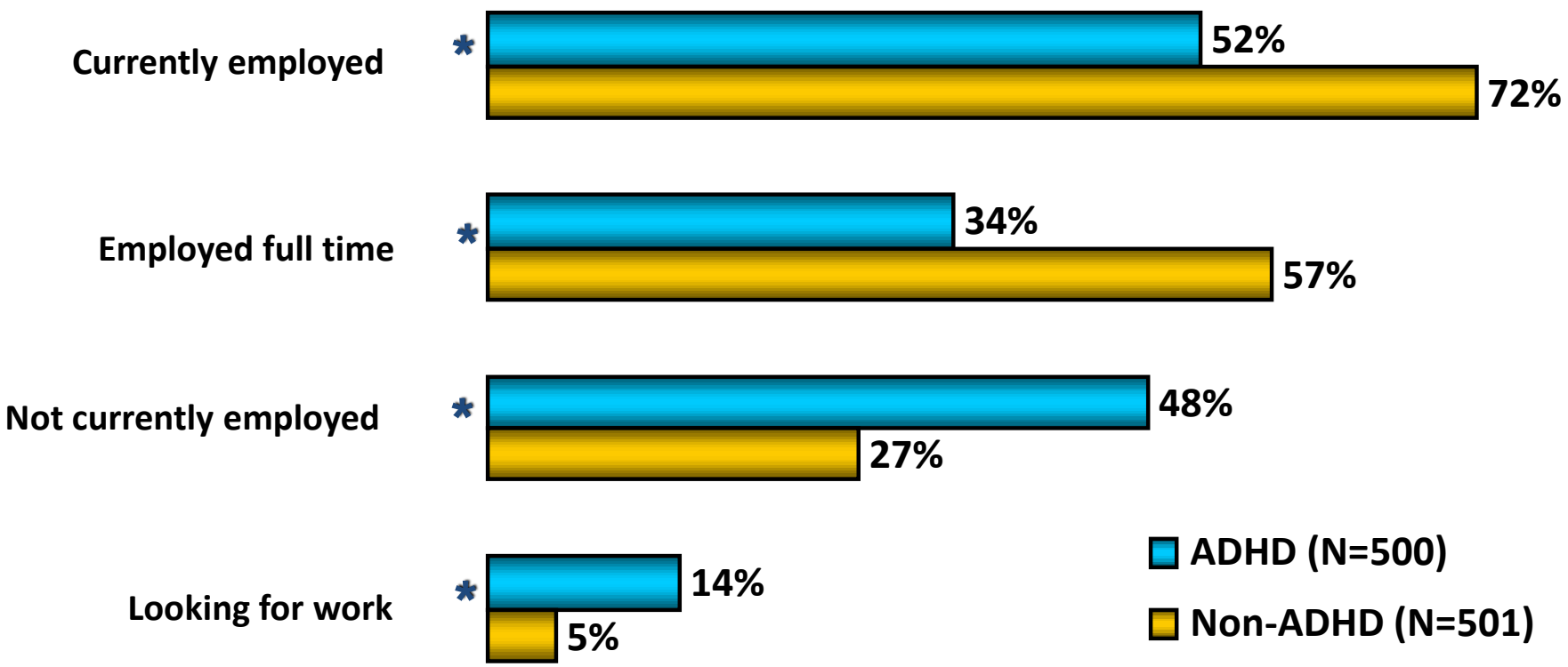
Current Employment Status

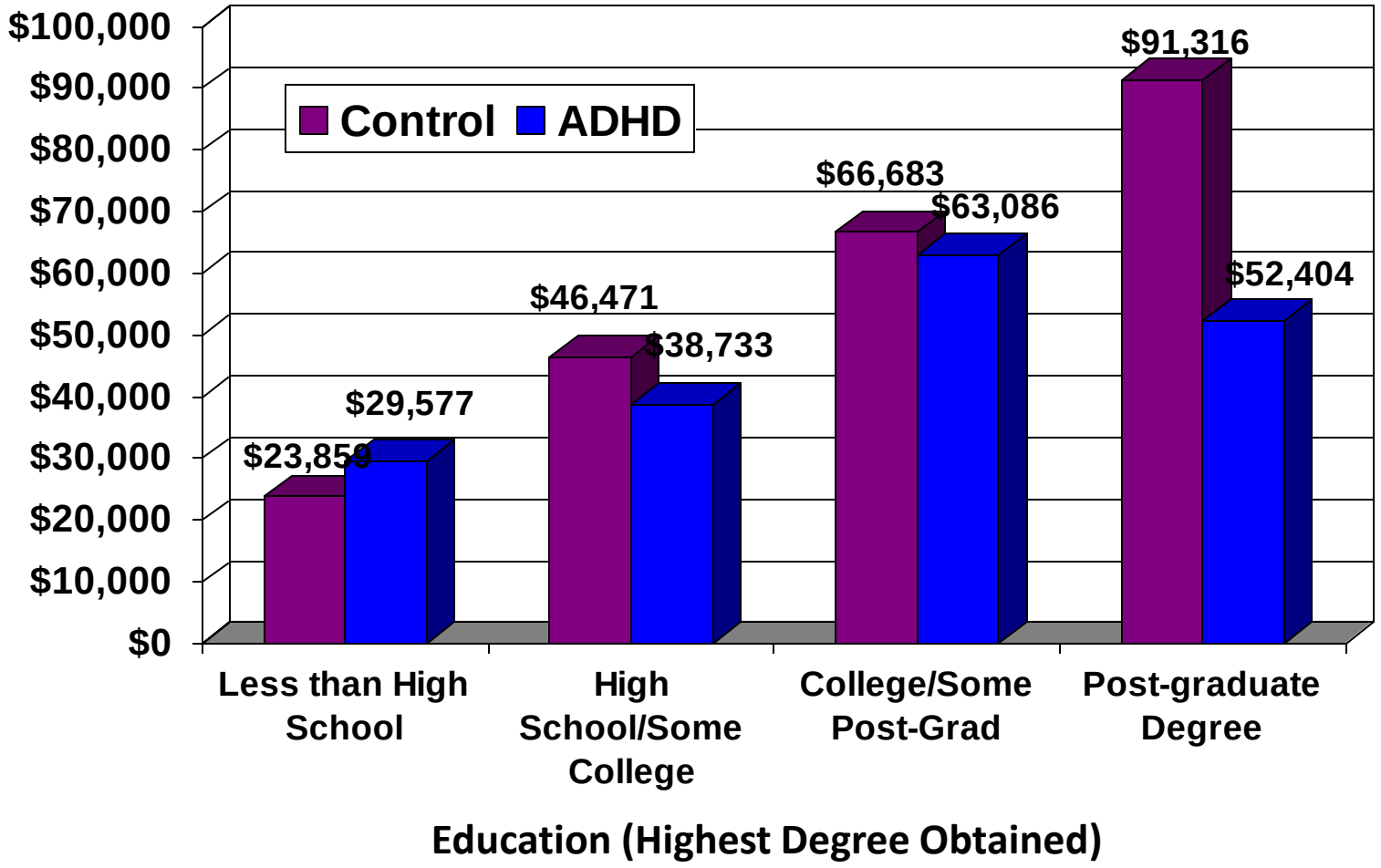
Percentage of Each Group



* $p \leq .001$

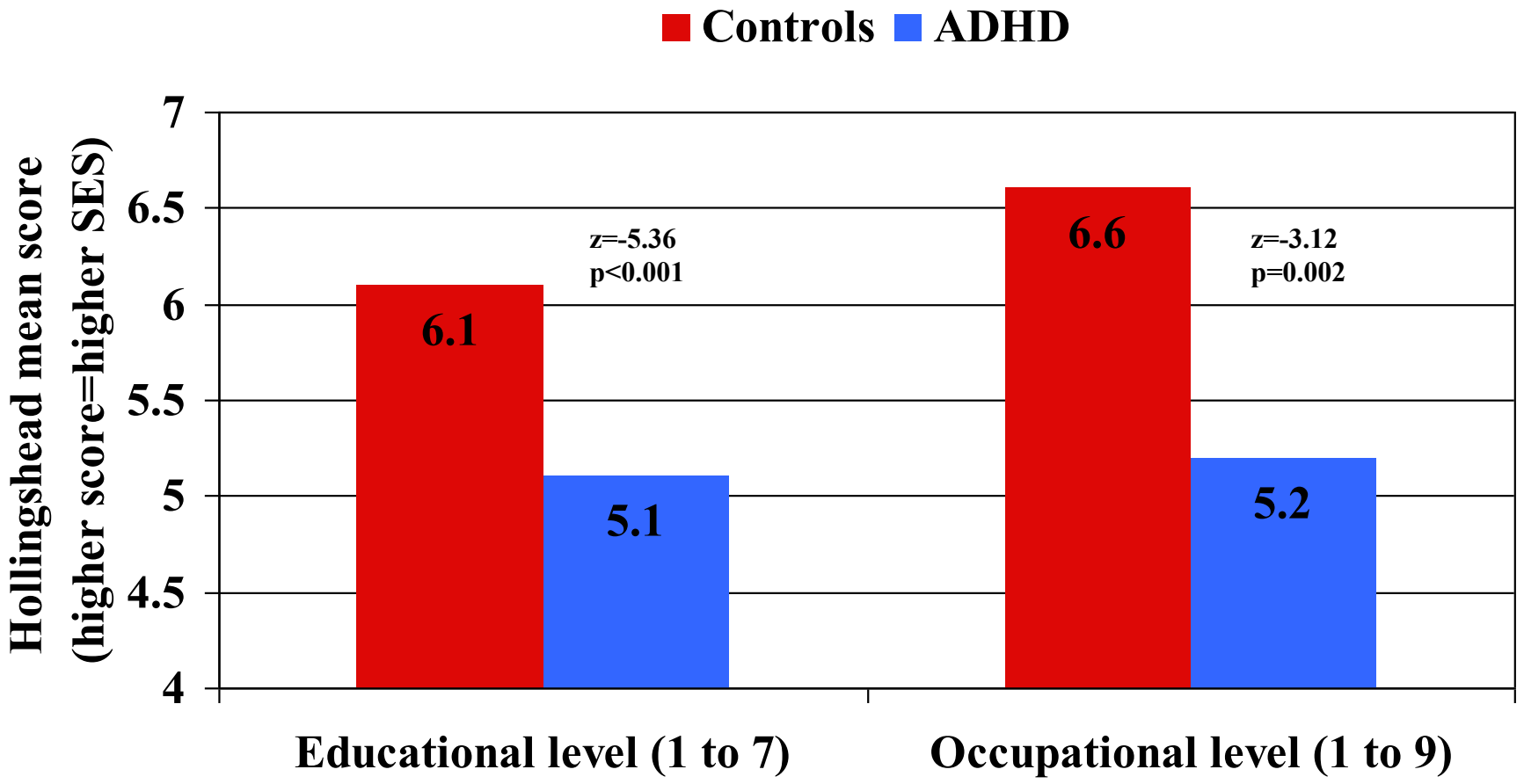
Biederman et al. *J Clin Psychiatry*. 2006 Apr; 67(4):524-40

Average Household Income by Education Level Attained



Biederman and Faraone. *Medscape General Medicine* 2006; 8:12.

Educational and Occupational Level at the 16-Year Follow-Up



Biederman et al. 2012 JCP

Why Study Work Impairments in Adults with ADHD?

- Despite well documented evidence regarding workplace deficits in adults with ADHD , uncertainties remain as to what drives them
- Such knowledge is critical to develop strategies to help mitigate them

How Can We Study Workplace Performance?

- Obtaining direct information from the employer may be neither feasible nor ethical
- Simulation paradigms could offer an approach to study this problem in a safe and ethical manner

How Do We Develop a Valid Workplace Simulation Paradigm?

- Assess subjects with and without ADHD under double blind conditions
- Simulate a full work day
- Use tasks that require skills needed for productivity in the average work environment
- Use tasks that tax inattention, hyperactivity and impulsivity
- Measure subject's experiences through self reports
- Measure subject's objective performance through observer ratings

Do ADHD Symptoms Affect Work Performance?

- Moves Around Excessively (Hyperactivity)
- Interrupts and Disrupt Others
- Procrastinates
- Fails to Pay attention to Details
  - Press statement @WhiteHouse says 1 goals of @POTUS Israel trip is "promote the possibility of lasting peach"

The Secretary's Commission on Achieving Necessary Skills (SCANS)

- Allocates Time
- Inhibition
- Shifting
- Initiation/Arousal/Activation
- Working Memory
- Planning/Organization
- Self-Monitoring
- Time Perception/Estimation

Does ADHD adversely affect these skills?

Main Aim

- To develop a workplace laboratory paradigm specifically developed to assess workplace deficits in adults with ADHD

Funding Source

- NIH/NIMH 1R21MH081085-01

Study Hypotheses

- Adults with ADHD will show more impairment in work performance than controls
- Individuals with ADHD will exhibit more behavioral disruption and impulsivity as rated by objective blind observers compared with control subjects
- Adults with ADHD will self-report more symptoms of ADHD than will control subjects

Methods: Subjects

- Inclusion Criteria:
  - Adults 18-55 years
  - Both sexes
  - DSM-IV diagnosis of ADHD based on clinical assessment by an expert clinician
- Exclusion criteria:
  - Major sensorimotor handicaps
  - Any significant other psychiatric condition
  - Use of any psychotropics or stimulant medication
  - Insufficient command of English
  - IQ < 80

Methods: Assessments

- Clinical Assessment
- SCID (supplemented with modules form KSAD-E to assess for ADHD, other childhood disorders)
- Neuropsychological battery: WASI; TOWRE;D-KEFS; WAIS-III Processing Speed & Digit Span; CANTAB
- Endicott Work Productivity Scale
- Self Evaluation Scale (ADHD symptoms)
- Observer Assessment (ADHD symptoms)

Work Simulation Schedule

Time	Tasks
08:00 AM - 08:30 AM	Orientation
08:30 AM - 10:00 AM	Period 1: Structured Tasks
10:00 AM - 11:30 AM	Period 1: Unstructured Tasks
11:30 AM - 12:15 PM	Lunch Break
12:15 PM - 01:45 PM	Period 2: Structured Tasks
01:45 PM - 03:15 PM	Period 2: Unstructured Tasks
03:15 PM - 03:30 PM	Break
03:30 PM - 05:00 PM	Period 3: Structured Tasks
05:00 PM - 06:00 PM	Period 3: Unstructured Tasks

Workplace Simulation Tasks

Each task below was administered 3 times during the work day:

Task	Time Allotment
Educational Video	30 min
Employment History Forms	10 min
Math	5 min
Lecture	15 min
Reading Comprehension	20 min
Editing	10 min
Unstructured Task Period	1 hour, 30 min
Total Time:	**9 Hours (each task 3xs)**

Observations: Hyperactivity

Criteria:

- 0=None=Out of room 1x for <10 min
- 1=Mild=Out of room 1x for >10 min
- 2=Moderate=Out of room 2x 10-15 min total
- 3=Severe=Out of room 3x or 2x >15 min total
- 4=Extreme=Out of room 4x or more >50% time-logic

Observations: Inattention

Criteria:

- 0=None= >90% of time spent on required tasks
- 1=Mild=81-90% of time spent on required tasks
- 2=Moderate=71-80% of time spent on required tasks
- 3=Severe=61-70% of time spent on required tasks
- 4=Extreme=≤60% of time spent on required tasks

Results

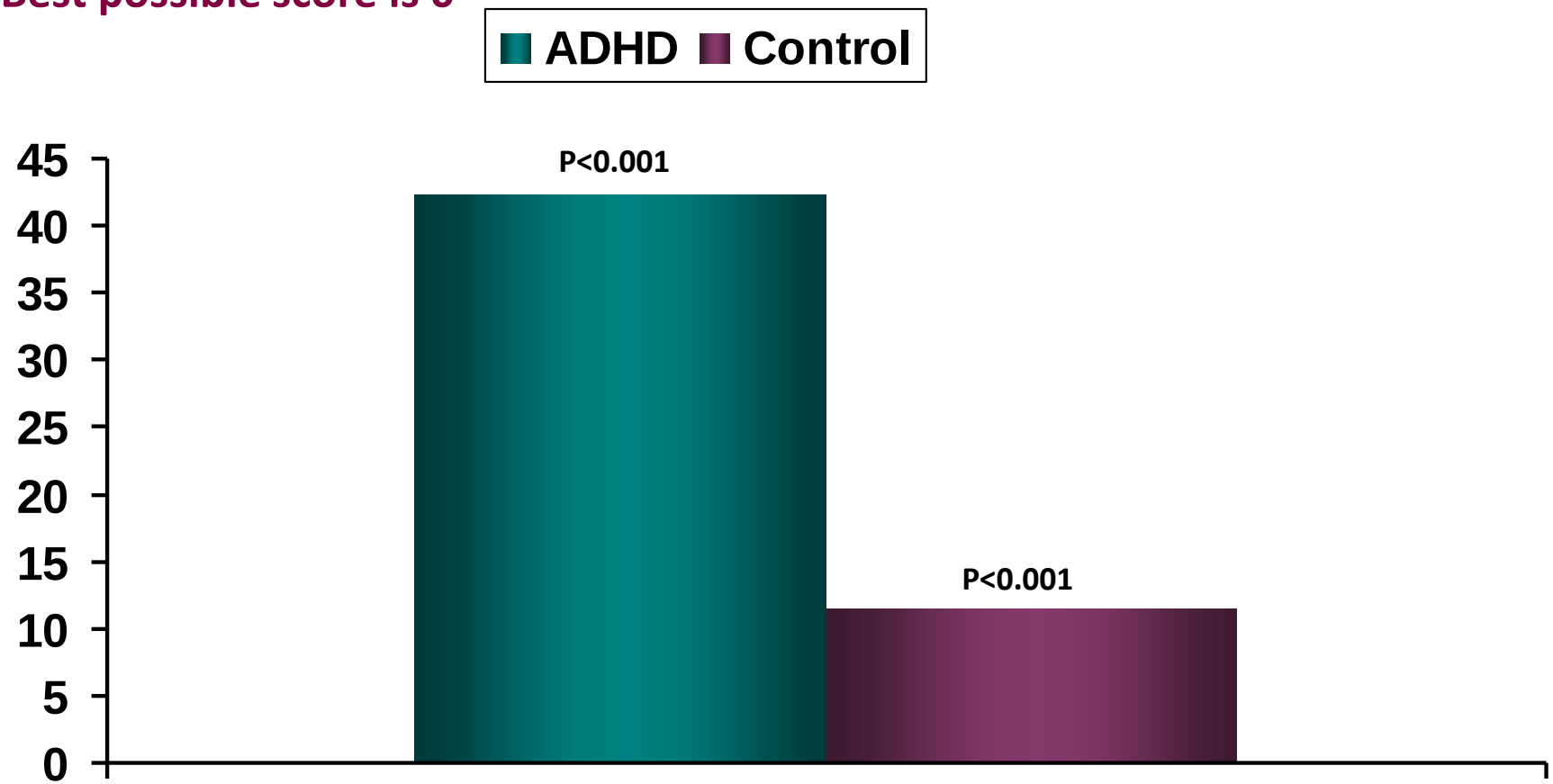
Demographics

	ADHD (N=56)	Controls (N=63)	Test statistic	p-value
	Mean ± SD or N (%)	Mean ± SD or N (%)		
Age	28.3 ± 8.5	30.8 ± 10.2	$t_{(113)}$=-1.40	0.16
Sex	29 (54)	25 (41)	$\chi^2_{(1)}$=1.86	0.17
Socioeconomic status	2.2 ± 1.2	2.2 ± 0.9	z=-0.48	0.63
Mean number of ADHD symptoms	8.2 ± 0.9	--	--	--
Global Assessment of Functioning	61.0 ± 4.8	70.5 ± 2.2	$t_{(113)}$=-13.76	<0.001
IQ	114.6 ± 10.8	118.4 ± 9.8	$t_{(111)}$=-1.92	0.06
Endicott Work Productivity Scale	42.4 ± 17.4	11.5 ± 10.4	$t_{(99)}$=11.10	<0.001
Number of jobs per year after completed education	0.82 ± 0.99	0.63 ± 0.69	z=0.82	0.41

Fried et al, Psychiatry Res. 2012 Dec 30;200(2-3):949-56.

Endicott Work Productivity Scale

- 25 items
- Maximum score possible (i.e. the worst possible score) is 100
- Best possible score is 0

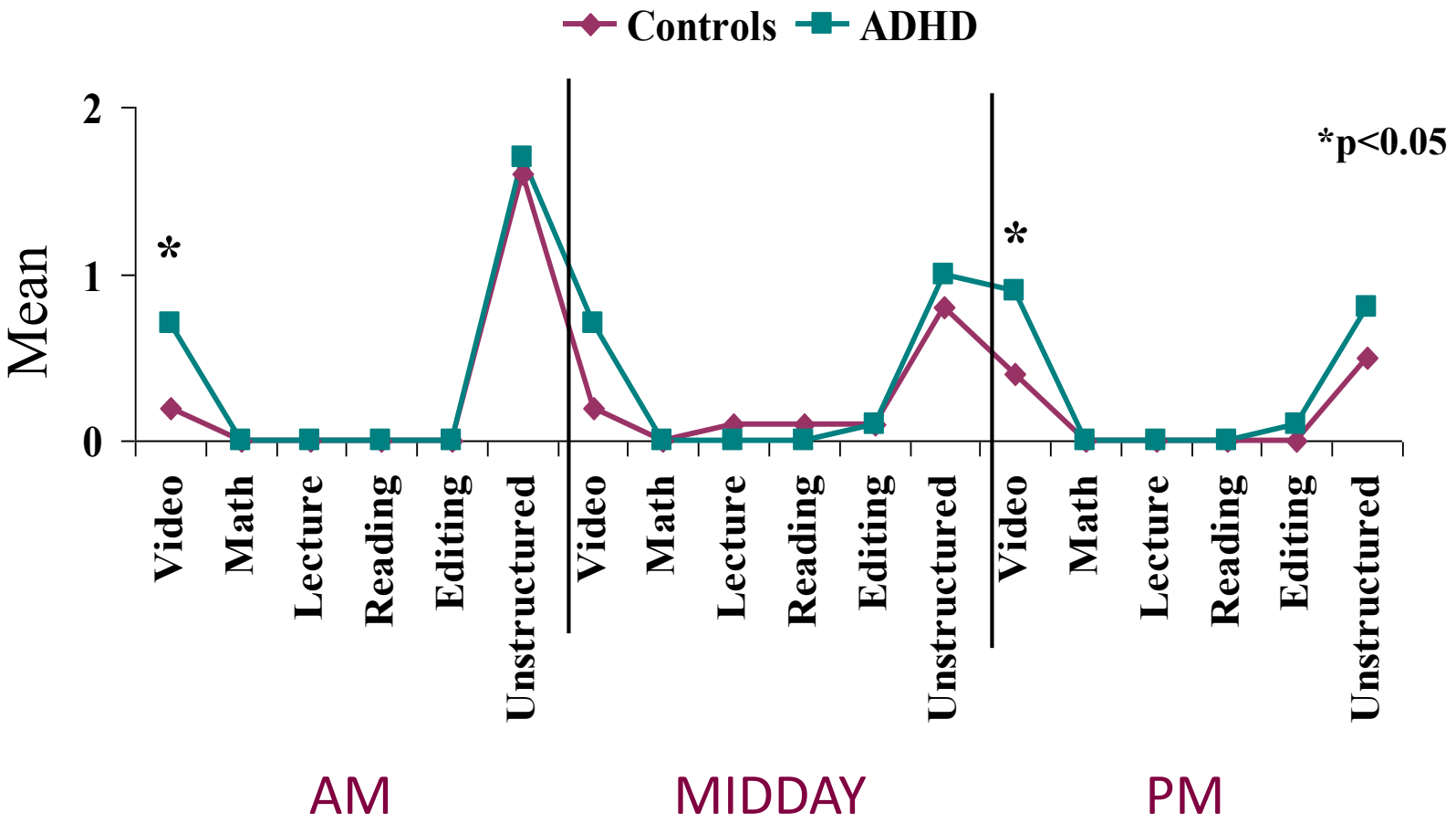


Fried et al, Psychiatry Res. 2012 Dec 30;200(2-3):949-56.

Work Simulation Results

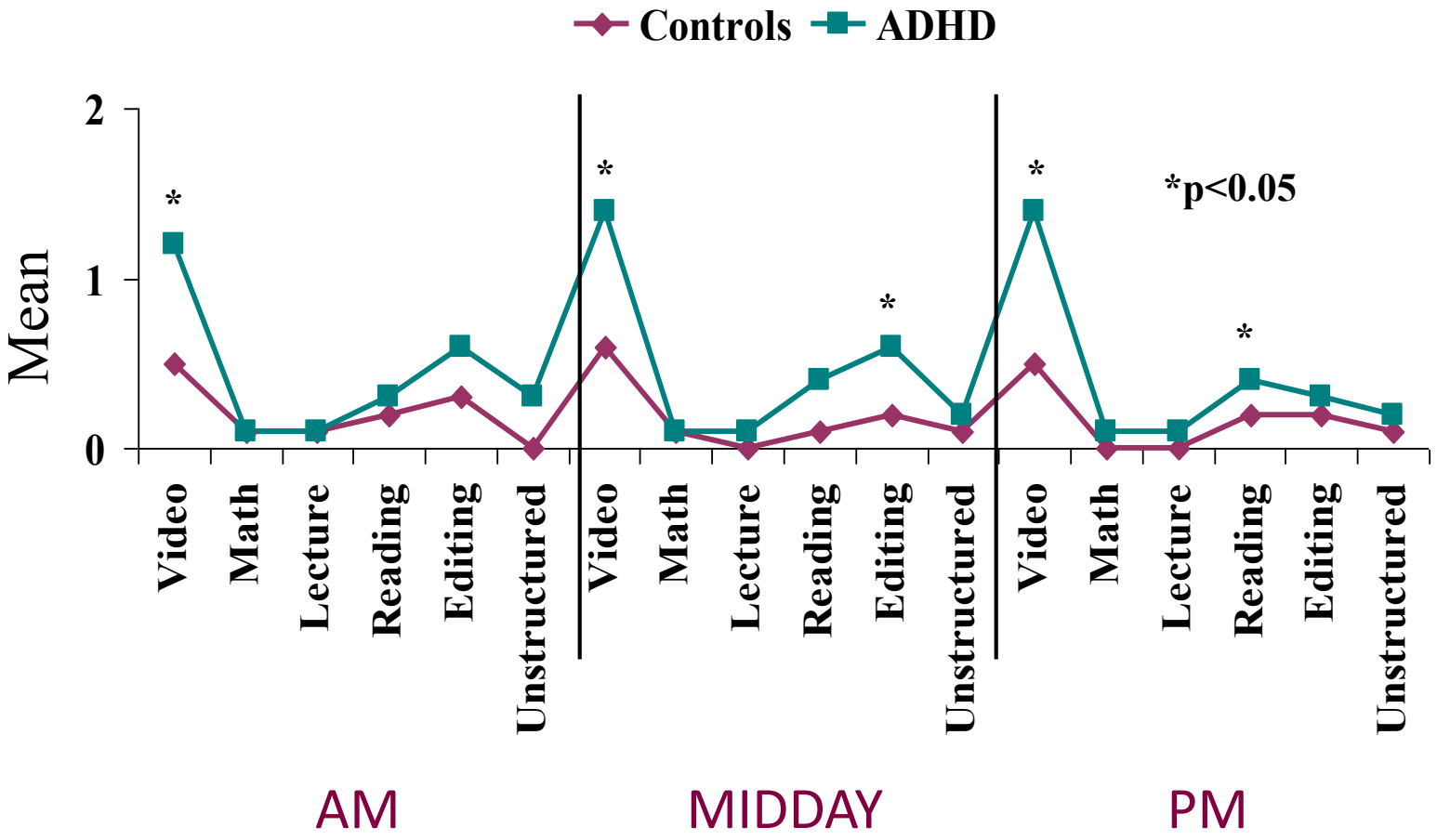
- Skills
- Observer Ratings
- Self-Report

Observer Rating: Inattention



Fried et al, Psychiatry Res. 2012 Dec 30;200(2-3):949-56.

Observer Rating: Hyperactivity



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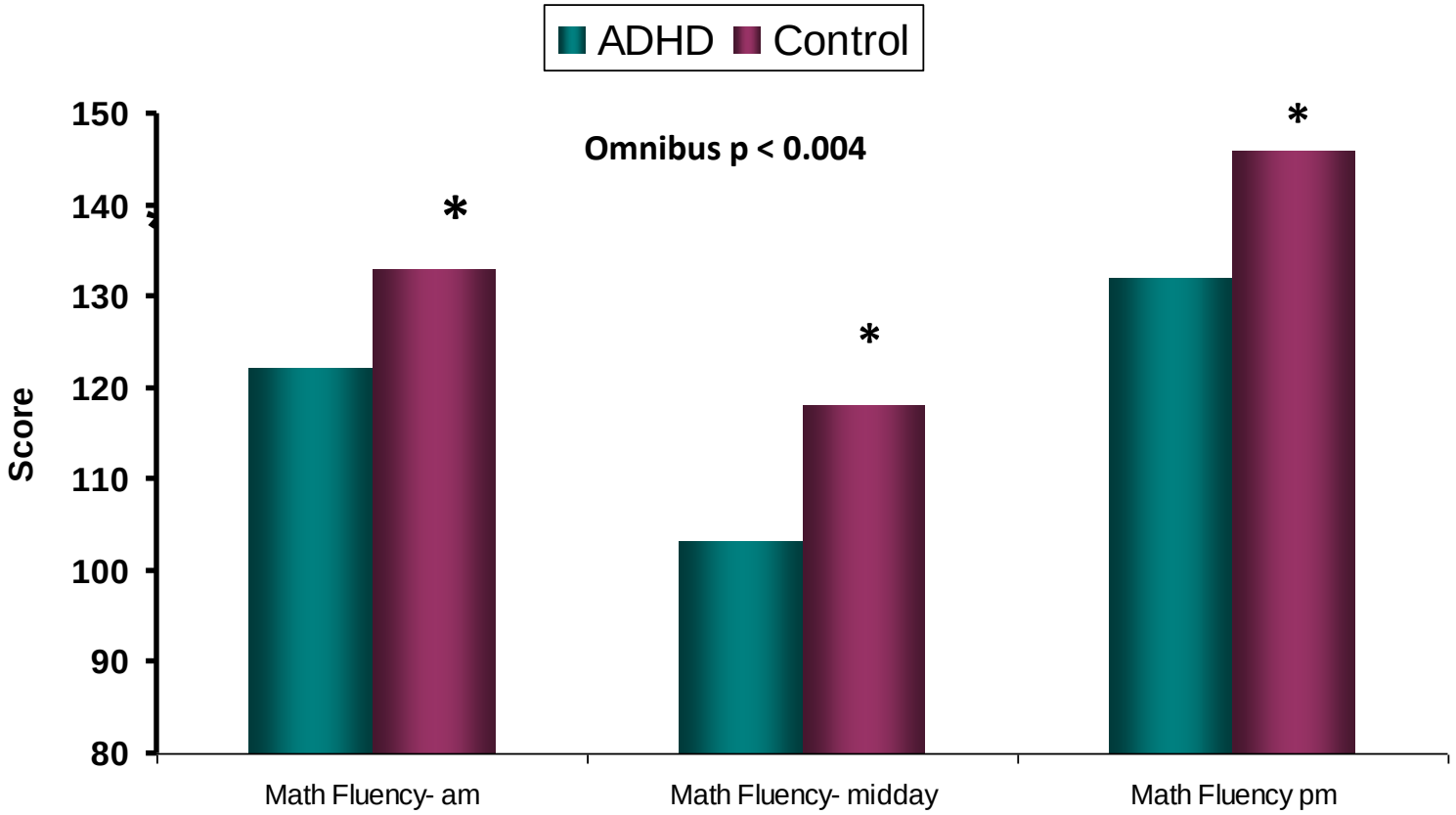
Math Fluency Scores



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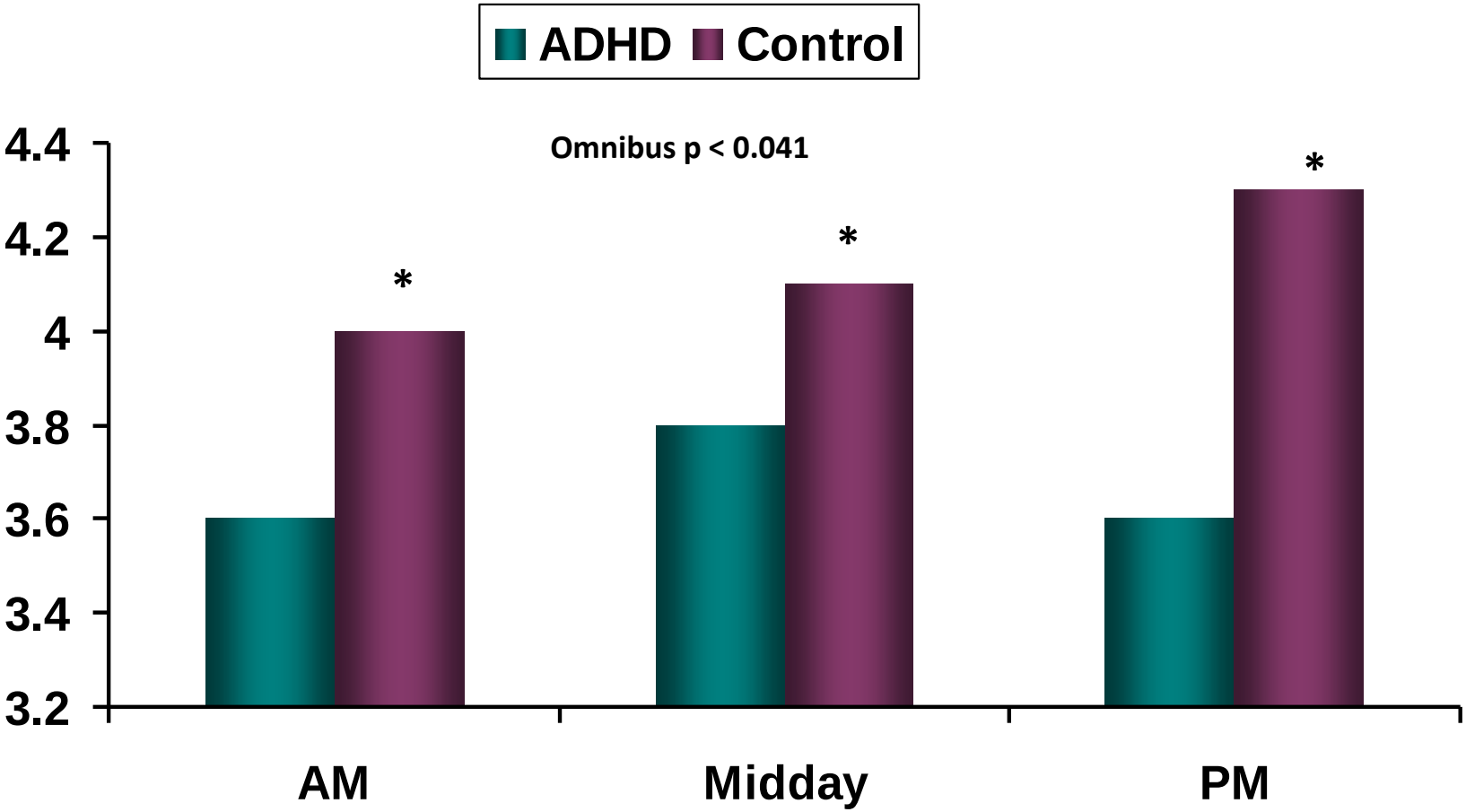
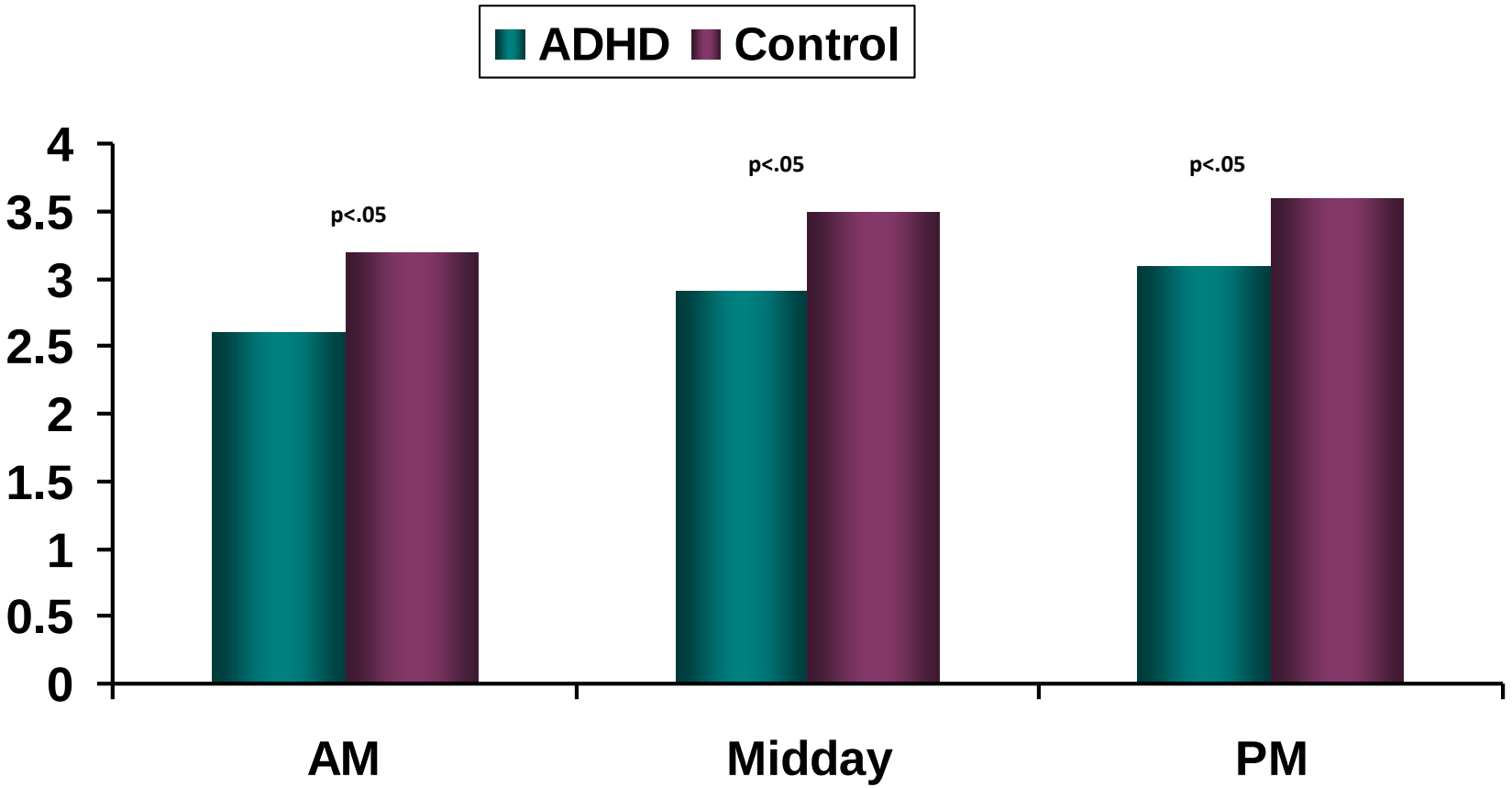
Reading Task



Fried et al, Psychiatry Res. 2012 Dec 30;200(2-3):949-56.

Editing (Punctuation)



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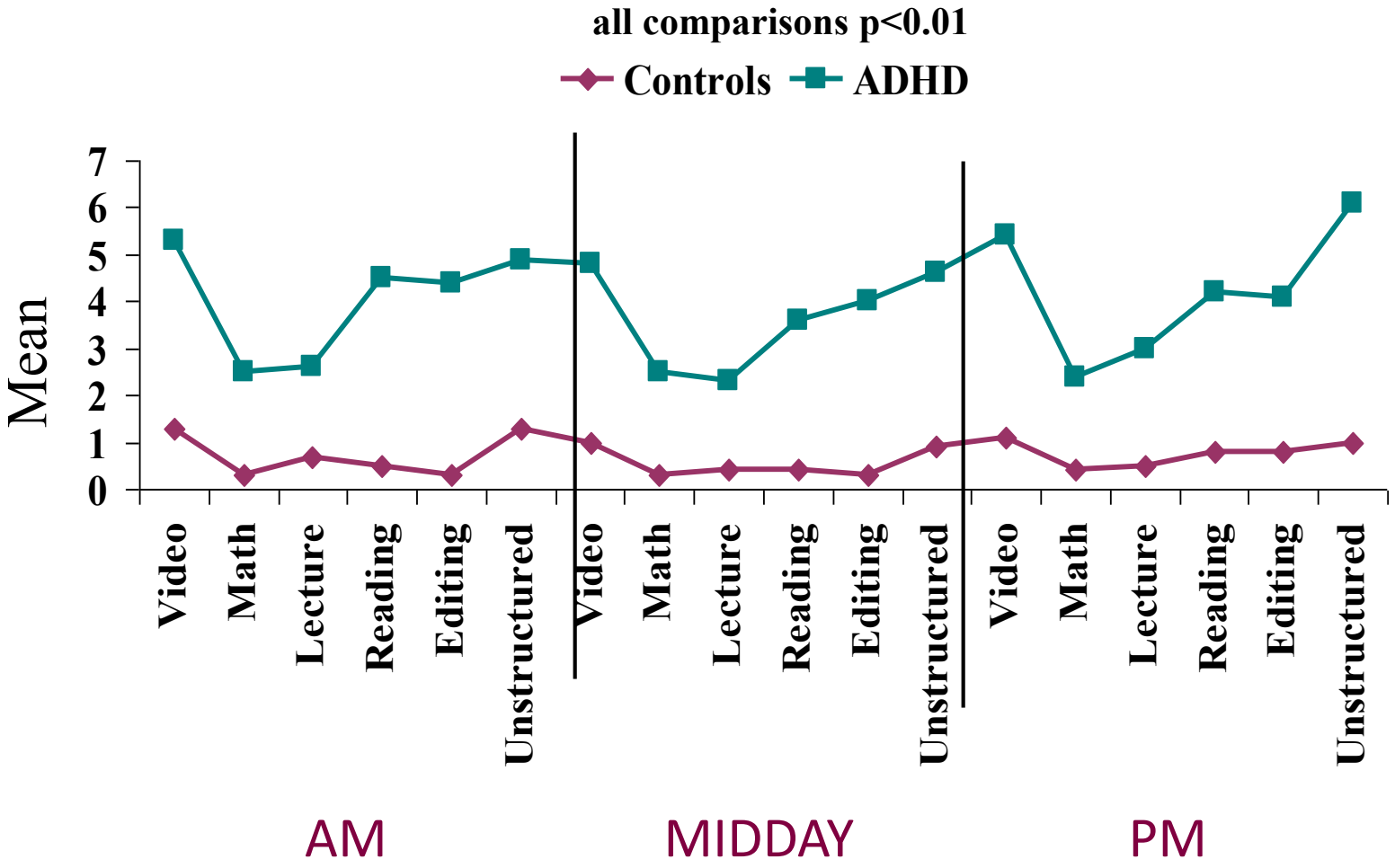
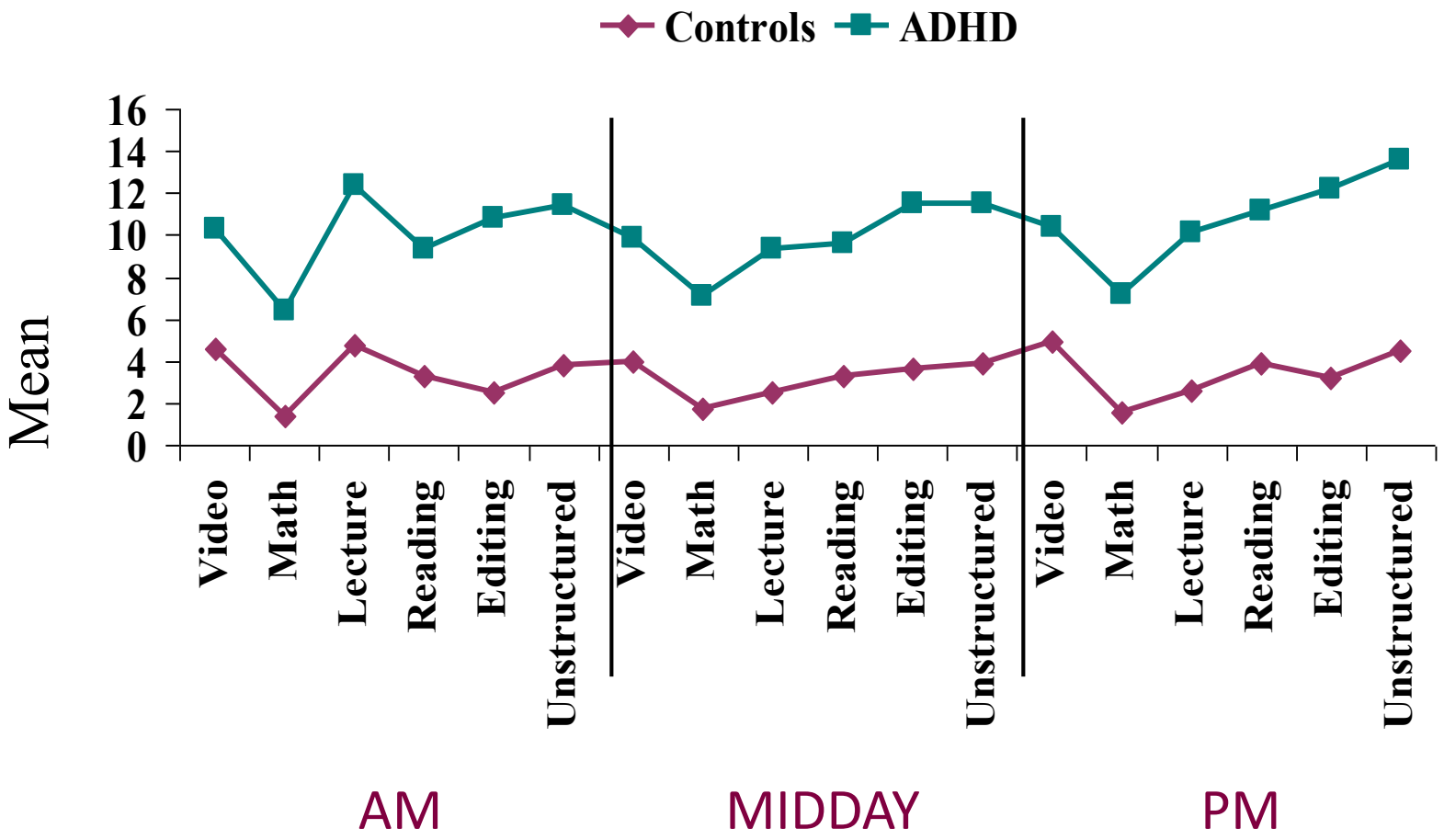
Self Rating: Hyperactivity



Fried et al, Psychiatry Res. 2012 Dec 30;200(2-3):949-56.

Self Rating: Inattention

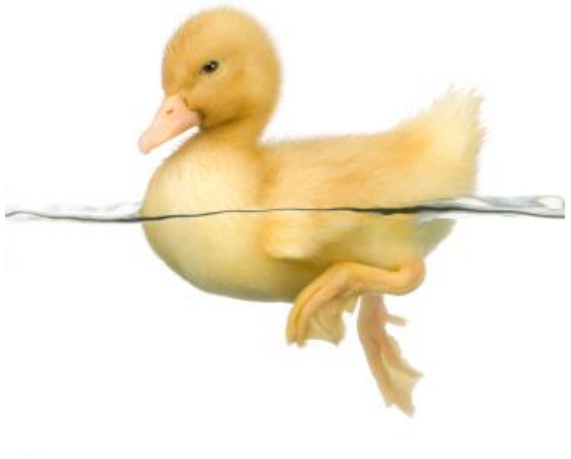
all comparisons p<0.001



Fried et al, Psychiatry Res. 2012 Dec 30;200(2-3):949-56.

Main Findings

- ADHD subjects had more trouble than controls sitting still during boring tasks

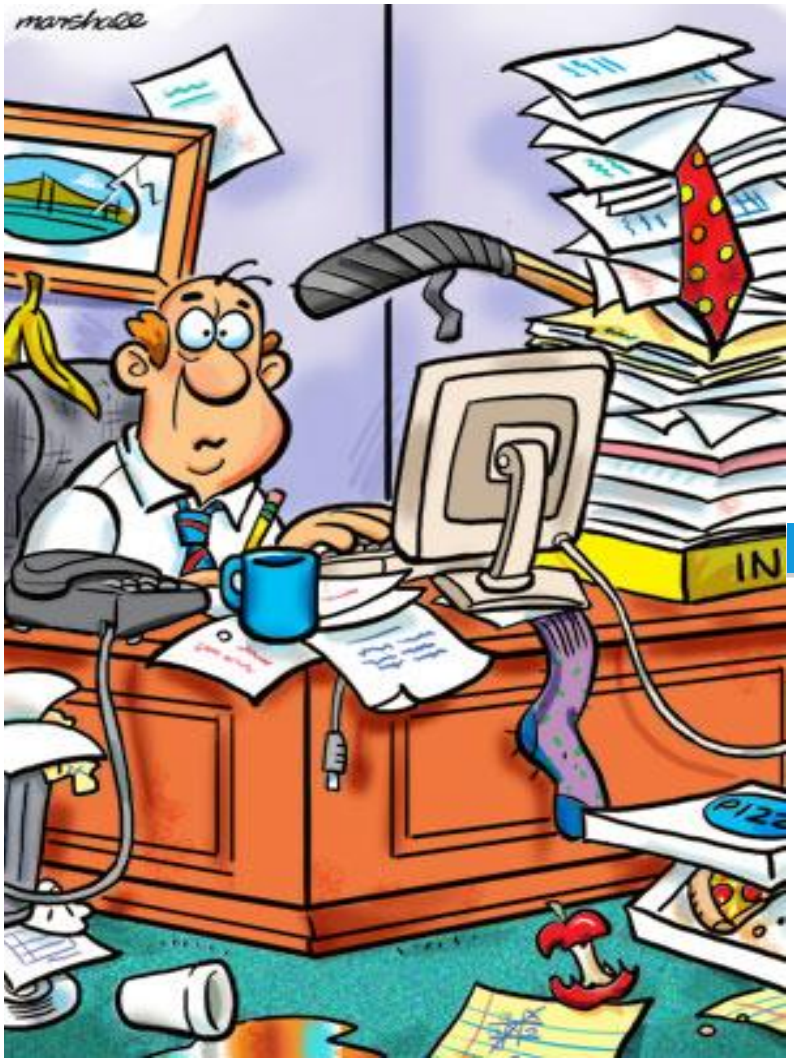


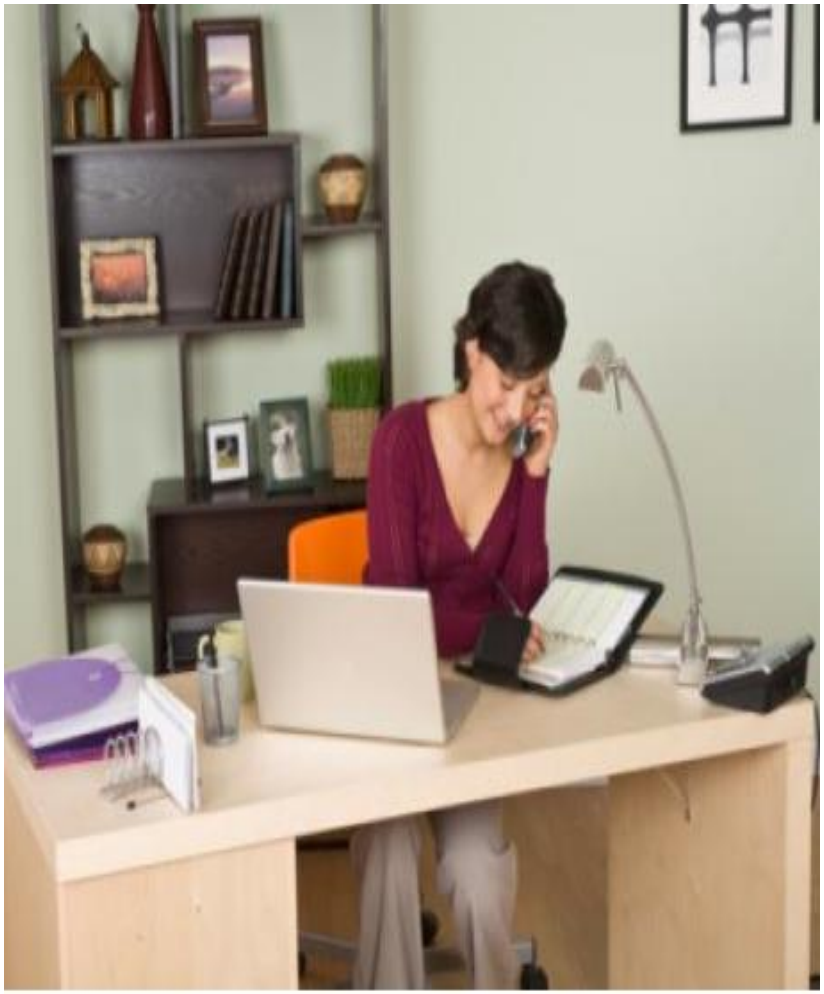
- Internal struggle with symptoms of ADHD reported by ADHD subjects across the board, despite lack of observer rating of externalized symptoms
- Consistent with previous research: Adults with ADHD more likely to appear calm but suffer from internal restlessness than children with same diagnosis

Implications

- Adults with ADHD have specific workplace deficits
- Research is urgently needed to investigate whether treatments for ADHD will improve workplace performance

Future Directions: Would Treatment Help?





MASSACHUSETTS GENERAL HOSPITAL
PSYCHIATRY ACADEMY

Autism Spectrum Disorder:
In the Workplace

Ronna Fried, Ed.D.

The Alan and Lorraine Bressler Clinical and Research Programs for Autism Spectrum Disorder at

Massachusetts General Hospital

Why Study Work?

- Estimated that at least 1% of adults in the country are affected by Autism Spectrum Disorder (59% high functioning)
- Difficulty securing and maintaining employment
- unemployment rate is 75% – 97%.
- annual indirect costs due to loss of productivity to the individual with ASD and his/her family to range from $39,000 to $130,000.

Why Study Work?

The ability to work not only provides the financial resources to lead an independent life, but also provides

- self-esteem
- stimulation
- social contacts
- structure to one's life

Background

- Literature does not address Reasons for workplace Failure
- Unethical to Observe within actual Workplace
- Unable to discern if ASD features or other causes are reason for failure

Methods

- 7 Participants with ASD
- Full 10-hour day
- Compared to Control Subjects
- Tasks Based on National SCANS report

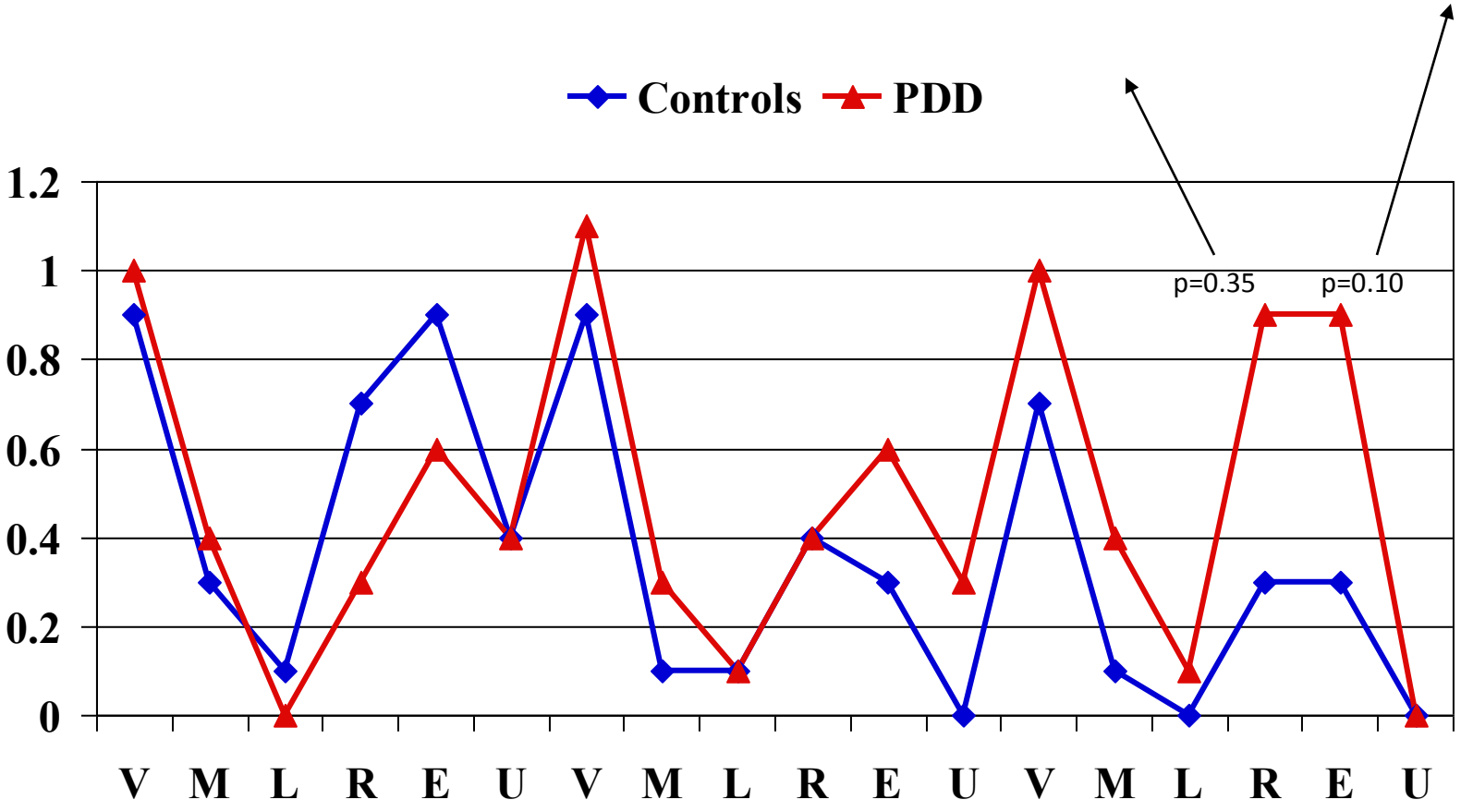
Methods

- **ASD subjects underwent a comprehensive psychiatric evaluation by an expert clinician**
- **Included a detailed assessment with the patient and the parent**
- **Diagnosis based on DSM-IV criteria.**
- **Control subjects were age and sex matched adults recruited from advertising in the local media.**

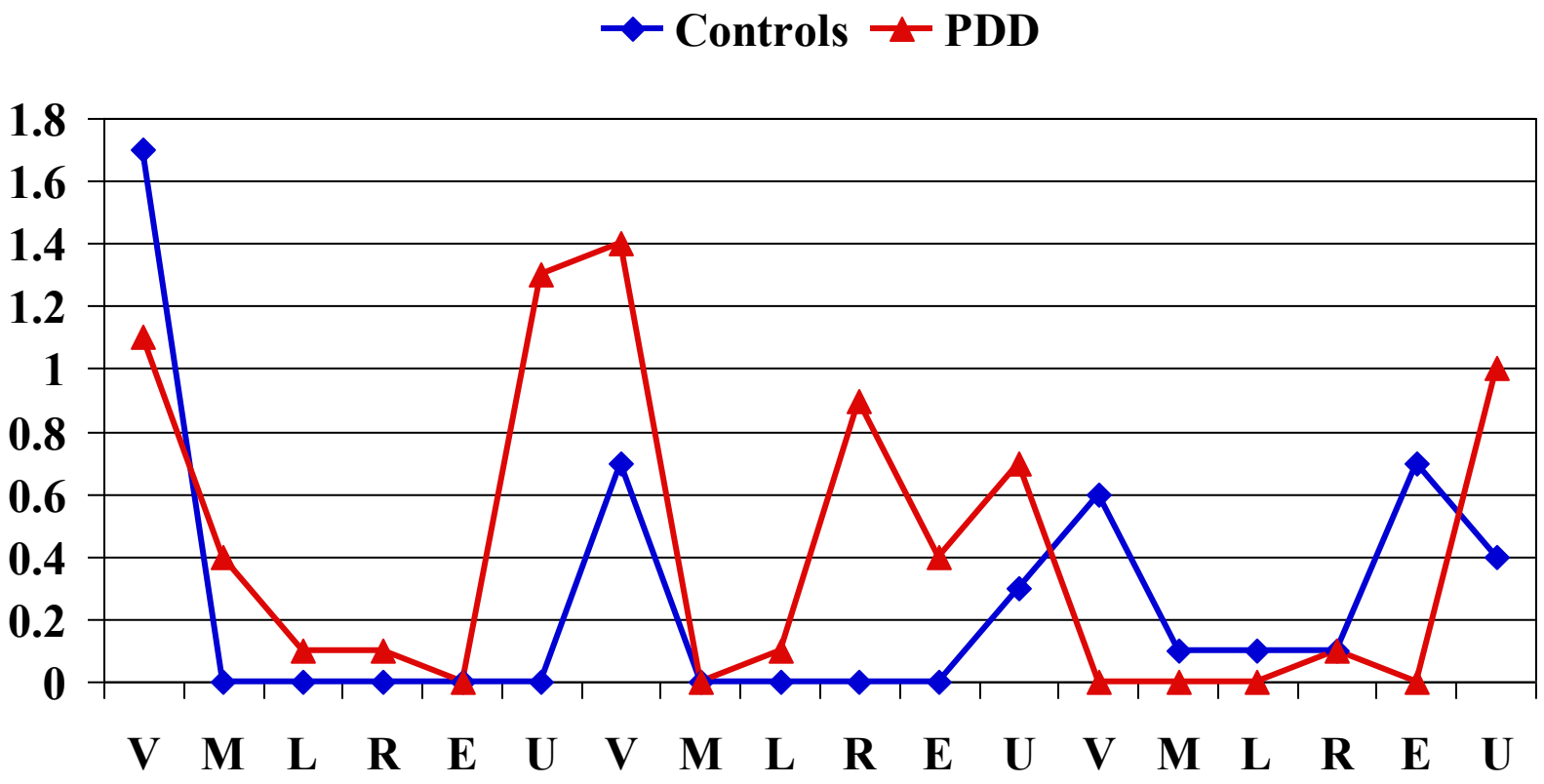
Schedule

8:30-9		Orientation
9-9:30	Structured	Video
9:30-9:40		Math
9:40-9:45		Lecture
9:45-10:05		Reading
10:05-10:20		Editing
10:20-12:00	Unstructured	Logic; Writing; Computer; Product Order
12:00-12:45		Lunch
12:45-1:15	Structured	Video
1:15-1:25		Math
1:25-1:30		Lecture
1:30-1:50		Reading
1:50-2:05		Editing
2:05-3:35	Unstructured	Logic; Writing; Computer; Product Order
3:35-3:45	Structured	Lecture Questions
3:45-4:15		Video
4:15-4:25		Math
4:25-4:30		Lecture
4:30-4:50		Reading
4:50-5:05		Editing
5:05-6:45	Unstructured	Logic; Writing; Computer; Product Order
6:45-7:00		Check-out

Observer Rating - Hyperactivity

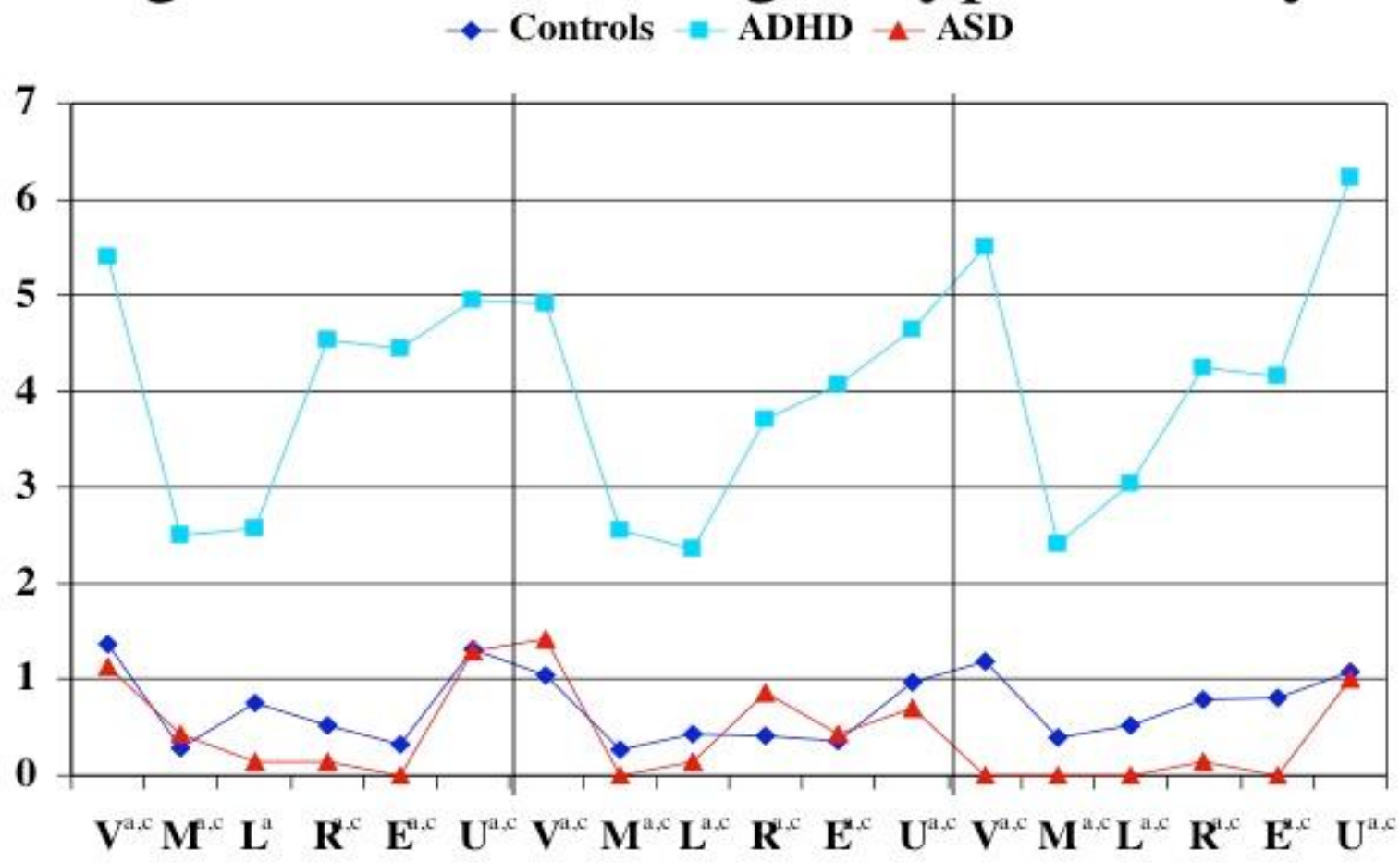


Self Rating - Hyperactivity



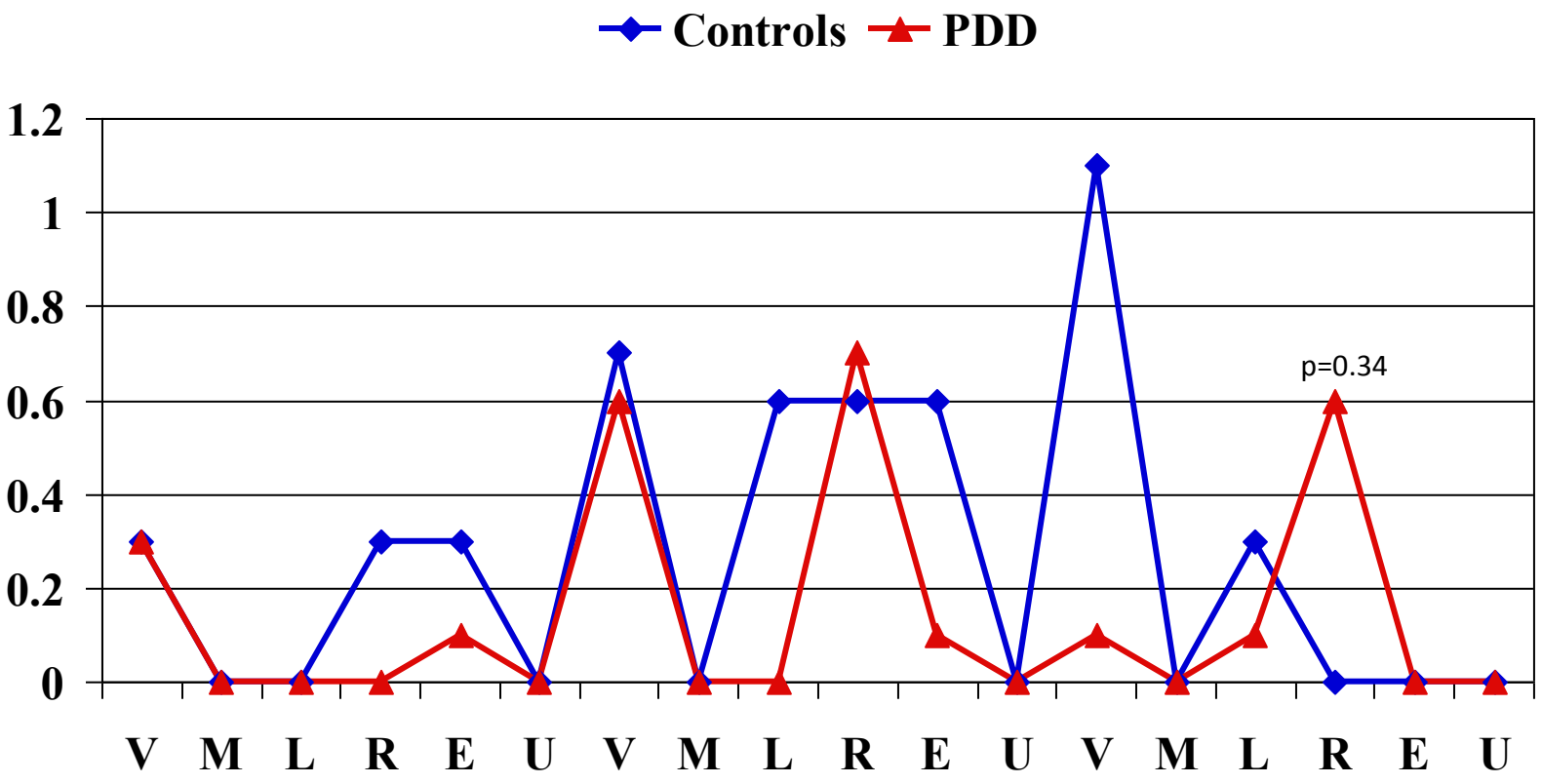
Results

Figure 1. Self Rating - Hyperactivity

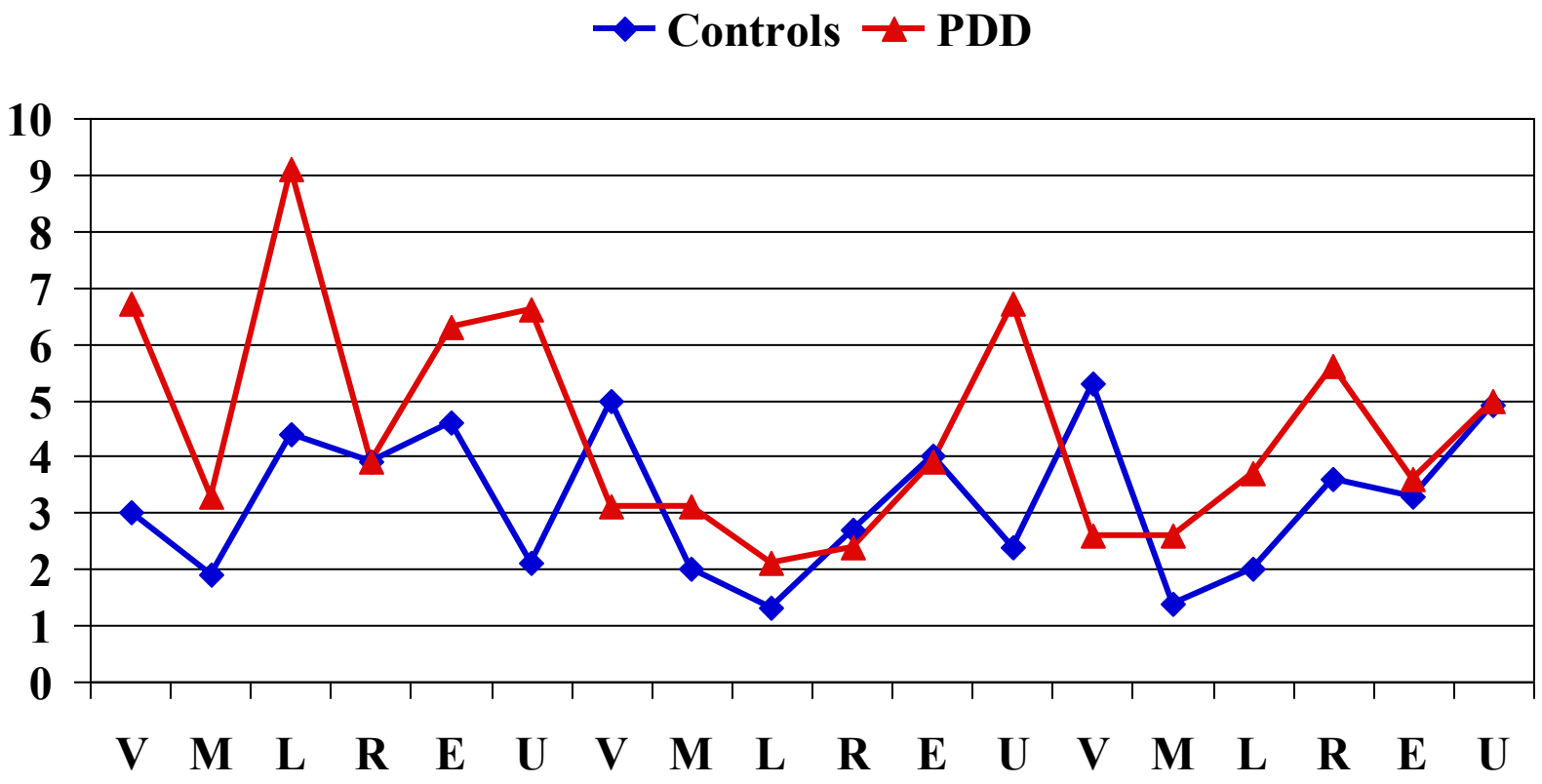


Key: where omnibus ANOVA significant at $p<.05$;
[a]ADHD ≠ Controls; [b]ASD ≠ Controls, [c]ADHD ≠ ASD
V=Video; **M**=Math; **L**=Lecture; **R**=Reading Comprehension; **E**=Editing

Observer Rating - Inattention

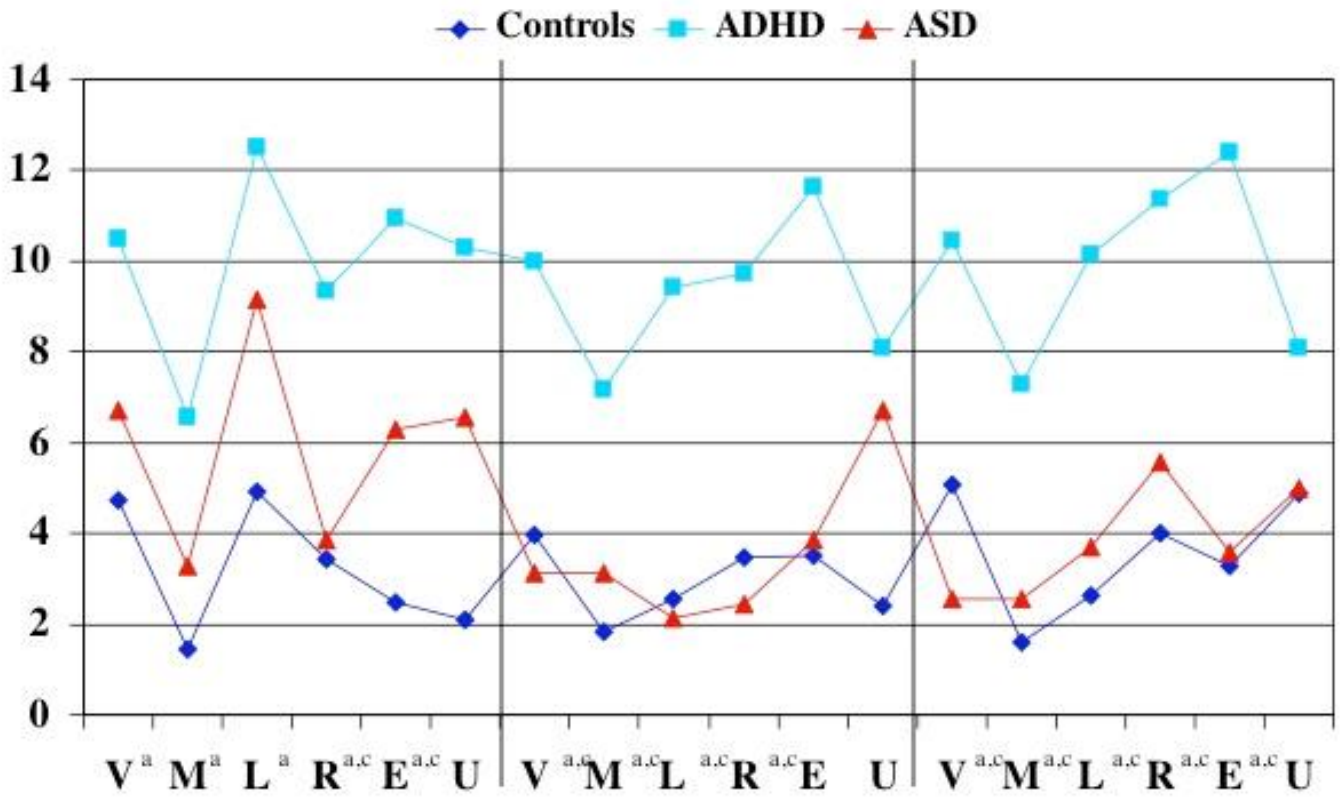


Self Rating - Inattention



Results

Figure 2. Self Rating - Inattention



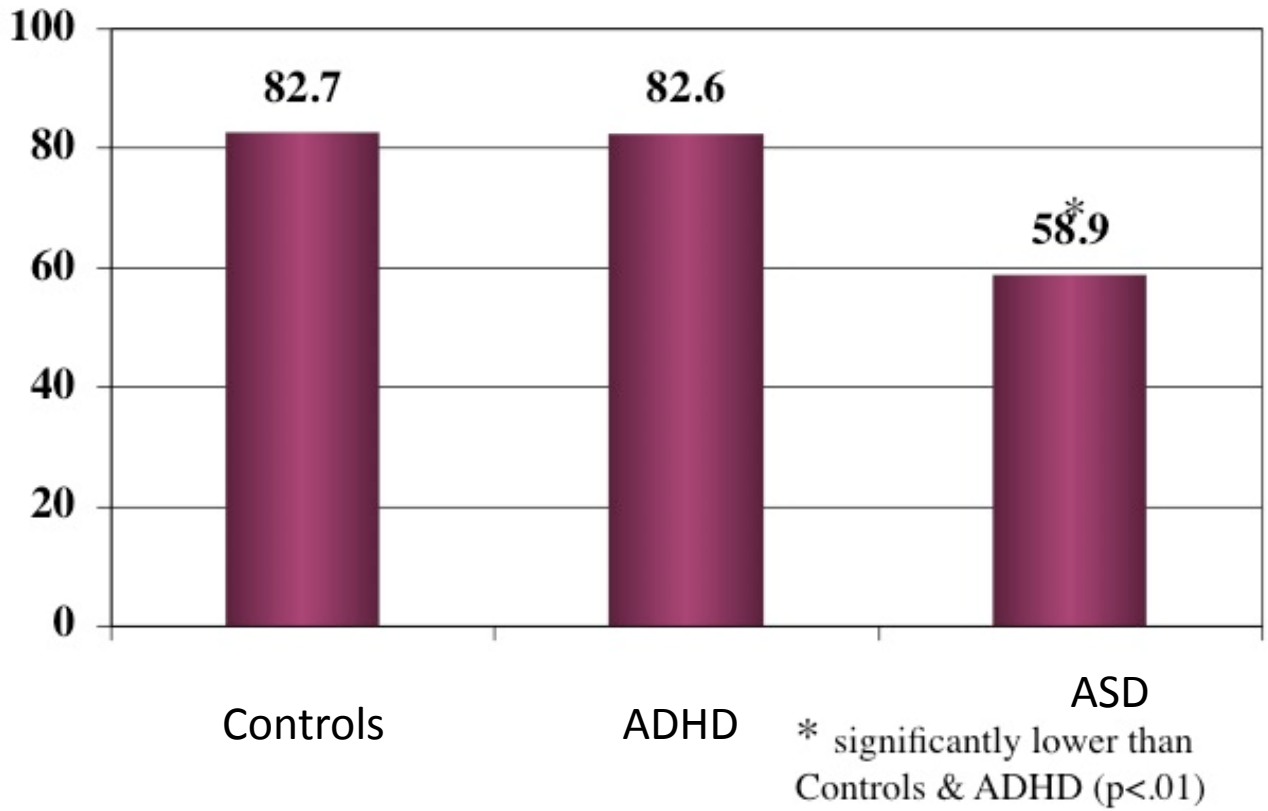
Key: where omnibus ANOVA significant at p<.05;
[a]ADHD ≠ Controls; [b]ASD ≠ Controls, [c]ADHD ≠ ASD
V=Video; **M**=Math; **L**=Lecture; **R**=Reading Comprehension; **E**=Editing

Unstructured Period

- Provided folder of Tasks to be Completed
- Clear Instructions on Tasks Required
- Collected at the end of the Day
- Although subjects passed in folder with Confidence, very few tasks completed

Results

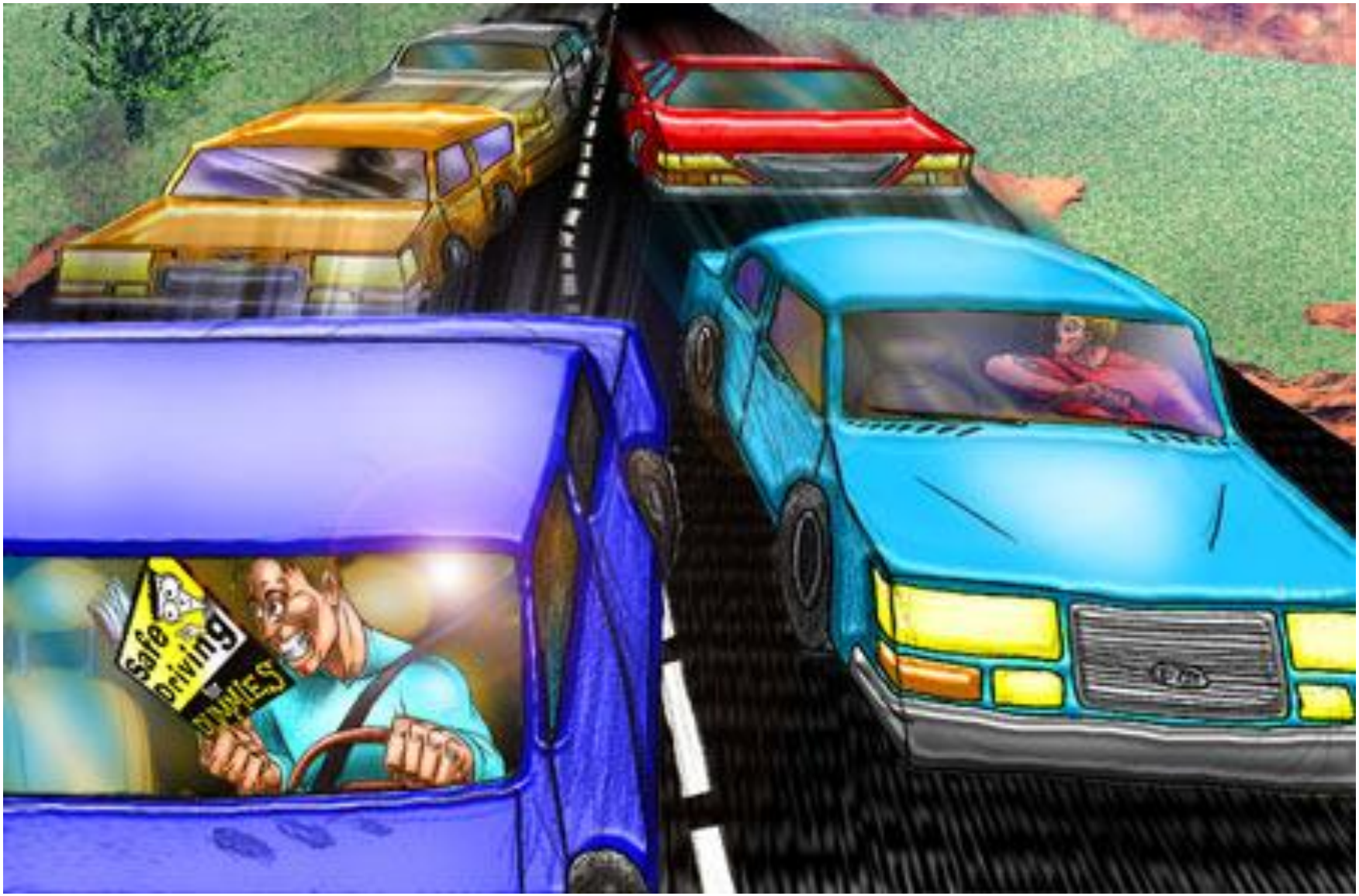
Figure 5. Percent of Tasks Completed



Summary of Findings

- Individuals with ASD appear to need structure and explicit directions to complete tasks
- Individuals with ASD have more difficulty making choices of what tasks to complete and thereby become frozen
- ASD symptoms may cause individuals to have feelings of anxiety when tasks are overwhelming
- Individuals with ASD may fatigue more quickly over a lengthy day and need a workplace with more time for breaks or movement

What About Driving?


Safe
Driving

Emerging Literature on Drivers with ADHD

- Drivers with ADHD are more likely than drivers without ADHD to commit traffic violations and have adverse driving outcomes
- Significantly more drivers with ADHD:
    - Drive without a license
    - Have a license revoked or suspended
    - Have multiple crashes (2+)
    - Have multiple traffic citations (3+), especially for speeding
- ADHD drivers are more likely to rate themselves as having poor driving habits

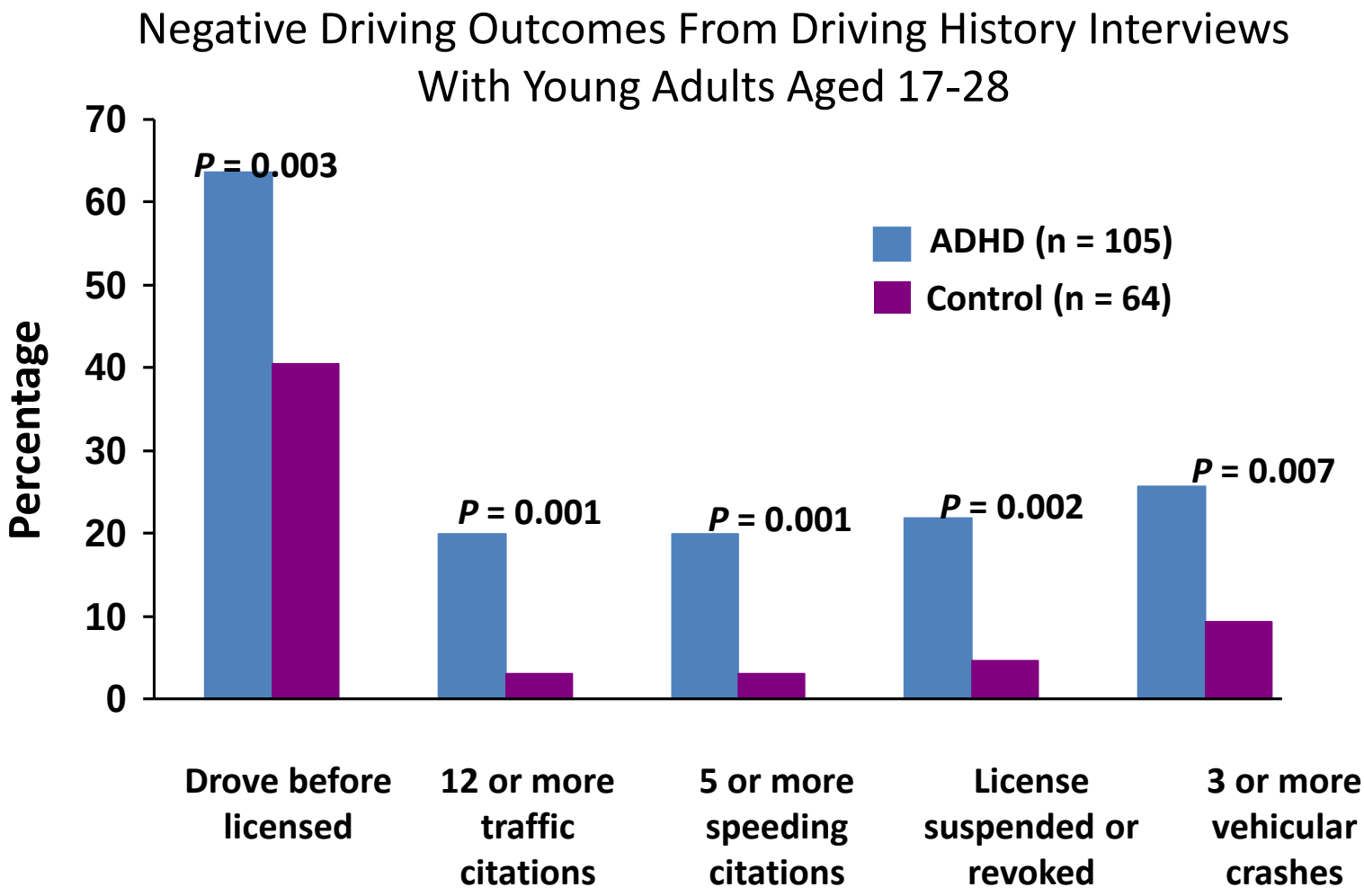
(Barkely et al., 1993; Nada-Raja et al., 1997; Woodward et al., 2000; Reimer et al., 2005)

What Makes ADHD Drivers High-Risk?

- "Inattention, impulsiveness and risk taking are likely to contribute to the observed high-risk behavior while driving."
- Individuals with ADHD have increased risk of traffic violations and accidents in situations that involve:
  - Speed
  - Inexperience
  - Inattention
  - Altered alertness / fatigue

(Barkley et al., 2003)

Traffic Accidents and Violations



Barkley et al. *J Int Neuropsychol Soc*. 2002;8:655-672.

Critical Needs in Research on ADHD Drivers

- To identify specific deficiencies in driving performance compared to controls
- To identify key susceptibility of drivers with ADHD to impairments such as distraction and inattention
- To identify different contexts under which ADHD drivers are at elevated risk of collision
- To evaluate the effects of treatments for ADHD on driving performance and behavior

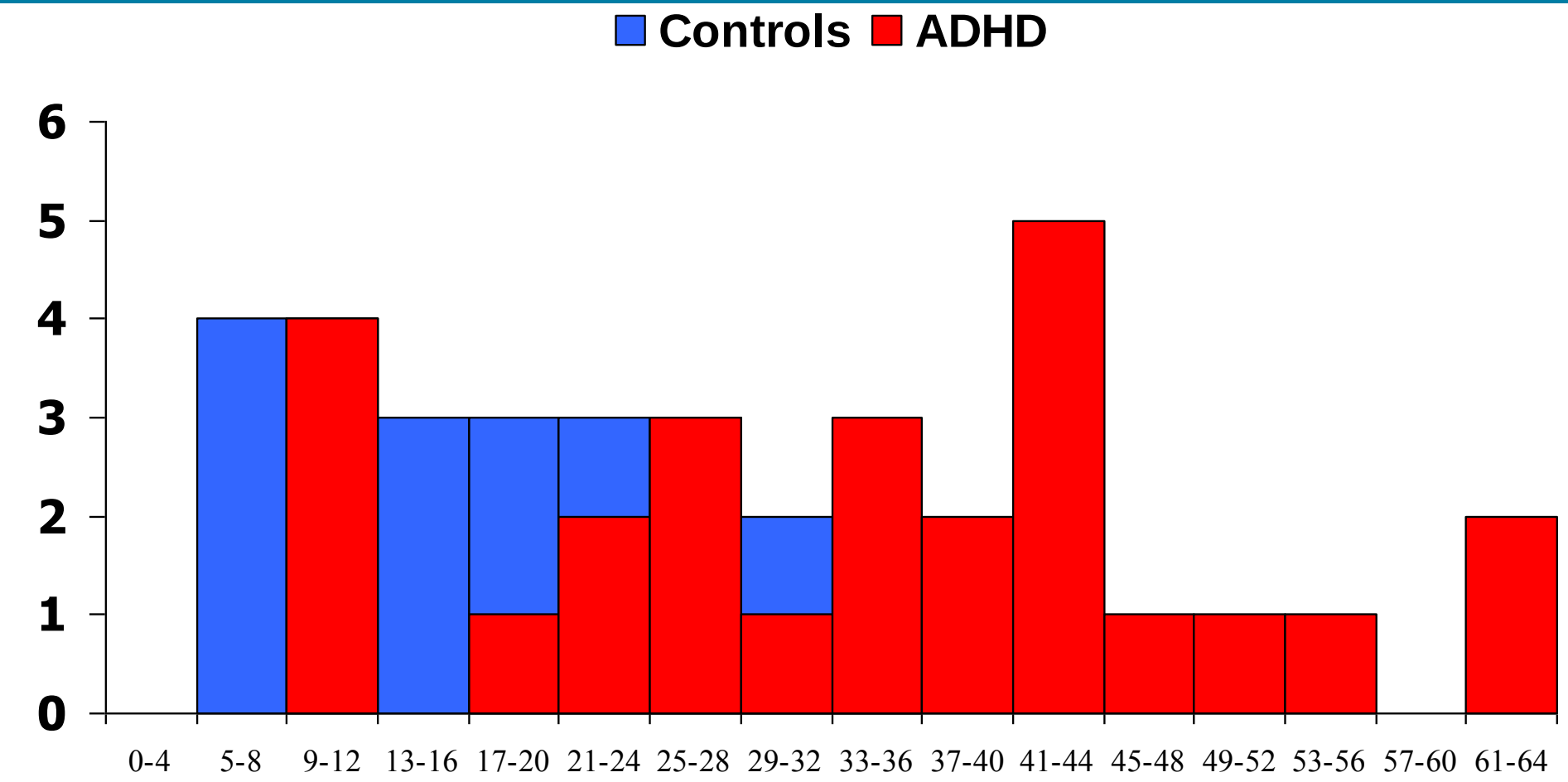
Approaches to Assess Driving in ADHD

- Rating scales (e.g.,Driving Behavior Questionnaire (DBQ))
- Laboratory driving simulator focused on deficits in attention, hyperactivity and impulsivity

Driving Behavior Questionnaire (DBQ)

- 24 questions divided into three self-reported risk behaviors:
  - Lapses – attention and memory
  - Errors – failure of planned actions to achieve their intended goal, “near misses”
  - Violations-deliberate deviations achieved to Be safe (accidents, speeding tickets)

Results: DBQ with ADHD vs. Controls



Characterizing Impaired Driving in Adults With Attention-Deficit/Hyperactivity Disorder: A Controlled Study

Ronna Fried, Ed.D.; Carter R. Petty, M.A.; Craig B. Surman, M.D.; Bryan Reimer, Ph.D.; Megan Aleardi, B.A.; Jessica M. Martin, M.A.; Joseph F. Coughlin, Ph.D.; and Joseph Biederman, M.D.

Received April 7, 2005; accepted Sept. 15, 2005. *From the Pediatric Psychopharmacology Department, Massachusetts General Hospital, Boston (Drs. Fried, Surman, Reimer, and Biederman and Mr. Petty and Mss. Aleardi and Martin); Department of Psychiatry, Harvard Medical School, Boston, Mass. (Drs. Fried, Surman, and Biederman); and AgeLab, Massachusetts Institute of Technology, Cambridge (Drs. Reimer and Coughlin).*

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Objective: We sought to confirm previously documented findings that individuals with attention-deficit/hyperactivity disorder (ADHD) demonstrate impaired driving behavior when compared with controls.

Method: Subjects were adults with (N = 26) and without (N = 23) DSM-IV ADHD ascertained through clinical referrals to an adult ADHD program and through advertisements in the local media. Driving behavior was assessed using the Manchester Driving Behavior Questionnaire (DBQ) and 10 questions from a driving history questionnaire. Neuropsychological testing and structured interviews were also administered to all subjects.

Results: Substantially more ADHD subjects had been in an accident on the highway (35% vs. 9%, $p = .03$) or had been rear-ended (50% vs. 17%, $p = .02$) compared with controls. Analysis of the DBQ findings showed that ADHD subjects had significantly higher mean ± SD scores than control subjects on the total DBQ (34.1 ± 15.2 vs. 18.0 ± 8.6, $p < .001$) and in all 3 subscales of the DBQ: errors (9.3 ± 5.4 vs. 4.6 ± 3.5, $p < .001$), lapses (12.4 ± 6.2 vs. 6.1 ± 3.5, $p < .001$), and violations (12.4 ± 5.2 vs. 7.4 ± 4.1, $p < .001$). Using the score that separated ADHD from control drivers on the DBQ as a cutoff, ADHD drivers at high risk for poor driving outcomes had more severe rates of comorbidity and exhibited more impaired scores on neuropsychological testing.

Conclusions: Our results confirm and extend previous work documenting impaired driving behavior in subjects with ADHD. Results also suggest that ADHD individuals at high risk for poor driving behavior might be distinguishable from other ADHD individuals on DBQ scores, neuropsychological deficits, and patterns of comorbidities.

(J Clin Psychiatry 2006;67:567–574)

MGH-MIT Driving Simulation Paradigm

- Our group developed and validated a novel driving simulation paradigm with varying driving demands in ways observed on actual roadways
  - Range of driving environments (rural, highway, urban)
  - Differing stimulus intensity (active, monotonous)
  - Periods of both single task driving as well as dual task driving, (e.g. driving while having a cellular phone conversation)

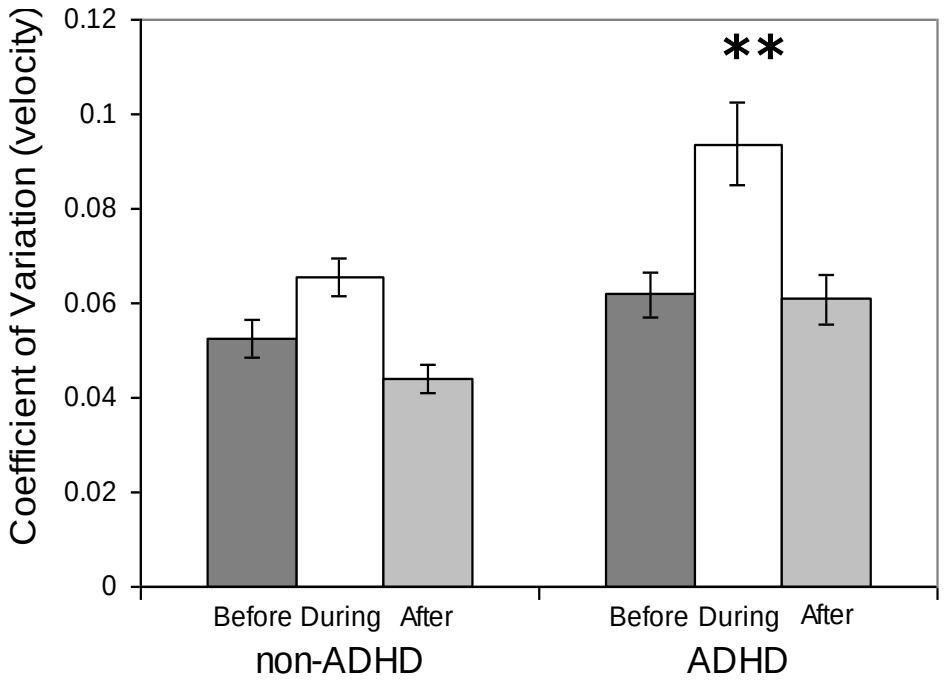
Overview of the MIT AgeLab Driving Simulator "Miss Daisy"

- State of the art full cab 90 degree field of view vehicle simulator provides an exceptional platform for human factors evaluations

- Force feedback and sound system provide additional responsiveness to the driver
- Measures include: brake and throttle position; steering amplitude; acceleration; velocity; and lane position

Highway Driving

- ADHD impacted speed control
- ADHD enhanced difficulties with speed control under dual task conditions (driving and cell phone use)



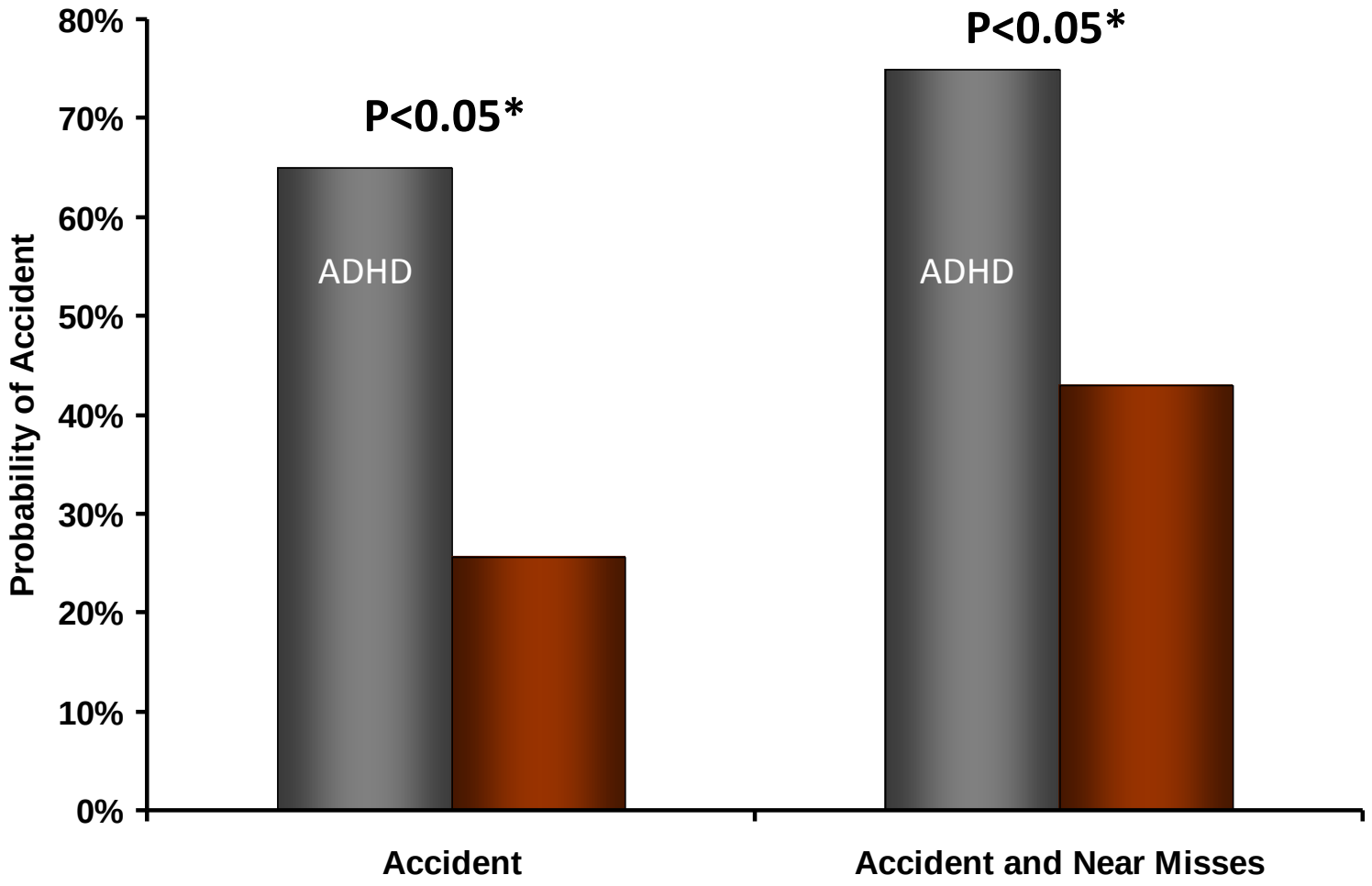
MGH-MIT Driving Simulation Paradigm

- ADHD drivers were more likely to crash into a sudden peripheral surprise event under monotonous, low stimulus conditions after an extended period of driving

MGH-MIT Driving Simulation Paradigm

- ADHD subjects reported a higher frequency of speeding, passing and weaving in traffic, and number of real-life accidents, which corresponded with behaviors observed in the simulation, further supporting the validity of our driving simulation paradigm

Accidents and Near Misses



*Indicates P<0.05 after controlling for gender, age, time of day and the age*ADHD interaction

Reimer, B., et al. 2007. Traffic Inj Prev 8(3): 290-299.

Conclusion

- Context plays an important role in the performance of ADHD drivers
- Differences exist in how ADHD drivers regulate the attention based upon complexity of the driving environment and secondary task
- Potential for certain combinations of factors to be over represented in ADHD accidents

Are Driving Impairments Treatable?

The Effects of LDX on Driving Performance in Young Adults with ADHD: A Randomized, Double-Blind, Placebo-Controlled Study

Joseph Biederman, MD, PI

Study funded by Shire Pharmaceutical

Context

- While stimulant medications have proven efficacy in reducing ADHD symptomatology, the extent to which these clinical effects generalize to driving impairment associated with ADHD remains uncertain

Main Aim

- To assess the impact of lisdexamfetamine dimesylate (LDX) on driving performance in young adults with ADHD

Crashes per 100,000 Licensed Drivers (Traffic Safety Facts 2003)

Age	Fatal Crashes	Injury Crashes	Property Damage
16-20	62.02	4695	10801
21-24	45.98	2962	5965
25-34	31.17	2050	4283
35-44	26.79	1695	3495
45-54	23.45	1370	2953
55-64	10.51	1137	2426

Methods: Subjects

- Outpatients
- Both sexes
- 18-26 years of age
- Met full DSM-IV criteria for ADHD with onset of symptoms in childhood, a persistence of impairing symptoms into adulthood, and did not have pharmacological treatment for ADHD in the past month

Study Design

- This was a randomized, double-blind, parallel-design, placebo-controlled, 6-week study examining the effects of LDX and placebo on driving performance in young adults with ADHD using a driving simulation paradigm that had been shown to discriminate between ADHD and control drivers
- Eligible subjects underwent a baseline (pre-medication) driving simulation assessment and then were randomized, in double-blind fashion, to receive placebo or active medication

Study Design

- Medication was titrated from an initial dose of 30 mg at week 1 to 50 mg at week 2, and to a maximum of 70 mg by week 3
- Subjects experiencing adverse events were able to decrease in increments of 20 mg, if determined necessary by the treating clinician
- After 6 weeks of treatment with LDX or placebo, subjects underwent a second driving simulation assessment
- The two simulation assessments were identical except for the addition of five surprise events during the second visit

Assessments: Baseline

- Psychiatric evaluation (board certified psychiatrist with expertise in adult ADHD)
- DSM-IV-SCID plus modules from K-SADS-E (DSM-IV ADHD and disruptive behavior disorders)
- Medical Hx, vital signs, laboratory assessments (LFT's, CBC), weight, vital signs, & ECG

Driving Simulation

- 43-mile virtual roadway
- Urban driving (stimulating) (±phone task)
- Straight unpopulated road (monotonous)
- Rural and highway driving (moderate demand) (±CPT)
- Straight unpopulated road (second monotonous period)

Driving Simulation

- The driving simulation was identical in the 1st and 2nd visits, but differed in the 2nd visit by the addition of 5 surprise events distributed throughout the simulation to minimize learning and expectation effects
- The surprise events included cyber dogs that appeared at the end of each of the two monotonous periods, and 3 vehicles that encroached on the lane of travel at various points in the scenario

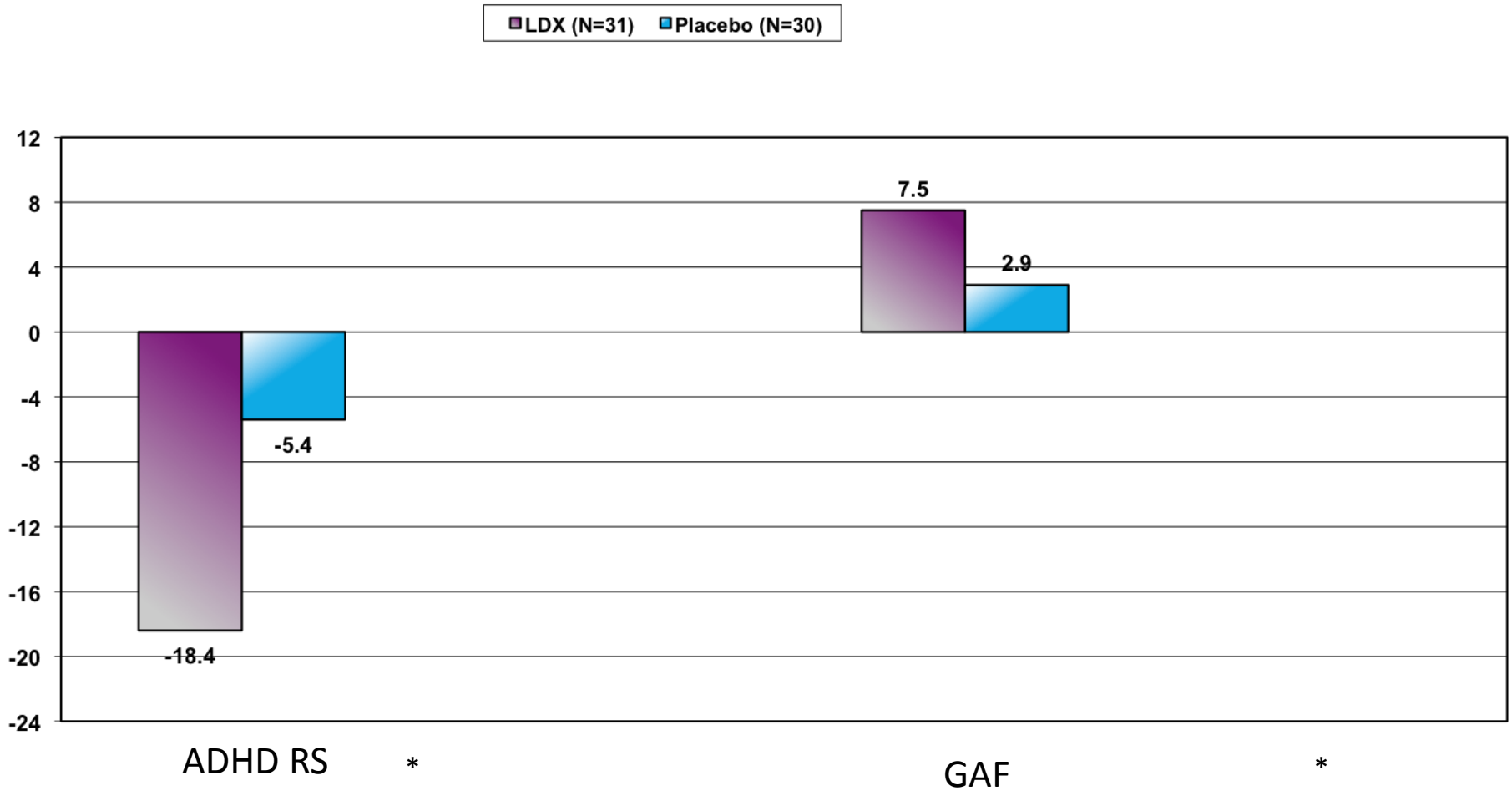
Statistical Approach

- Continuous dependant variables were assessed using either univariate or repeated measures GLM procedure as appropriate in SPSS (version 16)
- Pearson Chi-squared tests and logistic regression were used for binary data

Results

- 75 subjects enrolled in the study and 61 subjects completed the two driving simulations
- Sex: 62% % males
- Age: 21.6 ± 2.1 years
- No statistical differences in age or sex between drug and placebo
- No subject took a concomitant psychotropic medication

Mean Change from Baseline to Endpoint in Clinical Parameters



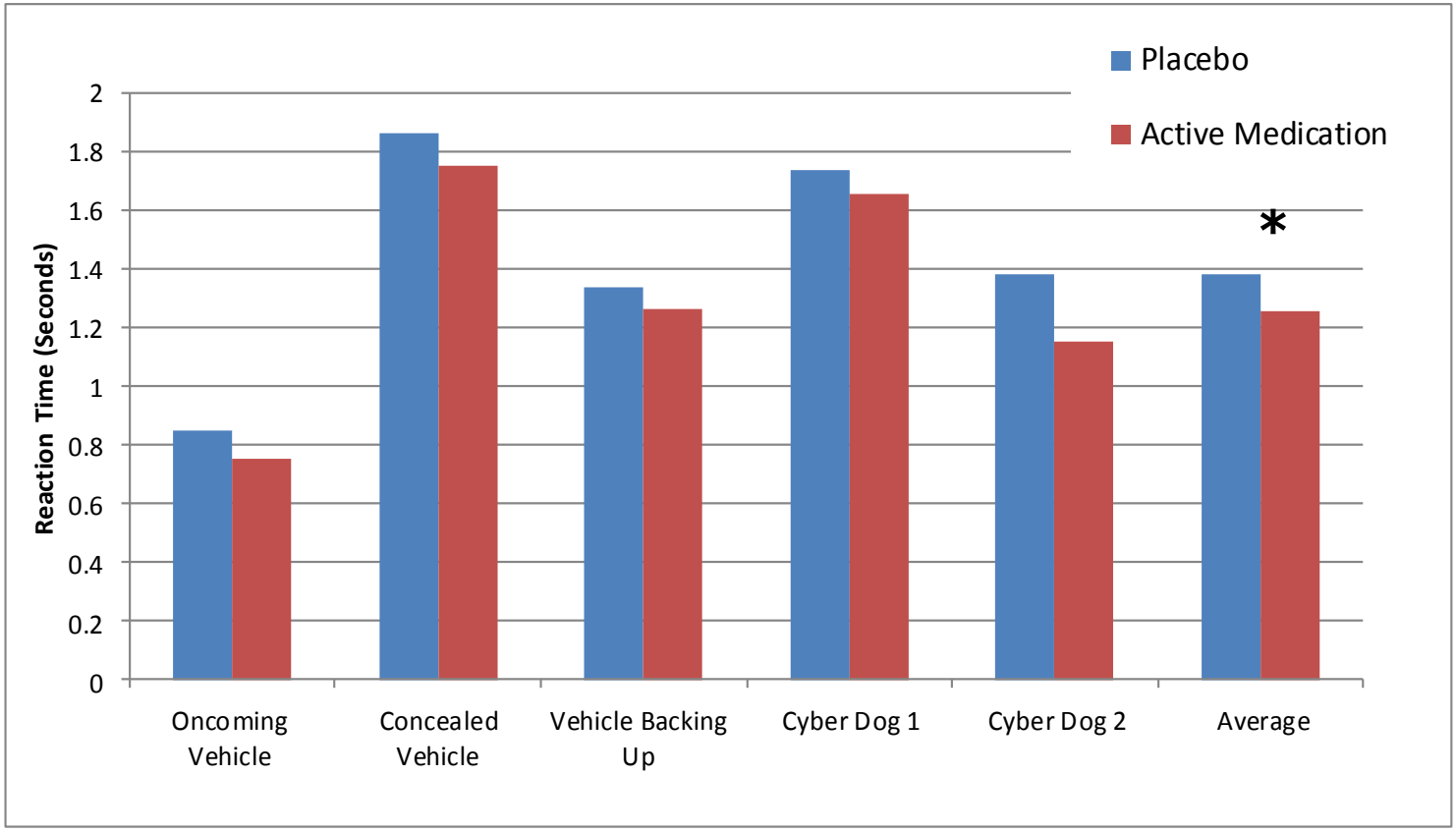
*p-value reflects drug by time interaction assessing the relative effects of LDX vs. placebo

Biederman et al. *J Psychiatr Res* 2012 Apr;46(4):484-91

Driving Outcomes

- There were no differences between drug and placebo in ratio of low to high mileage drivers (greater or less than 10,000 miles in the past year) or in the ratio of frequent to infrequent drivers (driving more or less than “a few” times per week)
- At baseline, 15% were involved in a crash in the past year (4/9 cases were in the active medication group) and 23% (N=10 in the active medication group) reported being stopped by the police for a traffic-related reason over the past year

Results: Reaction Times To Surprise Events



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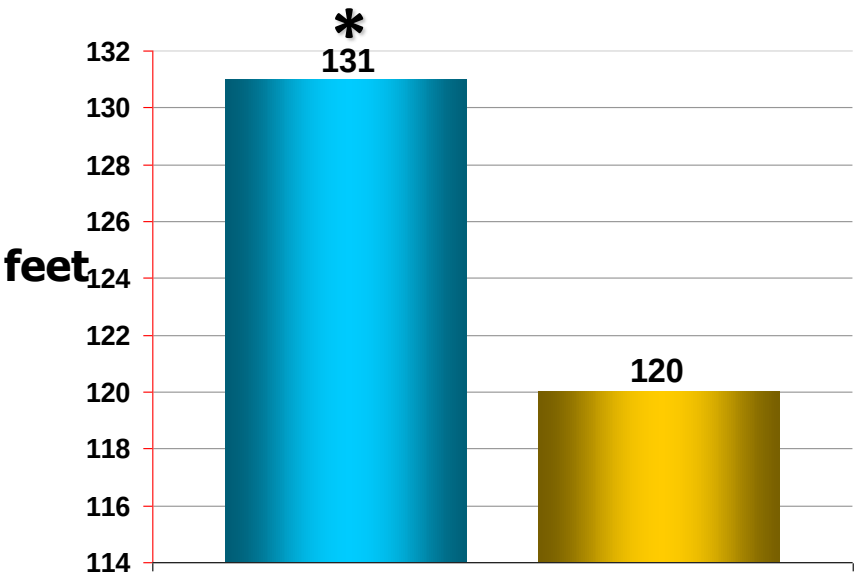
Summary: Surprise Events Reaction Time Results

- Significant effect of medication status on the average reaction time computed across all five events ($F(1,58)=5.231$, $p=.026$)
- Although not attaining statistical significance, examination of individual events showed that the active medication group consistently reacted faster than the placebo group
- Participants in the active medication group reacted 0.126 seconds or 9.1% faster, on average, than participants in placebo group

Implications for Surprise Events Reaction Time Results



- When considering a driver traveling at 65 mph the average reaction times translates to 131 and 120 feet, for placebo and LDX, respectively
- Therefore, non-medicated drivers traveled 11 feet further before reacting to an event which could results in hitting a pedestrian in a crosswalk

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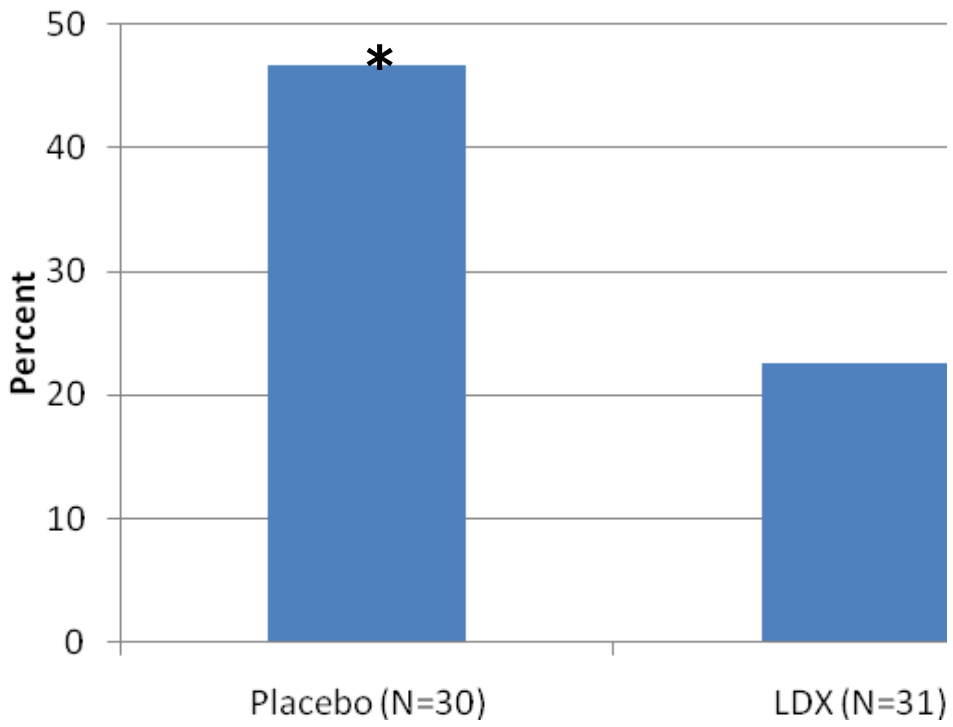
Percent of Subjects Involved in Collisions During Surprise Events



- During the five surprise events, drivers in the medication group were 67% less likely to have a collision than drivers in the placebo group

LDX = lisdexamfetamine dimesylate

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The effects of lisdexamfetamine dimesylate on the driving performance of young adults with ADHD: A randomized, double-blind, placebo-controlled study using a validated driving simulator paradigm

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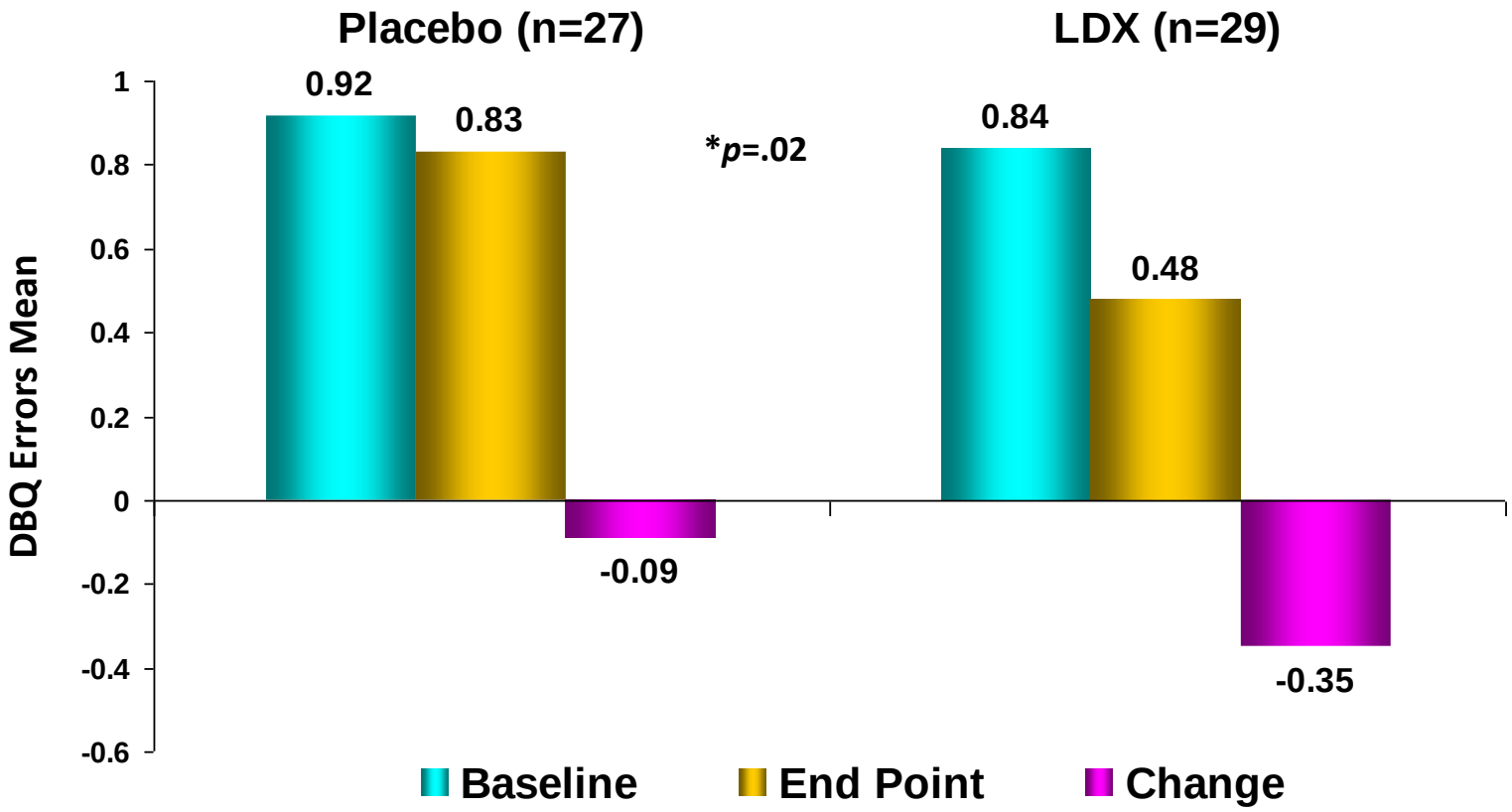
ABSTRACT

Young adults with Attention Deficit Hyperactivity Disorder (ADHD) have been shown to be at increased risk for impairment in driving behaviors. While stimulant medications have proven efficacy in reducing ADHD symptomatology, there is limited knowledge as to their effects on driving impairment. The main aim of this study was to assess the impact of lisdexamfetamine dimesylate (LDX) on driving performance in young adults with ADHD using a validated driving simulation paradigm. This was a randomized, double-blind, 6-week, placebo-controlled, parallel-design study of LDX vs. a placebo on driving performance in a validated driving simulation paradigm. Subjects were sixty-one outpatients of both sexes, 18–26 years of age, who met DSM-IV criteria for ADHD. Subjects were randomized to receive LDX or placebo after a baseline driving simulation and completed a second driving simulation six weeks after beginning drug or placebo. Examination of reaction time across five surprise events at post-treatment showed a significant positive effect of medication status. LDX treatment was also associated with significantly fewer accidents vs. placebo. LDX treatment was associated with significantly faster reaction times and a lower rate of simulated driving collisions than placebo. These results suggest that LDX may reduce driving risks in young adults with ADHD.

Effects of LDX on Driving Behavior as Assessed Through the DBQ

DBQ Errors Mean Scores



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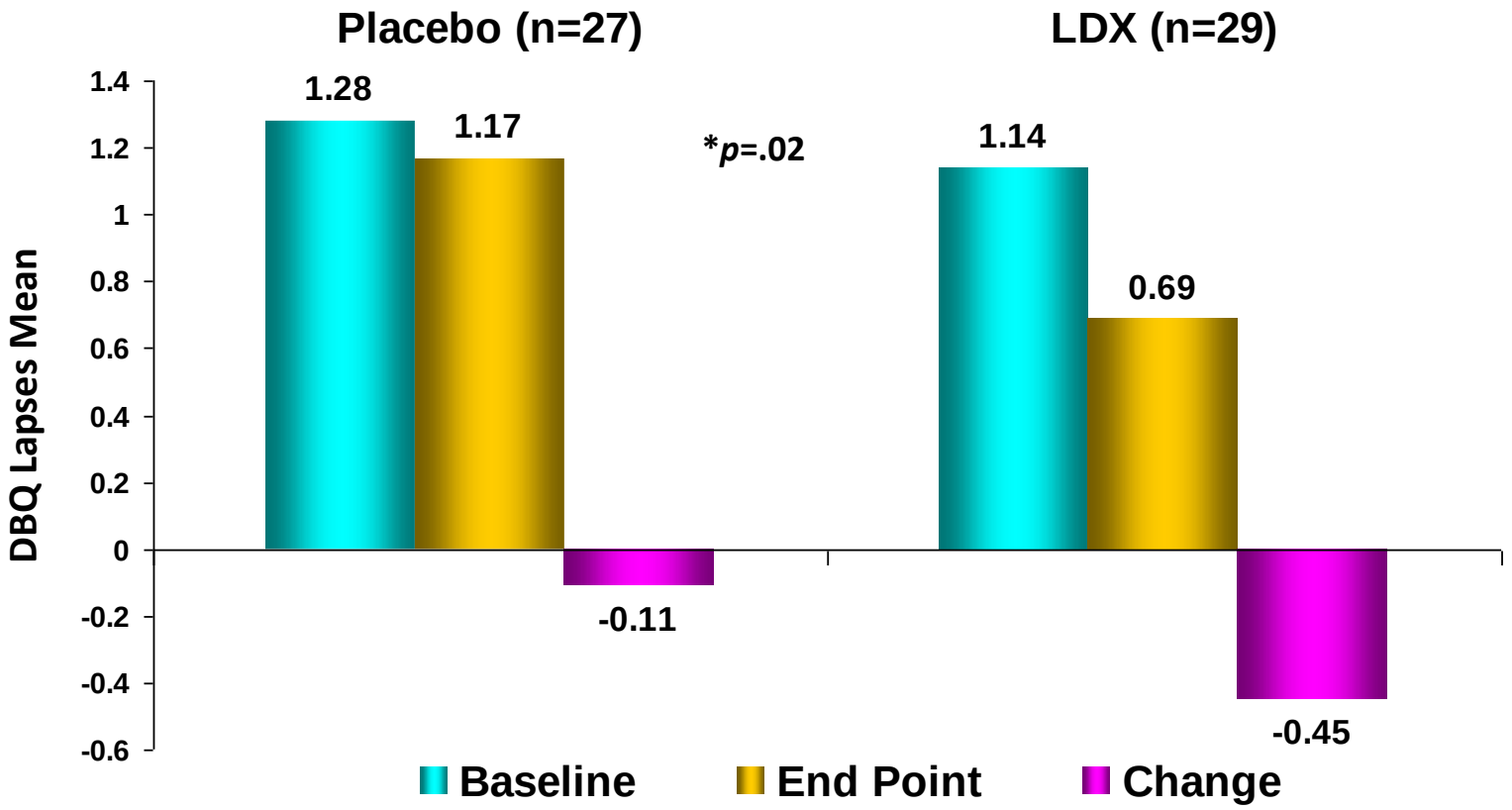
DBQ Lapses Mean Scores



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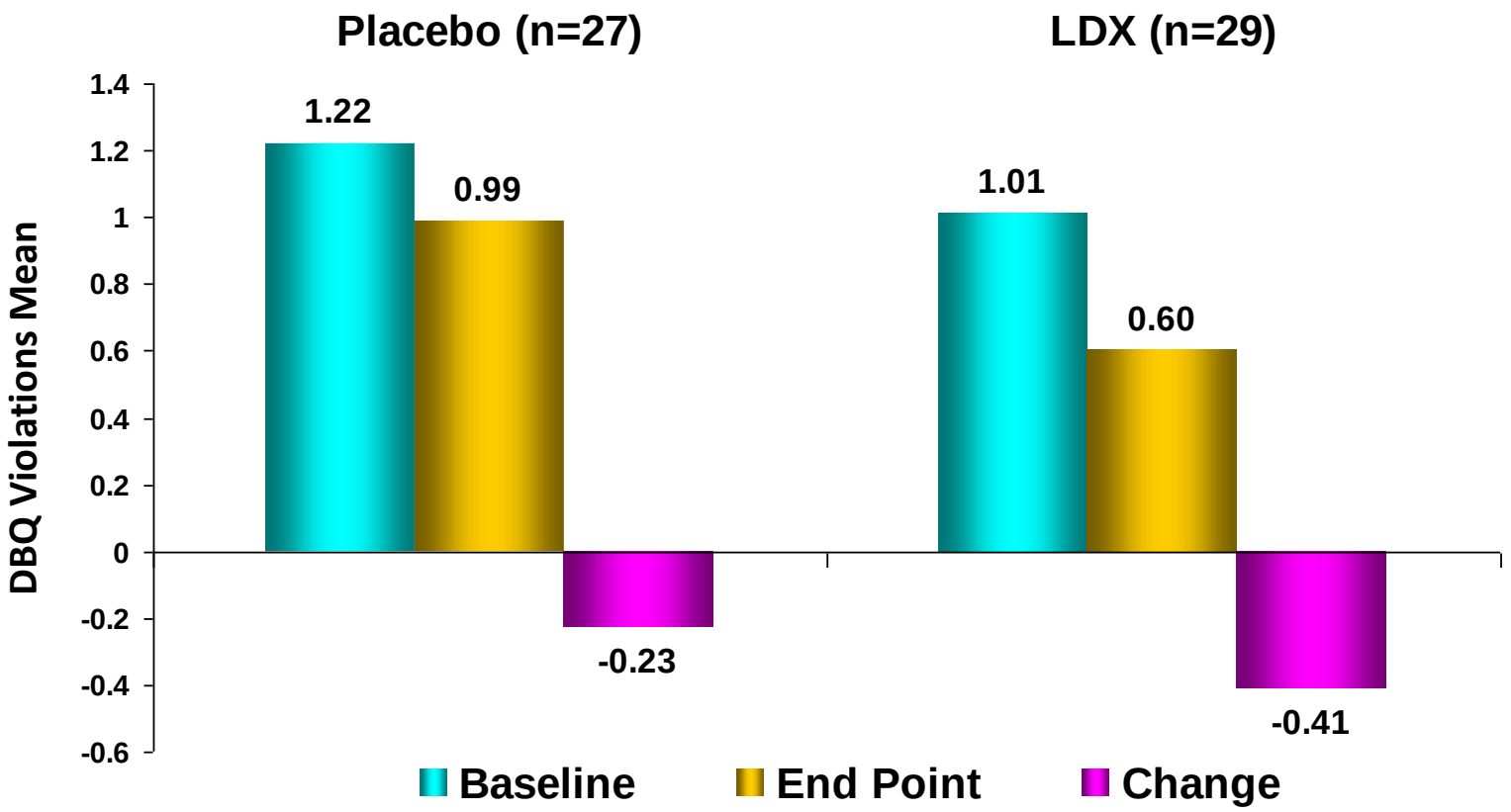
DBQ Violations Mean Scores



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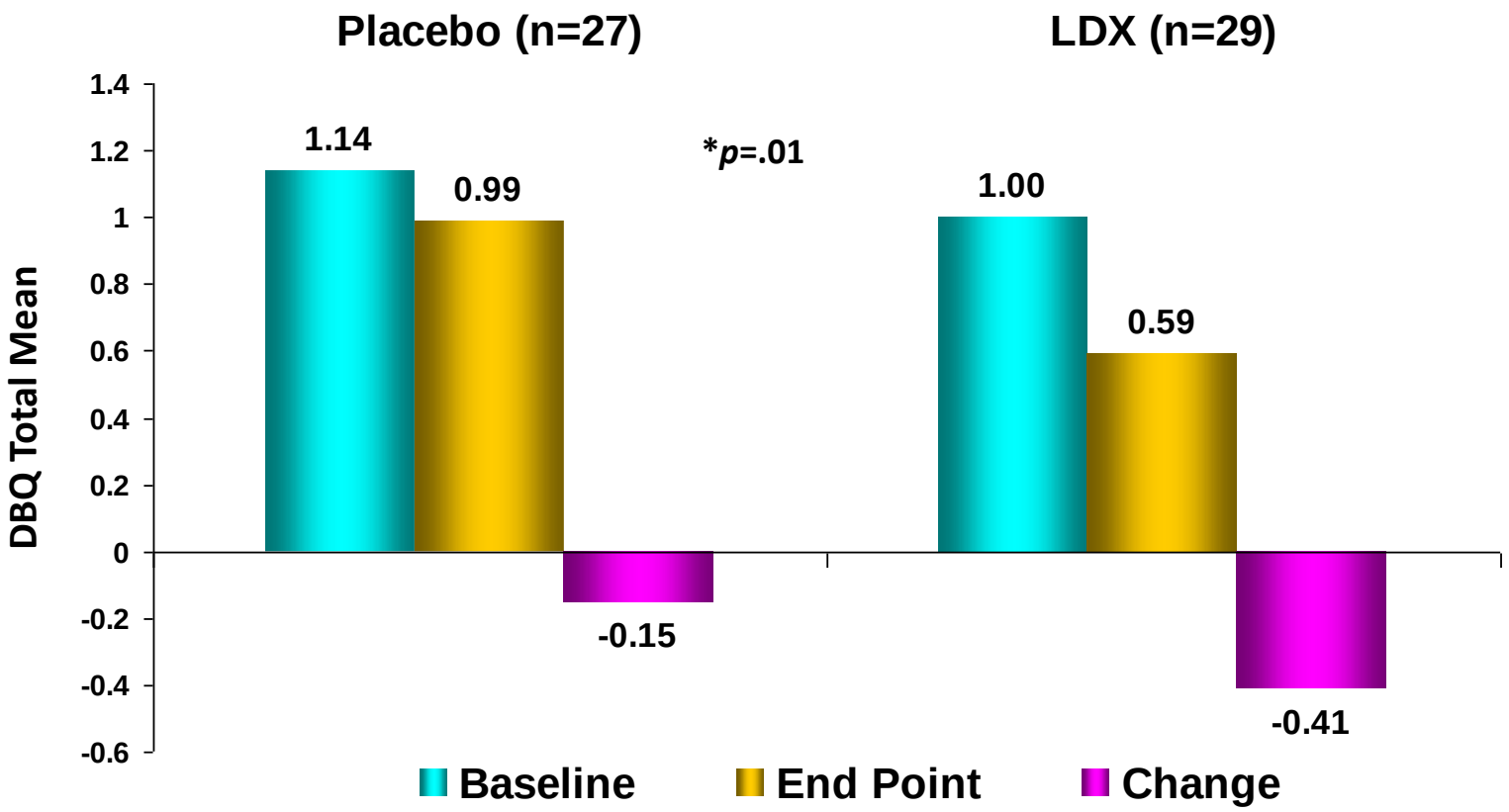
DBQ Total Mean Scores



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Main Findings

- Treatment with LDX was associated with significant clinical improvement
- Treatment with LDX was also associated with faster reaction times and a lower likelihood of having a collision independently of the clinical effects

Main Findings

- There were no associations between clinical improvement in ADHD symptoms and driving outcomes

Comments

- Our finding that ADHD drivers taking LDX were 67% less likely to be involved in a collision than those on placebo has major public health relevance, considering the high prevalence of ADHD in the population and the high risk of accidents associated with this disorder
- In 2008, 4,378 pedestrians were killed and another 69,000 were injured in motor vehicle accidents in the US
- Two of the surprise events in the simulator consisted of dogs running across the road; the collisions could have been with pedestrians or bicyclists

Conclusions

- Results from this randomized, double-blind, parallel group, placebo-controlled study of LDX in young adult drivers with ADHD showed faster reaction times and a lower rate of simulated driving collisions in subjects taking LDX than in those taking placebo
- Marked Improvements in driving behaviors
- These results suggest that LDX may be useful in clinical practice to reduce driving risks of young adults with ADHD
- **Clinical Trials Registry:** Clinical Trials.gov NCT00801229

What About ASD?

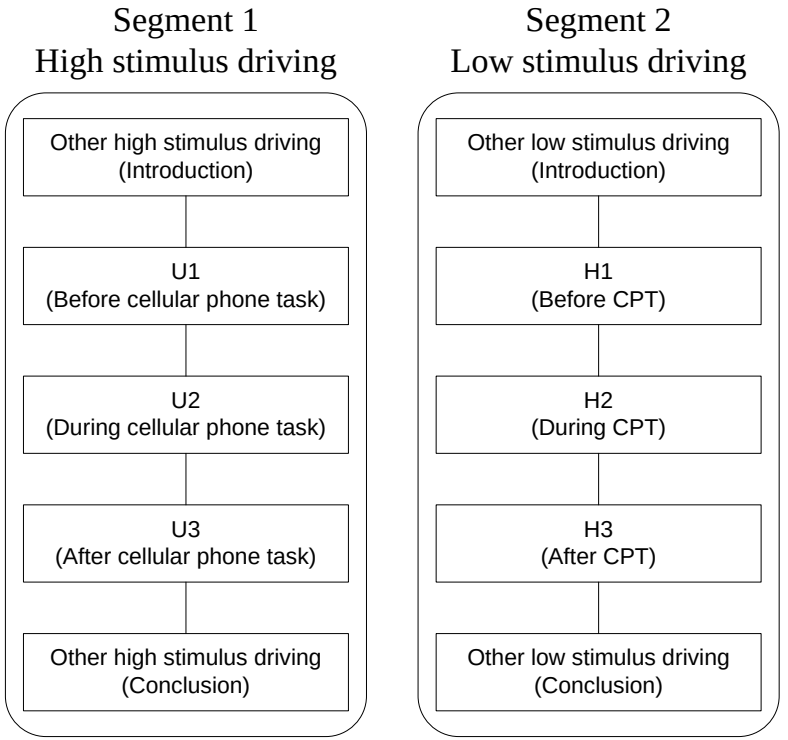
- The main aim of this study was to conduct a pilot driving simulation examining driving performance in young adults with HF-ASD in comparison with a community sample of non-affected individuals matched for age and sex

Subjects

- Twenty male 18-24 year olds,
- 50% met DSM-IV criteria for HF-ASD
- 50% community controls.

Simulation (overview)

- Urban + cell phone
  - Two lane high density road
  - 35 MPH
  - Stop signs modulate flow
- Highway + CPT
  - Right half of a 4 lane highway
  - 65 MPH
- Monotony Key in Both Segments



Prior Work with Simulation

- community samples of young adult drivers showed good correspondence between eye movements recorded across varying in-vehicle demands in the simulator with data collection in the field (Wang et al. 2010).
- Reimer and Mehler (2011) showed that changes in physiological reactivity to increasing levels of cognitive demand were highly consistent between the driving simulator and actual on-road driving.

Demographic Features

	Age	IQ	Gender	Infrequent Drivers
Controls	20.7 (SD 1.89)	Unknown	100% Male	6
HF-ASD	20.20 (SD 2.80)	99-126 (Mean =107.4, SD 5.1)	100% Male	6

Subjects

The HF-ASD group met :

- DSM-IV criteria for ASD
- IQs of 85 or greater,
- valid driver's licenses
- no major sensorimotor handicaps (e.g. deafness, blindness),
- and the capability to understand and speak English.

Community Controls

- from a sample of 75 participants in a concurrent study at MIT
- valid driver's license
- able to understand and speak English.
- Selection was made based upon sex (male), age and availability of eye tracking measurements.
- The community control group was not subject to a psychiatric or cognitive evaluation. Therefore, variables such as IQ were not considered in selection

Simulation Measures

- driving behavior including speed, lane deviation and collisions.
- skin conductance
- heart rate
- eye tracking

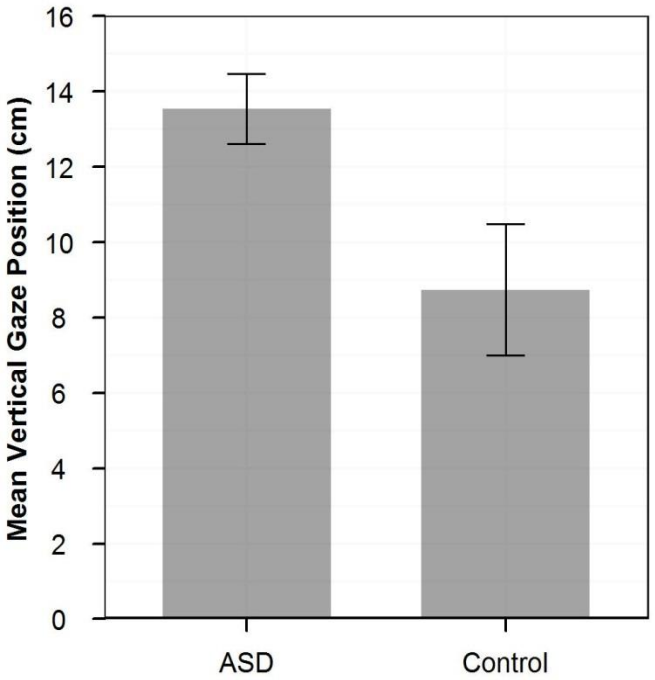
Cognitive Distracter Tasks

- **Phone Task**: Hands-free call to 10-digit phone number to schedule a doctor's appointment
- Name; time; date needed to be held in working memory
- prompted to leave "your first name, a daytime telephone number, the doctor's last name, as well as the date and time of the appointment you are requesting"
- **CPT Task**: "say check" when the letter "A" was preceded by three letters by the letter "Q" (e.g. QRCTA)

Summary of Results

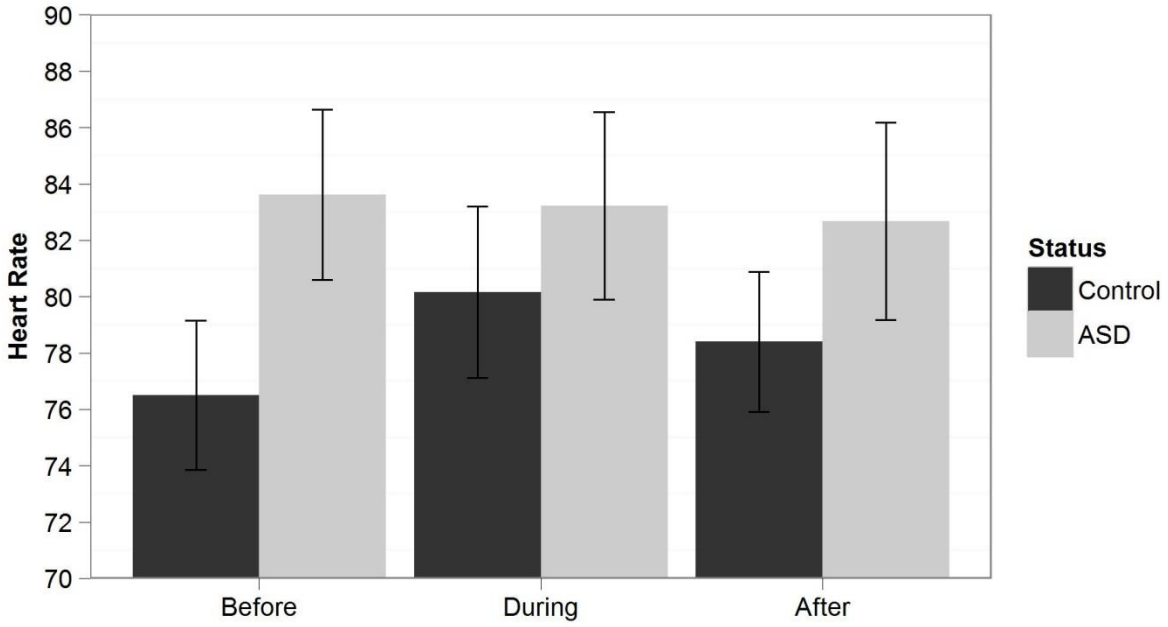
- no difference in speed from the posted limit and standard deviation of lane position between the two groups.
- Individuals with HF-ASD displayed a higher, but unvaried heart rate throughout the simulation when compared with Controls.
- Visual attention was significantly different in the HF-ASD individuals as compared to Controls

Vertical Gaze



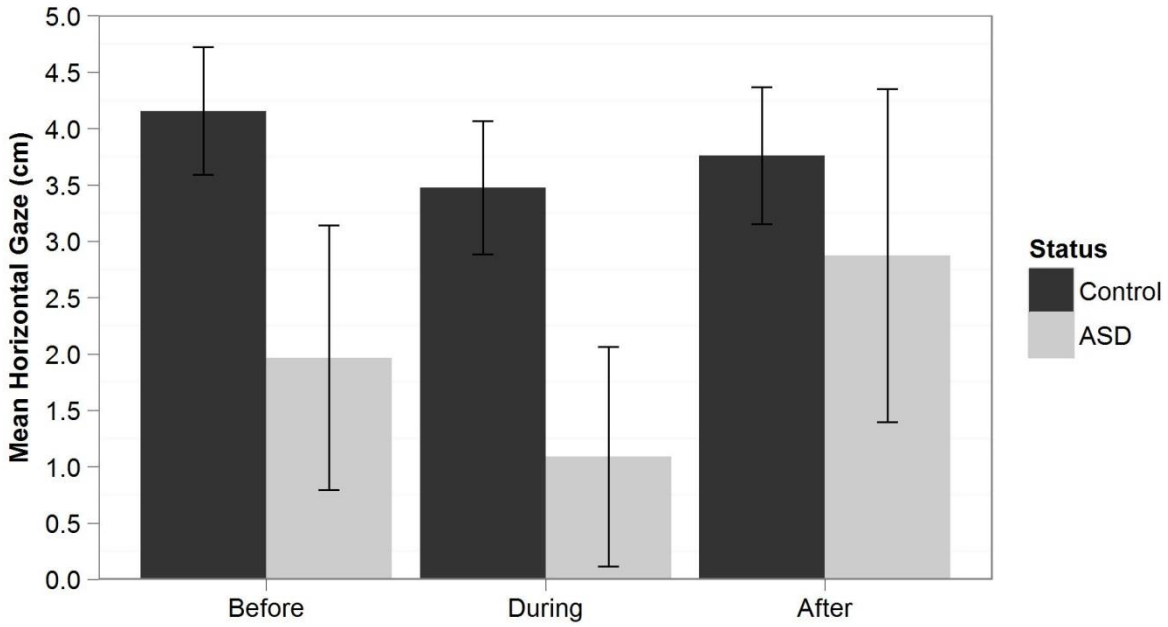
The average vertical position of HF-ASD drivers' gaze was 44% higher than the community control group

Heart Rate



Average heart rate across environments for the period before, during and after the secondary cognitive tasks by HF-ASD status

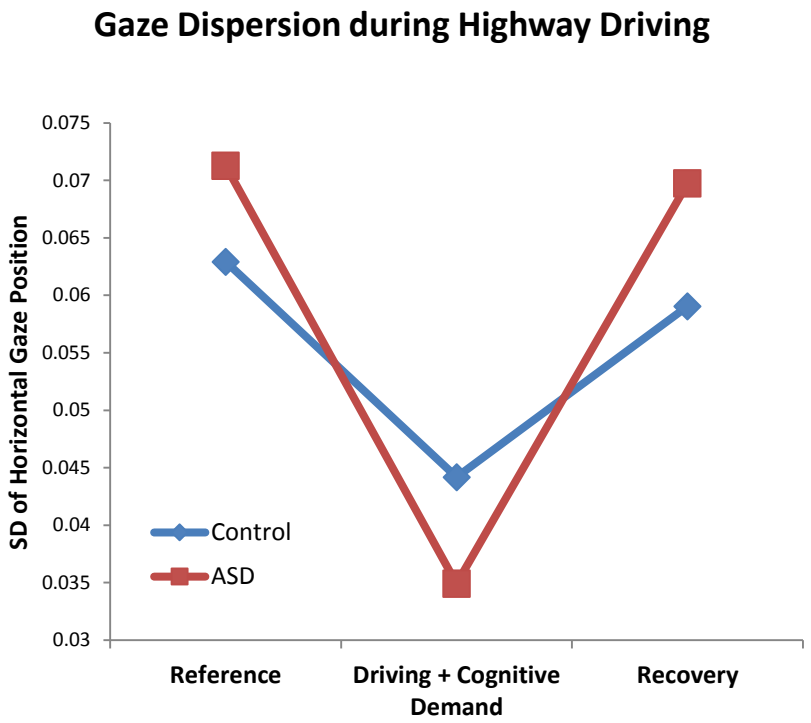
Horizontal Gaze



With cognitive demand ASD shifted their focus to the left across environments even in urban areas where stimulus were present on the right

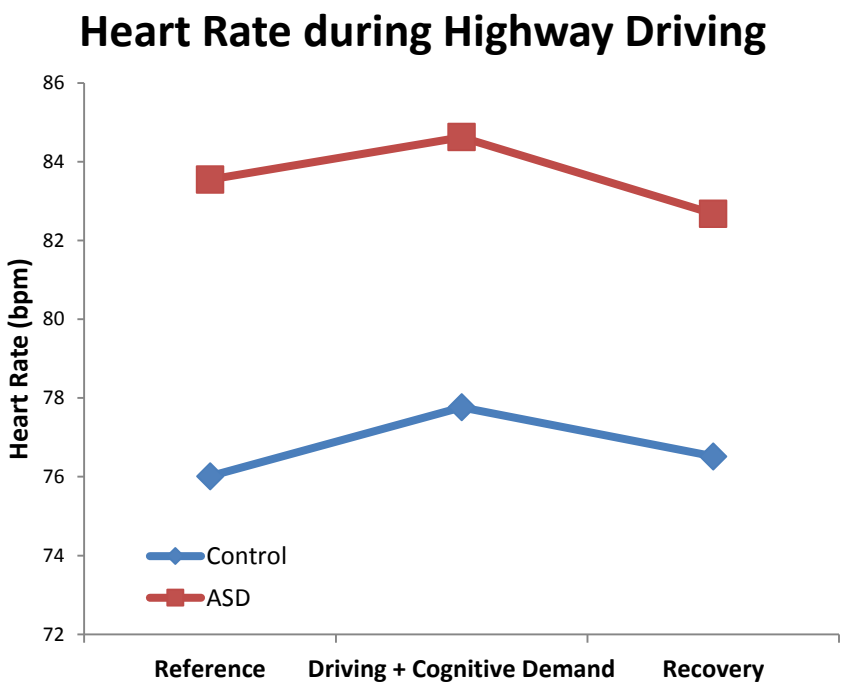
Young Adults with ASD Have Difficulty Attending to the Roadway

- Higher vertical gaze position
- Increased variability in attention
- Ineffectively scanning and less engaging eye position when presented with added cognitive demand
- Results suggest ASD drivers:
  - Their gaze is directed higher above the roadway than other drivers – suggesting "shifting" of attention away from key road features
  - Disengage visually from the driving task as demand increases – suggesting "freezing"
  - This is likely to result in a decreased ability to detect threats, e.g. vehicles and pedestrians



ASD Group Drives W/ Higher Level of Arousal

- Young adults with ASD show a trend towards higher heart rate
- Higher heart rate suggests increased arousal to driving demands
- Suggesting:
  - Difficulty managing driving task
  - Increased anxiety
  - This level of activation may be above the optimal point on the arousal curve making ASD drivers less capable of responding to changing traffic demands



Discussion

- The movement of attentional focus away from the forward roadway with increased cognitive demand suggests that while cognitively distracted, HF-ASD drivers may require longer than community controls to respond to critical events.

Conclusions

- A better understanding of driving behavior in drivers with HF-ASD has important clinical and public health relevance
  - specific driving intervention strategies aimed at their amelioration
- Small sample size indicates more research needed