A Pilot Study for Distracted Driving in Teens With and Without ADHD

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Project Summary: Motor vehicle collisions (MVCs) are the leading cause of death for teenagers, accounting for approximately 1 in 3 deaths for this age group (National Center for Injury Prevention and Control [NCIPC], 2009). With advancing technology, the number of distractions to which drivers are exposed continues to increase and such distractions may especially increase the risk and severity of motor-vehicle related injury for teens because of their lack of experience (Neyens & Boyle, 2008). The purpose of the present study is to examine what effect two common forms of distractions (cell phone & text messaging) might have on increased motor-vehicle injury risk in teens with and without Attention-Deficit/Hyperactivity Disorder, Combined Type (ADHD-C) - a group that has been identified as at particular risk for injury (Barkley, Guevremont, Anastopolous, DuPaul, & Shelton, 1993).

A. Specific Aims

Motor vehicle collisions (MVCs) are the leading cause of death for teenagers, accounting for approximately 1 in 3 deaths for persons between the ages of 16 and 19 (National Center for Injury Prevention and Control [NCIPC], 2008). With advancing technology, the number of distractions to which drivers are exposed continues to increase and may especially increase the risk and severity of MVC-related injury for teens because of their inexperience (Neyens & Boyle, 2008).

The purpose of the proposed study is to determine the effect(s), if any, speaking on a cell phone or text messaging, two common forms of distractions, has on increased MVC-related injury risk in teens with (and without) Attention-Deficit / Hyperactivity Disorder, Combined Type (ADHD-C). Teens with ADHD-C were selected for further study because previous research has identified them as being at increased risk for injury (Barkley, Guevremont, Anastopolous, DuPaul, & Shelton, 1993).

Suffice to say, effective interventions that promote safe driving while discouraging unsafe driving are critically needed if we are to reduce elevated and unacceptably high rates of MVC-related injuries among teenagers.

Thus, it is of far more than casual interest that a promising computerized cognitive intervention has been used extensively with older drivers who show declines with age in higher order cognitive functions such as executive control, a function responsible for controlling behavior (e.g., Ball et al., 2006; Edwards et al., 2008). The point is made because Barkley (1997) reported that teens may show similar deficits due to the immaturity of the frontal lobes during the adolescent stage of development and the deficiencies in those with ADHD-C may be even more pronounced given the central impairment in executive function associated with this disorder. The proposed study will be among the first to pilot the cognitive intervention previously used with older adults in a sample of teens, particularly those who have demonstrated difficulty with executive control (e.g., those with ADHD-C).

The proposed study has two primary specific aims:

> **Primary Specific Aim 1) To compare the driving performance of a group of teenagers between 16 and 19 years of age who have been diagnosed with ADHD-C and a matched control sample without ADHD-C (NO), operating a virtual driving simulator while (a) engaged in a cell phone conversation, (b) engaged in a text messaging conversation, or (c) undistracted**

Teenagers use cell phones and text messaging at a greater frequency than other age groups. Previous literature has established that cell phones may impair the performance of typically developing teens in a driving environment (McCartt, Hellinga, & Bratiman, 2005). An extensive literature also concludes that a diagnosis of ADHD-C increases the likelihood of risky teen driving (Barkley et al., 1993; Barkley, Murphy, DuPaul, & Bush, 2002). However, to the best of our knowledge, no published studies have compared the potentially detrimental effect of talking on a cell phone or text messaging while driving for teens with and without ADHD-C (although a few studies have examined the impact of these two distractions while driving for young adults in general). The proposed study will assess the driving performance of teens with ADHD-C in a virtual driving simulator and compare their performance to a matched control group without the disorder across two driving sessions and three distraction conditions. See Figure 1 on p.10 for an illustration of the basic research design for the study.

This aim will be tested using a series of linear mixed models, with distraction condition as a three-level within-subjects factor (cell phone conversation, text messaging conversation, and no distraction) and session as a two-level within-subjects factor (pre- and post-intervention). Group status (ADHD-C, NO) will serve as the between-subjects factor. Participants will be matched on age, gender, an index of SES (an aggregate of household income and parent education level), and months of reported driving experience. These linear models will be computed for each dependent variable (i.e., deviation of lane position, reaction time, average driving speed, motor vehicle collisions and close calls, and visual attention). Significant main effects and interactions will be further explored with appropriate post-hoc analyses.

We are particularly interested in examining whether there will be a main effect of distraction. A planned contrast (cell phone versus text messaging) will yield results indicating whether the text messaging task impairs performance significantly more than a cell phone conversation (Hypothesis 1). We are also interested in determining whether the two-way interaction (Group (ADHD-C vs NO) x Distraction (cell phone vs. text messaging vs. no distraction) is significant. A test of statistical equivalence as outlined by Wellek (2003) will be conducted to compare undistracted teens with ADHD-C to distracted teens without ADHD-C (NO) to determine whether the behavioral and cognitive deficits associated with ADHD-C make these individuals resemble distracted (non-ADHD-C) drivers (Hypothesis 2).

- **Hypothesis 1:** Teens (with and without ADHD-C) will exhibit riskier driving behavior during the text messaging condition given that it may be more cognitively demanding than a naturalistic cell phone conversation.

- **Hypothesis 2:** Undistracted teens with ADHD-C will display equally risky behaviors as teens in a distracted condition.

Primary Specific Aim 2) To compare short-term changes in driving performance of teens with and without ADHD-C in a virtual driving simulator as a function of a cognitive training intervention

There is substantial evidence that computerized cognitive training yields positive gains in driving performance for older adults. However, no study, to our knowledge, has examined the potential benefit of the same training program on teen drivers, particularly those with ADHD-C who may also have meta-cognitive deficiencies, particularly in executive control.

In the proposed study, it is planned that half the participants in each group (ADHD-C and NO) will receive a cognitive training program for home use and will complete 9 hours of training over a 6-week period. The other half of participants will serve as the control group. At pre- and post-intervention, all teens will drive in a simulator (as outlined above in Primary Specific Aim 1). To test whether the intervention produced short-term changes in driving performance, an *intention-to-treat analysis* will be used. Specifically, we will use linear mixed models where the difference between pre- and post-intervention scores on all simulator variables will be of interest. Distraction condition will serve as a three level within-subjects factor (no distraction, cell phone, and text messaging) and session (pre-intervention vs. post-intervention) as a within-subjects factor. Models will be computed for each dependent variable as described in the previous aim (Hypothesis 3).

- **Hypothesis 3:** Post-intervention driving performance will be significantly improved for both groups (those with and without ADHD-C).

The study also includes a Secondary Aim, support for which will come from non-UTC sources:

Secondary Specific Aim 1) To explore the role of physician-prescribed stimulant medication in reducing risky driving in teens with ADHD-C

A few studies have examined the effect of stimulant medications in reducing the risks for ADHD-C drivers. However, this study will be among the first to investigate what role these medications may play in the performance of distracted teen drivers.

This will be accomplished by assessing the driving behavior of teens with ADHD-C in a virtual driving simulator while first off of their medication and then medicated by their usual dosage of stimulants. Teens who are prescribed medications to treat ADHD symptoms will arrive to the pre- and post-intervention sessions unmedicated. After completing the procedures as outlined in the primary specific aims above, participants will take their prescribed medication dosage. After a 30-minute waiting period (in order to allow the medications to enter their system), teens will engage in another driving session. This aim will be tested using a series of Repeated Measures Analyses of Variance, but only within ADHD-C participants. Two within-subjects factors will be entered: distraction condition (cell phone, text message, no distraction) and medication status (on/off). The models will be replicated across all driving simulator dependent variables as described in the primary aims above (Hypothesis 4).

- **Hypothesis 4:** Medications prescribed to mitigate the symptoms related to ADHD-C will also reduce risky distracted driving behavior.

Long-Term Objectives

With evidence suggesting that a cognitive training intervention is associated with reductions in MVCs, the potential for wide-scale implementation of the intervention is substantial. Collectively, findings from this study will have important implications for designing programs to facilitate safe driving in teens, especially those who may have more crash and injury-related risk factors than found in the overall pool of teenage drivers.

The proposed research will be the primary postdoctoral activity of the principal investigator. If pilot data results warrant further investigation, the PI will use them to pursue a grant award (e.g., NIH, NHTSA, CDC) to underwrite a larger-scale research project as she transitions from postdoctoral fellow to an academic-based faculty position.

B. Background and Significance

B1. Overview

1. Motor vehicle collisions (MVCs) are the leading cause of death for teenagers ages 16 to 19, accounting for approximately 1 in 3 deaths for this age group (National Center for Injury Prevention and Control [NCIPC], 2008).
2. Certain factors may increase teens' risk for involvement and/or injury in a MVC, including new technologies contributing to driver distractions (e.g., cell phones or text messaging) and certain developmental disabilities (e.g., Attention-Deficit/Hyperactivity Disorder)
3. Effective interventions are vital for reducing rates of injury though most previous attempts with teens have not been translated to driving improvement.
4. The proposed study will provide pilot data intended to help determine whether a cognitive intervention enhances safe driving for teens with and without ADHD-C.
5. Meaningful translational efforts are needed to promote safe driving practices among teenagers.

B2. Epidemiology of Cell Phone Use

With advancing technology, the number of distractions to which drivers are exposed continues to increase. One of the most common distractions drivers face is using a cell phone. Rates of use while driving continue to increase dramatically from year to year. A recent poll revealed that in the United States approximately three-fourths of adults who drive have a cell phone and a majority of those adults admit that they sometimes talk on a cell phone while driving (Harris Poll, 2006). This pattern holds true across most geographic regions, with particularly escalated patterns in the South and Midwest sections of the United States.

Multitasking proves to be taxing for any driver, but such distraction may greatly increase the risk and severity of motor-vehicle related injury for teens because of their inexperience (Neyens & Boyle, 2008). Moreover, there are estimates that almost nine in ten young adults talk on a cell phone while driving (Harris Poll, 2006) and younger individuals are more likely to use a cell phone when driving (Walsh, White, Hyde, & Watson, 2008). Given that MVCs are the leading cause of death for teenagers, accounting for approximately 1 in 3 deaths for persons between 16 and 19 years of age, the magnitude of the current problem is readily apparent and the potential for it increasing to even more alarming proportions is readily apparent (National Center for Injury Prevention and Control [NCIPC], 2008).

The number of teens who own a cell phone has increased from 40 percent to 60 percent since 2004 (Reardon, 2008). Further, it has been well-established in the literature that cell phones compromise the performance of young adult drivers (Caird, Willness, Steel & Scialfa, 2008; Drews, Pasupathi, & Strayer, 2008; Horrey & Wickens, 2006). Cell phone conversations impose certain cognitive demands that interfere with driving performance given the verbal and attentional processing required to successfully engage in both tasks (Charlton, 2009). Since few studies have examined cell phone distraction in novice, teen drivers (Shinar, Tractinsky, & Compton, 2005) it is important to measure and document that which we suspect to be a significant increase in the risk of MVC and MVC-related injuries among teenage drivers.

B3. Text Messaging

Text messaging is another popular form of electronic communication especially among teens. Yet, very few well-done studies have examined a possible role of text messaging as a motor vehicle crash risk factor. In September 2008, a report by the Nielsen Group revealed that text messaging rates increased by 450% between 2006 and 2008, with typical U.S. mobile subscribers sending or receiving significantly more text messages than phone calls per month. With the increased usage of text messaging, it seems likely that text messaging while driving might be on the rise as well. Given the cognitive and motor constraints required to complete both tasks simultaneously, the effect of text messaging on driving performance may be even more detrimental than the effect of a cell phone conversation. For example, distracted attention from the road that is re-directed to the cell phone may be greater for a text messaging task than for a cell phone conversation. One recent study examining text messaging and driving in a young adult population (aged 18-21) found that teens spent 400% more of the simulator time with their eyes off of the road while texting than when undistracted (Hosking, Young, & Regan, 2006). The proposed study aims to extend that finding by examining distracted driving among novice teen drivers and teen drivers with ADHD-C, two groups who are actually more likely to engage in risky driving.

B4. Novice Drivers

Novice drivers between sixteen and nineteen years of age are overrepresented in severe crashes. Moreover, the crash rate is particularly elevated in the first six months after licensure (Mayhew, Simpson, & Pak, 2003). In 2006, 3,490 15- to 20-year-old drivers were killed and an additional 272,000 were injured in motor vehicle crashes (Department of Transportation [DOT], 2008). A number of factors have been identified as increasing the risk for novice drivers: (a) they may be particularly vulnerable to distraction given their poor behavioral control and decreased attentional capacity which is needed to accommodate for unexpected roadway demands, (b) they may be less able to anticipate and identify hazards, (c) they may be more willing to take risks (Lee, 2007), and (d) perhaps they lack the skill and judgment required to navigate effectively and safely (McGwin & Brown, 1999). With experience, driving becomes a subconscious task and, in turn, the effect of distraction may be less of a risk factor (Crundall, Underwood, & Chapman, 1999), though in certain circumstances even adult drivers' safety may be compromised by cell phone conversation or text messaging (Hosking et al., 2006).

B5. ADHD-C Drivers

Another group at-risk for poor driving performance involves those who have been diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD). ADHD is a behavior disorder affecting an estimated 3% to 7% of the population, with males overrepresented at a ratio of 3 to 1 (Barkley, 1997). Teenagers with the Combined Type of ADHD are characterized as having impulsive, hyperactive, and inattentive behavior patterns (American Psychiatric Association, 1994), as well as deficits in executive functioning (Barkley, 1997). These cognitive and behavioral deficits may be implicated in applied settings such as the driving environment. For example, driver inattention is a major factor related to MVC involvement, so it may be inferred that those with a disorder of attention may be at particularly elevated risk for injury (Lamm, 2002).

Numerous studies have shown that teens with ADHD-C are more likely to engage in risky driving behavior. One of the first studies to demonstrate this relationship showed that teens with ADHD-C are more likely to engage in illegal driving practices such as speeding; and, that they are nearly four times more likely to have had a MVC than their typically developing counterparts (Barkley et al., 1993). One major limitation of this study is that driving performance was measured by parent report rather than direct observation. More recent studies have revealed similar findings through self-report. One study found that adults with ADHD-C exhibit deficient driving knowledge and less safe driving habits (Barkley et al., 2002). Observational and self-report studies have provided important data regarding this issue, but to our knowledge few studies have experimentally examined the potential increased risk that cell phones or text messaging may introduce for typically developing novice teen drivers and their same age counterparts who have been diagnosed with ADHD-C.

A number of studies have demonstrated that driving performance in individuals with ADHD-C may be improved with psychostimulant medication (Cox, Humphrey, Merkel, Penberthy, & Kovatchev, 2004; Jerome, Segal, & Habinski, 2006; Weafer, Camarillo, Fillmore, Milich, & Marczinski, 2008). The effect of stimulants on driving performance is an important research topic for various reasons. For example, there are times when teens voluntarily forego taking their medication (e.g., weekends and summers), which may inadvertently place them at an elevated risk for involvement in a MVC and even if a teen takes stimulants daily, there are certain medications which wear off after several hours, which coincides with times that teens will be in driving situations (e.g., driving home from school or in the evenings on weekends). Most studies to date have focused on psycho-stimulant use by young adult drivers, rather than novice, teen drivers and no studies to our knowledge have examined the effect of stimulants on distracted driving. The proposed study seeks to fill this gap in the literature and will attempt to do so through a secondary aim funded by non-UTC sources.

B6. Driving Simulators

Few studies to date have examined distracted driving in teens with and without ADHD-C in an experimental manner. One explanation for the limited empirical research in this area is that it would be unethical to ask teens to drive on real roads while engaging in distracting tasks. A virtual driving simulator is an ethically viable tool for studying distracted driving behavior. Simulated driving environments give the user a sense of being fully in the environment through realistic virtual images, high quality sound, the feeling of immersion (being surrounded by the virtual world rather than just viewing it on the screen), and the ability to interact with the virtual world (Reid, 2002). Numerous studies have examined driving behavior by using a virtual driving simulator in a variety of experimental manipulations including adults with ADHD-C (Barkley et al., 2002; Fischer, Barkley, Smallish, & Fletcher, 2007; Weafer et al., 2008) and adults distracted by a naturalistic cell phone conversation (Rakauskas, Gugerty, & Ward, 2004). However, few, if any, studies have investigated behavior when a driver is distracted by more advanced technologies such as text messaging (Hosking et al., 2006; Reed & Robbins, 2008). The latter two studies cited focused on typically developing young adults and text messaging, while the proposed study will focus on additional groups which may be particularly at risk, novice teen drivers with and without ADHD-C.

B7. Improvements in Driving Performance with Cognitive Training

The ability to process information and respond quickly to make safe decisions when driving may be difficult for a young driver, especially those simultaneously engaging in a distracting task such as talking on a cell phone (Charlton, 2009). Those with ADHD-C may have particular difficulty with processing speed and other high order cognitive functions such as divided attention. Processing speed deficits have been documented in the ADHD-C literature as differing significantly when ADHD-C subjects are compared with controls (Rucklidge & Tannock, 2002). A study by Fried et al. (2006) examined neurocognitive correlates of driving performance in drivers identified as having high or low risk by self-report of driving risks on the Driving Behavior Questionnaire (DBQ). High risk drivers with ADHD-C showed significant impairments on a number of cognitive tasks including the Stroop task, a measure of response inhibition, and processing speed tasks (two WAIS subtests, Digit Symbol Coding and Symbol Search) as compared to low risk ADHD-C drivers. This gives some preliminary indication that impairment in certain cognitive processes (e.g., processing speed and response inhibition) may lead to riskier driving in those with ADHD-C, though few cognitive remediation programs have been used to train teen drivers.

Some prevention efforts have included cognitive training requiring quick mental manipulation such as working memory training in children with ADHD-C (Klingberg et al., 2002; Klingberg et al., 2005). Frontal lobe impairments involving working memory processes as well as other cognitive processes have been shown to significantly improve due to computerized cognitive training, particularly in the area of response inhibition and as evidenced by the reduction of ADHD-C symptoms on rating scales (Klingberg et al., 2005). However, the previously mentioned study did not translate findings to the driving context. Few studies have examined the potential of cognitive interventions for increasing safe driving in teens, despite promising results across numerous studies with older adults utilizing speed of processing training (e.g., Roenker, Cissell, Wadley & Edwards, 2003).

Speed of processing training has the primary aim of improving the fluid ability of mental processing speed (not psychomotor reaction time) such that trainees can process increasingly more information and increasingly more complex information over briefer periods of time. Speed of processing training has traditionally involved trainer-guided practice of computer-based nonverbal exercises that are presented very briefly and involve target detection, identification, discrimination, and localization (Ball et al., 2002; Ball et al., 1988; Sekuler & Ball, 1986). Unlike other cognitive training protocols, such as reasoning or memory training (Ball et al., 2002; Rebok, Montaglione, & Bendlin, 1998; Willis & Schaie, 1986), speed of processing training tasks are nonverbal. Speed training, as described here, targets practice of tasks and is intended primarily to improve a basic cognitive ability, speed of information processing, which may be impaired in novice teen drivers, particularly those with ADHD-C. These studies provide evidence that speed of processing training has the potential to enhance driving performance, particularly in individuals with processing speed deficits. The proposed study seeks to investigate whether similar gains can be made by novice teen drivers by the use of the same training protocol used in the previous studies with older adults.

B9. The Proposed study

The overarching goal of the proposed study is to use recent advances in research and technology to 1) gain a fundamental understanding of how potentially distracting new technologies are for teen drivers and 2) evaluate an existing cognitive intervention used successfully in older adults as a means of facilitating safe driving for teens with ADHD-C.

This study is highly related to the research agenda listed in the identified funding source's (UAB-UTC) Strategic Plan; a plan rigorously based on the major goals of several federal entities, including the Center for Disease Control and Prevention's National Center for Injury Prevention and Control (CDC – NCIPC), the US Department of Transportation (USDOT), and the Federal Highway Administration (FHWA).

In addition, two of the three overarching research goals of the UAB-UTC are directly related to the proposed study; (1) "*Achieving a statistically significant reduction in morbidity, catastrophic disability and mortality resulting from motor vehicle crashes (MVCs*)" and (2) "*Crash-related injury prevention and control as a function of the operator, the vehicle, the roadway infrastructure, or any combination thereof"* (UAB-UTC Strategic Plan, 2006).

C. Preliminary Studies

C1. The PI's Prior Experience Conducting Transportation-Related Injury Risk Research

During her doctoral training, the PI established a respectable research history focusing on transportation-related issues from a psychological perspective. That training trajectory led to her receiving the prestigious Dwight David Eisenhower Graduate Fellowship through the U.S. Department of Transportation for two consecutive years (2007-2008 & 2008-2009), as well as receiving the Student of the Year Award by the proposed funding sponsor (the UAB-UTC) in 2008.

During her graduate training, the PI conducted a number of studies under the mentorship of Dr. David Schwebel. These included investigations of pedestrian injury risk under a number of conditions and in various populations, including cell phone distraction in early adolescents (Stavrinos, Byington, & Schwebel, 2009) and adults (Stavrinos, Byington, & Schwebel, in preparation), heavy backpack use in college students (Schwebel, Stavrinos, & Dulion, 2009) and increased risk of adult pedestrians with certain personality characteristics such as poor attentional control and high intensity pleasure (Schwebel, Stavrinos, & Kongable, 2009). She also played a leading role in designing an ongoing study examining text messaging and portable music player (e.g., mp3 and iPod) use among college student pedestrians.

Dr. Stavrinos' work on cell phone distraction and pedestrians which was published in *Pediatrics* in February 2009, received widespread local, regional, national, and international recognition and appeared in over 1000 media outlets, including most major national news outlets (e.g., CNN, MSNBC, ABC, CBS, and CBC news) and major periodicals (e.g., the *New York Times, US News and World Report, Forbes Magazine*). This particular study also led to the PIs receipt of the Injury Prevention Award from the CDC-NCIPC and the Society for Pediatric Psychology.

C2. Experience in Working with Children with ADHD-C

The PI has extensive experience in working with children with ADHD-C both clinically and in a research setting. She served as a trainee for two years at one of the proposed recruitment sites where she evaluated children referred for behavior disorders and worked with a team consisting of a licensed clinical psychologist and a developmental pediatrician to determine whether a child met criteria for an ADHD-C diagnosis. During her traineeship, the PI evaluated over 100 children referred for suspected developmental disabilities.

Children with ADHD-C were the primary focus of the PIs recently completed dissertation project which investigated the possible underlying mechanisms of increased pedestrian injury risk in children with this developmental disability. The study, which was funded by the National Science Foundation – Center for Child Injury Prevention Studies, the Society for Public Health Education, and the Centers for Disease Control and Prevention, revealed that executive functioning mediated the link between increased pedestrian injury risk and children with ADHD-C (Stavrinos, Biasini, Hodgens, Khatri, Mrug, & Schwebel, in preparation).

C3. Experience in Simulator Research

The PI has extensive expertise with simulator use for research purposes as all of the aforementioned studies involved the use of a CDC/UAB-ICRC funded virtual pedestrian environment simulator. The project collaborator for the proposed project, Mr. David Ball, has particular expertise with the driving simulator to be employed in the proposed study and his role is outlined in greater detail in a later section (see "Resources").

D. Method

D1. Participants

A total of 22, 16- to 19-year-old teens with a diagnosis of ADHD-C, Combined Type (ADHD-C) and 22 typically developing controls (NO) matched on age, gender, an index of socioeconomic status (an aggregate of household income and maternal education level), and months of driving experience will be recruited and constitute the study population (power = .95 for a medium effect size; accounting for 10% attrition; Cohen, 1988).

Teens with ADHD-C will be recruited through local behavioral assessment clinics and from the community through advertisements and flyers, while controls will be recruited from the community through advertisements and flyers. This method of recruitment has proven successful in previous studies with clinical populations led by the PI (e.g., Stavrinos et al., in preparation). For those in the ADHD-C group, diagnosis will be confirmed by medical chart review as well as by self-report of clinically elevated ADHD-C symptoms on a rating scale (the same self-report measure will be used to rule-out ADHD-C in control subjects, specifically those rated as exhibiting more than 3 inattentive or 3 hyperactive/impulsive symptoms will be excluded). A parent rating scale of ADHD-C symptoms will further confirm or rule out assignment to the ADHD-C group.

Approximately 35-45% of the sample is expected to be of minority status (primarily African American), reflecting the ethnic composition of the local area. It is expected that the sample will include more boys than girls, as more boys have ADHD-C diagnoses. Inclusion criteria for the two groups include those who regularly use a cell phone with text messaging capability and who are willing to use their own phone for 15-25 minutes during each session. Participants must also possess a valid driver's license and have access to a home computer to engage in the cognitive intervention. Exclusion criteria for both groups include physical disabilities (e.g., visual or hearing impairment, use of a wheelchair) that would prohibit full participation in the experimental protocol.

Because certain comorbidities (e.g., Oppositional Defiant Disorder, Learning Disabilities) are common in those with ADHD-C, participants will not be excluded on this basis. However, we will document comorbidities reported in a structured diagnostic interview and will control for their effects in statistical analyses if present. Those with ADHD-C who are prescribed stimulant medications (e.g., Ritalin, Adderall, Concerta) to treat symptoms of inattention, hyperactivity and impulsivity will not be excluded but will be instructed to forego taking their typical medication dosage during one of the first two sessions (medication use to be assigned by random order), to examine what effect stimulants may have on driving ability (Secondary Specific Aim 1). However, those who are prescribed any medications other than stimulants, such as non-stimulant ADHD-C medications (e.g., Straterra), anxiety or depression medications (e.g., Zoloft, Celexa, Prozac), sleeping aids (e.g., Clonidine) or anti-psychotic medications (e.g., Risperdol, Trileptal) that remain active in the body for up to two weeks will not be eligible for participation due to their inability to forego taking medication on the day of the session.

D2. Procedure

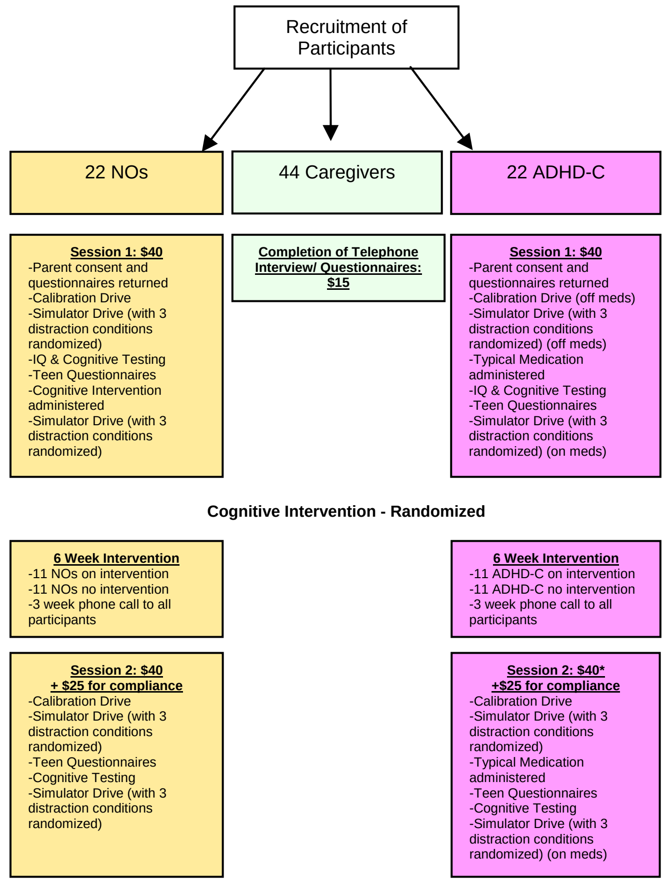
In preparation for the administration of testing tasks, a team of undergraduate and graduate student research assistants will be trained. Standardized protocols will be developed for use in administering the tasks. Research assistants will be blinded as to what group each participant belongs (ADHD-C vs NO). When developing the driving scenarios, careful consideration will be made to traffic density and traffic speed to mimic local roads surrounding the Birmingham area.

Figure 1 shows an outline of participant flow through the study. Participants will participate in a total of two sessions (see subsequent sections for a detailed listing of session activities).

Participants enrolling in the study will be sent a package containing (a) detailed information regarding usage of medication for the first session (recall that those prescribed stimulant medication will be asked to bring their medication with them so that they may take the medication halfway through the sessions) and a reminder to bring their own cell phone to the session, (b) informed consent and assent forms, and (c) a packet of questionnaires to be completed by the caregiver. Caregiver questionnaires enclosed in this package include: (a) report of ADHD-C behaviors, (b) information regarding the teen's diagnosis, level of impairment, comorbidities (if any), and medication dosage and schedule (if applicable), and (c) how families approached learning to drive with their teens. Teens will be asked to bring signed consent forms and completed questionnaires with them to the first scheduled session to participate in the study. For those with ADHD-C, the informed consent document will also include a form asking for the release of medical records for chart review to confirm the ADHD-C diagnosis. All participants will provide assent upon arrival and will provide their cell phone number for utilization during distraction conditions. Caregivers will be contacted to participate in a brief structured diagnostic interview and will be offered monetary compensation ($15) for participating in the interview and for completing and returning questionnaires.

D2a. Session One Activities: Pre-Intervention

Figure 1. Participant Flow Through Study



***Note: Amount to be covered through a student grant recently awarded to the Principal Investigator through the National Science Foundation – Center for Child Injury Prevention Studies.**

As illustrated in Figure 1, participants will be asked to provide parental signed consent and will provide assent to participate. In the circumstance where a participant may fail to bring the signed consent form to the first session, an attempt will be made to reschedule the participant, as they will be unable to proceed with the study without first providing parental consent. In the case that parent questionnaires are not returned at session one, questionnaires must be returned at session two to continue with participation. Participants in the ADHD-C group will arrive to the session unmedicated (that is, without having taking any stimulant medication for the past 12 hours) but will be instructed to bring their medication with them to the session. Once the participants have been consented/assented, the participant will become acquainted with the simulator during a brief calibration session to ensure that all participants meet a minimum standard of proficiency with basic driving tasks (maintaining a steady speed, lateral position, and headway to a lead vehicle, and acceptable performance on braking, turning, and reaction-time). In the calibration drive, participants will drive a standardized scenario with no distraction involved until they meet all criteria for stable driving performance. Previous studies have used "familiarization drives" to rule out learning effects (Weafer et al., 2008), but none have employed measurable proficiency tests that test for stable levels of driving performance.

Participants will subsequently engage in three driving scenarios, each spanning a 5 mile driving distance, with distraction conditions randomly presented to participants: (a) no distraction, where participants anticipate a text or phone call but do not receive either, (b) cell phone conversation, where participants receive a cell phone call 10 seconds after beginning the scenario, quickly answer the phone, and subsequently engage in a naturalistic phone conversation with an unfamiliar research assistant for the remainder of the scenario, or (c) text message conversation, where participants receive a text message 10 seconds after beginning the scenario and engage in reading and responding to text messages from an unfamiliar research assistant for the remainder of the scenario. Cell phone and text messaging conditions will be semi-structured to imitate a typical conversation between unfamiliar individuals, and research assistants will maintain a natural conversation flow. Example conversational questions include, “What is your favorite television show?” and “What do you like to do for fun?”

During each scenario, participants will be instructed to pretend that they are on a real road and to drive as they normally would in a real situation like this one. The virtual road environment will closely match driving situations typically encountered in the Birmingham metro area, in terms of scenery, traffic flow and density. Participants will be instructed to keep their cell phone in their laps and to respond quickly if their cell phone rings or if a text message is received. For each scenario, the drive is expected to last between 7 and 12 minutes, when driven at speed limit.

Following the drive, those with ADHD-C will be instructed to take their regular dose of stimulant medication. All participants will then will then engage in a battery of tasks, presented in random order, including (a) IQ testing, (b) a trail making test, (c) a computerized test of attention, and (d) digit span (see “Measures” for detailed information about these tasks). Participants will also complete several brief paper-and-pencil questionnaires with a research assistant that will inquire about (a) basic demographic information, (b) ADHD-C behaviors, (c) cell phone and text messaging use, (d) driving history and experience, (e) risk behaviors in driving, (f) personality, and (g) perception of distraction. Participants will participate in another simulator driving session at the end of the session in order to evaluate the effect of medication for those with ADHD-C. All participants will drive twice in this session in order to rule out any additional practice for those with ADHD-C.

Half of the participants will be randomly selected to receive a cognitive intervention computer program at the end of the session. Randomization procedures will proceed as follows: The PI will prepare three lists of random assignments (one per subgroup: those with ADHD-C on meds first session, those with ADHD-C off meds first session and NOs) based on a computerized random number generator. Sealed envelopes will be prepared, to ensure allocation concealment, which will be opened sequentially at time of scheduling. Those assigned to the intervention will receive the computer software and will receive a brief training session on how to install the program and instruction on how often to use it (see next section for details). The other half of participants will not receive a cognitive intervention. All participants will receive monetary compensation for participation (varying by session activities; See Figure 1) and will be scheduled for the third and final session to occur 6.5 weeks ± 3 days from the first day they login for the 6-week cognitive training (or 6.5 weeks ± 3 days from the date of session one for those not receiving an intervention).

D2b. Cognitive Intervention

Eligibility criteria dictate that all participants should have access to a home computer for participation in the cognitive intervention program. In session one, those randomly assigned to the intervention condition will be instructed on how to install the program on their computer and will be asked to complete a minimum of 9 hours of training on RoadTour™ over a 6 week time period (90 minutes of training per week). A $25 bonus gas card incentive will be provided for those demonstrating training compliance (i.e., completing the full 9 hours). When the individual connects to the internet, the Insight™ software automatically uploads to a central server at Posit Science. Posit Science maintains a technical support center that participants may call for assistance. Within 5 days of receiving the training program, we will call study participants to determine if they were able to install the software successfully.

Posit Science will develop a secure web portal that will permit the PI to access daily updates of the performance data. The data updates include the following information: participant ID, time spent on each training occasion, number of trials completed, accuracy, display speed used, etc. See Table 1 below for a complete listing of the data available from Insight. Study compliance will be evaluated at the halfway point of the training program (i.e., three weeks post first login). A phone call will be made to all participants during week three of training (the halfway point) to check on progress and to ensure that there are no questions regarding the use of the program. To ensure consistency of contact between those receiving the intervention and those who are not, a phone call will also be made to those not receiving the intervention as a reminder about the appointment approaching three weeks from then. When an individual has completed 9 hours of RoadTour™ training, a phone call will be made to the participant informing him/her that they have completed minimal training requirements for the study and reminding them of their next scheduled appointment. Another appointment reminder call will be made to controls as well.

Table 1

Demographics:	Participant ID Age Gender Years of education Ethnicity
Usage Data:	Date of activation Beginning use date/time per session End use date/time per session Number of trials per assessment/exercise
Improvement Data:	Total time trained in exercise (cumulative) Total trials trained in exercise (cumulative) Final threshold
Trial-By-Trial:	Correct/incorrect, Trial ID Adaptive value (e.g., Stimulus duration) Stair ID, mean value, standard deviation Trial configuration

D2c. Session Two Activities: Post-Intervention

Participants will attend a third and final session 6.5 weeks ± 3 days from the first day they login for the 6-week cognitive training (or from the last appointment for those not receiving the intervention). The procedure for this session will be similar to session one; participants in the ADHD-C group will arrive to the session unmedicated (that is, without having taking any stimulant medication for the past 12 hours) but will be instructed to bring their medication with them to the session. As outlined in Figure 1, participants will first engage in a calibration drive followed by the three driving scenarios with random order presentation of the distraction condition. Participants will then engage in re-administration of several cognitive tasks that are robust with respect to practice effects, including (a) a computerized test of attention and (b) digit span. Participants will also complete the following questionnaires: (a) report of ADHD-C behaviors, (b) perception of distraction, (c) report of intervention usefulness and (d) a consumer satisfaction questionnaire. Participants will participate in another simulator driving session at the end of the session in order to evaluate the effect of medication for those with ADHD-C.

Participants will be debriefed and will receive monetary compensation for participation (varying by session activities; See Figure 1).

D3. Measures

D3a. Driving Simulator

Figure 2. STISIM Driving Simulator

Participants will engage in a computerized driving simulation task to provide an index of driving performance under specified conditions of interest (STISIM Drive, Systems Technology Inc., Hawthorne, CA). The simulation will be displayed on three, 20” LCD computer monitors, providing a 135° field of view (see Figure 2). Participants will sit within the cab of the vehicle, providing a view of the roadway and dashboard instruments. Participants will control the vehicle by moving a steering wheel and manipulating accelerator and brake pedals. A stereo sound system will provide engine noise, external road noise, and sounds of passing traffic, all of which enhance the realism of the task.

First, participants will complete a calibration drive to ensure that they meet a minimum standard of proficiency with basic driving skills. Once stable performance is achieved, participants will complete three, five mile driving scenarios with distraction condition (no distraction, naturalistic cell phone conversation, and text messaging conversation) presented in random order. The driving scenarios will feature a 2 lane road in which traffic will flow in a bi-directional manner and day-time suburban scenery will be displayed. The participant will be required to navigate through several curves, traffic signals, stop lights, and a construction site, while avoiding several staged hazardous events such as a pedestrian darting out into the street, a lead vehicle suddenly hitting their brakes, and an oncoming car swerving in front of the driver. Presentation of hazardous events within each scenario will be randomly ordered so that the event will not be confounded by distraction condition order of presentation. Speed limits will vary within the scenario but will remain constant across conditions and a speedometer will be displayed at the bottom front of the participant's field of view. Key driving variables will be coded electronically by the simulator, except for visual attention, which will be coded electronically by supplemental eye tracking equipment (See Section D3b).

D3b. Eye tracking equipment

Given the importance of visual attention to the driving task, and particularly when competing distracters are present, we plan to purchase FaceLab Version 5 manufactured by Seeing Machines (www.seeingmachines.com) to track participants' eye movements as they drive and as they observe other vehicles, signposts, traffic signals, and their cell phones as they attempt to compose, send and read text messages. Data for each eye, including eye position, pupil diameter, and blink events will be captured. Tracking accuracy associated with the system is reported to be within +/- 1mm of translational error and +/- 1 degree of rotational error and thus, is considered adequate for these experiments. Supplemental equipment components will also acquired. These include a gazetracker and scenetracker (i.e., camera technology that allows investigators to "see "what the subjects are actually seeing). Details regarding use of this eye tracking technology appear in the Resources section of this document.

D3c. Indicators of Risky Driving

Based on previous literature examining risky driving in ADHD-C and novice teenage drivers, five indicators of driving performance will be electronically recorded by the simulator and eye tracking equipment and analyzed across the three distraction conditions and across the two sessions:

(a) Deviation of lane position is an indicator of the degree of adjustment that a driver implements to maintain a desired position within the lane. Greater within-lane deviation indicates poorer driving precision and the measure has been shown to be a sensitive indicator of the impairing effects of many factors suspected to disturb driving performance (e.g., Shinar et al., 2005; Weafer et al., 2008). Road edge excursions, situations in which the right tire touches or crosses the right line, will be measured as percent of occurrence as an additional measure of lane position.

(b) Reaction time will be measured by the amount of time in seconds that elapses from the time of the event trigger (e.g., lead vehicle hitting the brakes) to the first occurrence of one of three responses; (1) an accelerator position equal to 0, indicating pedal release, (2) a braking position greater than 0, indicating brake activation, or (3) a change in steering angle more than 3 standard deviations above or below the average steering angle of that participant on straightaways (Rakauskas et al., 2004). Meta-analyses have revealed that reaction time has been consistently shown to increase during cell phone distraction across a large number of studies with adults (Caird et al., 2008).

(c) Average driving speed will be calculated, as this measure of risky driving substantially increases the likelihood of severe injury for teens (Neyens & Boyle, 2008). The number of speed limit exceedences will also be recorded.

(d) A total number of motor vehicle collisions and close calls (instances when the vehicle was within 2 seconds of striking another object) will be computed across each driving scenario. Despite its importance, few studies have reported data of this genre. (Strayer & Drews, 2004).

(e) Visual attention will be measured via eye tracking. Of particular interest will be the percent of time the subject's eyes are off of the road (Horrey, Wickens, & Consalus, 2006), a behavior that may result in detrimental driving performance. In addition, glances to potential hazards will be calculated, as studies have revealed differences in visual scanning by driver's level of experience (Mourant & Rockwell, 1972). One study demonstrated a restricted field of view for cell phone users (Maples, DeRosier, Hoenes, Bendure, & Moore, 2008), but the proposed study will be one of the first, to our knowledge, to examine eye movement related to text messaging while driving.

D4. Cognitive Intervention: Speed-of-Processing Intervention (RoadTour™)

The *speed-of-processing intervention* was designed to improve the efficiency and accuracy of visual and information processing and the ability to perform complex visual attention tasks (Ball et al., 2002). The original training program was developed by Dr. Karlene Ball, one of the study's collaborators and has been used extensively with an older adult population. Users are trained to improve the speed and accuracy with which they identify and locate visual information using a divided attention format (Ball et al., 2002). Over time, the difficulty and complexity of each task is systematically increased as users successfully attain specified performance criteria (Ball et al., 2002). Manipulations used to increase difficulty include decreasing the duration for which the visual stimuli are presented, adding visual or auditory distracters, increasing similarity between target and distracters, and presenting visual targets over a broader spatial expanse (Ball et al., 2002). In all of the configurations, the basic tasks are the same (i.e., a central discrimination task and peripheral target location). We will be testing the latest version of this speed-of-processing program named RoadTour™. In developing the present version, Dr. Ball and Posit Science™ retained the tasks used in previous efficacy trials with older adults, but modified the delivery platform so that it can be easily self-administered. This modification improves the ease with which the intervention can be distributed and implemented across a variety of settings and contexts. The addition of certain game elements has been found to improve user engagement and enhance compliance and may especially be engaging for younger study populations as this one.

On each trial, a target vehicle is presented in the center of the screen. At the same time a target is presented in one of eight locations in the periphery (left panel of Figure 3). These stimuli are presented briefly and then vanish. Two vehicles are then presented in the center of the screen (right panel of Figure 3), one of which was the previously presented target. The user must click on the target vehicle and then click on the location where the peripheral target appeared.

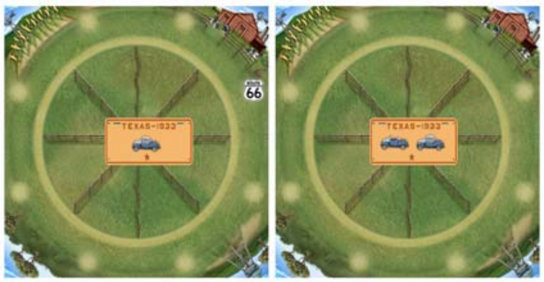


Figure 3. The left panel shows the target vehicle (car or truck) in the center and the peripheral target (Route 66 sign). The right panel shows the response screen. In the early configurations of this exercise there are no distracters. As the user progresses, however, distracters are added. In addition, the vehicle pairs morph to become more similar over time (see Figure 4 below left), which further increases task difficulty. A screen shot is provided in Figure 5.

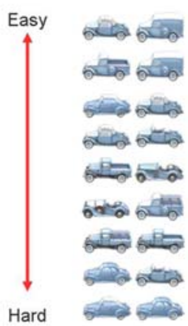


Figure 4. The 9 vehicle pairs

Figure 5. A screen shot of the training environment used in RoadTour™

The efficacy of the original UFOV speed-of-processing intervention at enhancing information processing speed and improving the useful field of view has been demonstrated in several prior studies with older adults (Ball et al., 2002; Edwards et al., 2005; Roenker et al., 2003; Vance et al., 2007; Wadley et al., 2006; Willis et al., 2006). The intervention is also associated with improvements in everyday functional abilities (Edwards et al., 2005) and driving skills (Roenker et al., 2003). In an effort to support the project and to assist with the implementation of the RoadTour™ speed-of-processing intervention, Posit Science™ has offered copies of the software at a production cost of $40 per copy. This price includes participant access to a technical support hot line should they need assistance in installing and using the training program on their home computer.

D4. Control Variables

The following questionnaires and cognitive tests will be administered to provide potential covariates for statistical analyses:

(a) The Conners Rating Scales – Revised (CRS-R; Conners, 1997), a self-report measure that validly measures ADHD-C behaviors in teens and young adults, will be administered. Results from this measure will be used to confirm elevated inattention and hyperactive/impulsive behavior in teens with ADHD-C and to rule out the presence of clinically significant behaviors in control participants.

(b) A brief questionnaire inquiring about basic demographic information of the teen and his or her household will be administered to the caregiver. Items will cover age, gender, income, parental education level, medication use, and any comorbid disorders. Household income and parental education level will be standardized and averaged to provide an index of SES on which participants will be matched.

(c) A structured clinical interview (The National Institute of Mental Health Diagnostic Interview Schedule for Children) will be used to verify the ADHD diagnosis and any comorbidities as well as to rule out any clinical diagnoses in control participants.

(d) A laboratory-developed questionnaire assessing other potential items of interest including, cell phone and text messaging use, driving history and experience, occurrence of crashes and traffic violations received, will be administered to teens.

(e) The Driver Behavior Questionnaire (DBQ; Reason, Manstead, Stradling, Baxter, & Campbell, 1990) will be used to assess self-reported risk behaviors in driving.

(f) The 2-subtest option form of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999) will be used to assess cognitive functioning in teens. One nonverbal subtest (Matrix Reasoning) and one verbal subtest (Vocabulary) will be administered. The two subtest option yields a reliable (.96) and valid (.88) estimate of general intellectual ability, while having the benefit of being administered in a brief manner.

D5. Other Variables of Interest

The following questionnaires and cognitive tasks will be administered to provide information for secondary areas of interest:

(a) The Trail Making Test (Reitan, 1958), is a two part paper-and-pencil neurocognitive measure of cognitive flexibility. In Trails A the participant is presented with a display containing the numbers 1 to 13 arranged in a random order. The participant is required to draw a line, from lowest to highest, thereby connecting the numbers in sequential order. The time needed to complete the sequence and the number of errors is measured. Trails B is similar to Trails A except that the targets include a mix of both numbers and letters of the alphabet. The participant is required to connect the numbers and letters in an alternating sequence (1,A,2,B,…). Time to completion and errors will be measured.

(b) Attention and impulsivity will be assessed with the Conners Continuous Performance Test II (CPT-II; Conners, 2000), a computerized, visual performance task that requires the participant to attend to non-target figures and inhibit responding whenever the infrequently presented target figure appears.

(c) A two-part Digit Span task will be administered to study participants. The first part, which measures verbal short term memory, requires the participant to repeat a series of numbers that are presented by the examiner. The second part requires that the participant repeat the numbers in reverse order of that presented by the examiner and serves a measure of working memory. Numbers are presented orally at a rate of one every second.

(d) The learning to drive process will be measured by a brief laboratory-developed questionnaire administered to the caregiver.

(e) A laboratory-developed questionnaire evaluating several aspects of the cognitive intervention (e.g., the user-friendliness of the program, its ability to hold participants' interest) will be administered.

(f) Personality will be assessed by the Adult Temperament Questionnaire (ATQ; Rothbart, Ahadi, & Evans, 2000) to examine personality traits that may potentially explain increased involvement in distracted driving. Sensation-seeking and impulsivity are linked to risky driving (Jonah, 1997; Shope & Bingham, 2008) and the proposed study will extend those findings by examining the relationship between these personality factors in novice drivers and their willingness to engage in a cell phone conversation or text messaging while driving.

(g) Perception of distraction will be assessed through a laboratory-developed measure both at pre- and post-intervention. Items will include perception of individual risk versus general population risk for a variety of driving conditions, including the two of primary interest in this study (cell phones and text messaging).

Previous research indicates that teenagers rate text messaging while driving as the second most likely situation to make "a lot of difference" in driving safety, second to drinking and driving (Ginsburg et al., 2008). In the same study, cell phone use was viewed as a significant hazard by just over a quarter of teenage respondents, while over half frequently witnessed cell phone use while driving. This suggests that teenagers do not fully see such distractions as hazardous. Novice drivers (Summala, 1987) and teens with ADHD-C (Barkley, 2004), tend to overestimate their ability, which may be an important factor in driving. Self-awareness of driving skills may help a driver use appropriate strategies to avoid MVCs; however, previous studies have only assessed general driving ability or particular conditions through questionnaires. The proposed study will assess self-awareness of driving risk using questions about actual conditions encountered by the participants during the virtual driving scenarios and to see whether perception of distraction risks vary across time.

(h) At each session, the participants will be asked to report on compliance-related issues, such as whether they have taken their medication that day, as instructed to (or not to) do so. Those failing to comply will be used in an analysis and will be compared to those who fully complied across sessions to detect any differences across dependent variables. Information about changes in the medication regimen will also be collected at each session. Training compliance will be monitored and analyzed in terms of duration and whether or not participants met the full nine hour training requirement.

(i) A consumer satisfaction survey will be developed and administered to participants in order to inquire about the participants' overall satisfaction with the computer program, its ease of use, whether they would be willing to purchase the intervention, and how much they would be willing to pay for it.

D6. Data Analytic Plan

Preliminary data analyses will entail (1) obtaining descriptive statistics on all measures; (2) examining the distribution of scores; and, (3) inspecting for kurtosis and skewness of each distribution. Non-normal distributions will be appropriately transformed.

The primary data analyses will proceed as follows:

Primary Specific Aim 1) To compare the driving performance of a group of teenagers between 16 and 19 years of age who have been diagnosed with ADHD-C and a matched control sample without ADHD-C (NO), operating a virtual driving simulator while (a) engaged in a cell phone conversation, (b) engaged in a text messaging conversation, or (c) undistracted

This aim will be tested using a series of linear mixed models (LMM), with distraction condition as a three-level within-subjects factor (cell phone conversation, text messaging conversation, and no distraction) and session as a two-level within-subjects factor (pre- and post-intervention). Group status (ADHD-C, NO) will serve as the between-subjects factor. Linear mixed models offer flexible handling of variance-covariance structures for repeated measures and, unlike traditional ANOVA and ANCOVA methods, these models can include time-varying covariates. In addition, LMM uses maximum likelihood procedures for parameter estimation, which provides efficient estimation of parameters in the presence of (randomly) missing data rather than listwise deletion of cases with missing data. Participants will be matched on age, gender, an index of SES (an aggregate of household income and parent education level), and months of reported driving experience. These linear models will be computed for each dependent variable (i.e., deviation of lane position, reaction time, average driving speed, motor vehicle collisions and close calls, and visual attention). Significant main effects and interactions will be further explored with appropriate post-hoc analyses. In order to examine whether undistracted teens with ADHD-C perform in a manner similar to distracted teens without ADHD-C (NO) (Hypothesis 2), a test of equivalence will be conducted (Limentani, Ringo, Ye, Bergquist, & McSorley, 2005; Wellek, 2003). Confidence intervals will be formed to examine the difference between the two mean values as compared to a theoretically-driven, a priori value (θ). If the confidence interval is within the range of this a priori value (-θ, θ), then there will be indication of equivalence. This will be repeated for each of the dependent variables.

Primary Specific Aim 2) To compare short-term changes in driving behavior of teens with and without ADHD-C in a virtual driving simulator as a function of a cognitive training intervention

To test whether the intervention produced short term changes in driving behavior, an intention-to-treat analysis will be used. We will use linear mixed models where the interaction between treatment condition and pre- to post-intervention change on all simulator variables will be of interest. The ability of LMM to estimate parameters without listwise deletion of cases with missing data makes it well-suited for intention-to-treat analyses. Distraction condition will serve as a three level within-subjects factor (no distraction, cell phone, and text messaging) and session (pre-intervention vs. post-intervention) as a within-subjects factor. Models will be computed for each dependent variable as described in the previous aim (Hypothesis 3).

Secondary Specific Aim 1) To explore the role of stimulant medication in reducing risky teen ADHD-C driving

This aim will be tested using a series of Repeated Measures Analyses of Variance, within only ADHD-C participants. Two within- subjects factors will be entered: distraction condition (cell phone, text message, no distraction) and medication status (on/off). The models will be replicated across all driving simulator dependent variables as described in above (Hypothesis 4).

D7. Timeline

The following timeline provides the tasks to be accomplished during the project year.

Task	**Month 1**	**Month 2**	**Month 3**	**Month 4**	**Month 5**	**Month 6**	**Month 7**	**Month 8**	**Month 9**	**Month 10**	**Month 11**	**Month 12**
Recruitment Site Approval & IRB	**X**	**X**										
Preparation of driving materials/scenarios		**X**	**X**	**X**								
Research staff training				**X**	**X**							
Participant Recruitment/Data Collection					**X**	**X**	**X**	**X**	**X**			
Data Management & Analysis										**X**	**X**	
Preparation of presentations and manuscripts											**X**	**X**

D8. Anticipated Results

This study has the potential to have a major impact on intervention development for at-risk teen drivers. Interventionists will be better informed about the potential risks of cell phone use and text messaging while driving (Primary Specific Aim 1) and automobile industry engineers may be informed of technology that could dissipate the risks associated with distracted driving. For example, lane departure systems may compensate for potential risky behaviors associated with distracted driving. While there is a growing body of research demonstrating that cognitive training is beneficial for older adults, this study will also attempt to address a rather glaring gap in the literature; that is, whether cognitive interventions are also able to facilitate safe driving for teens, especially for those with ADHD-C (Primary Specific Aim 2).

If stimulant medication also helps to reduce risky driving in teens (Secondary Specific Aim 1), this information will be critical for clinicians and other serving the ADHD-C population to inform patients about the importance of medication management. For example, teen ADHD-C drivers may be instructed to take their medication in the afternoon or on weekends, times when they may be more likely to drive.

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