How missing a treatment of Mixed Amphetamine Salts Extended Release affects performance in teen drivers with ADHD

Lana M. Trick and Ryan Toxopeus

Dept. of Psychology, University of Guelph, Guelph,ON Canada N1G 2W1 ltrick@uoguelph.ca

Introduction

Teen drivers are higher risk than any other age group[1] and the risk of being in a collision while driving for teen drivers with Attention-Deficit-Hyperactivity-Disorder (ADHD) is 4 times higher than that for other teens[2]. Research suggests that some stimulant medications may improve performance in drivers with ADHD[3,4], but it is not at all uncommon for teens to skip their medications. This study investigates how driving performance changes over the course 12 hours as a function of a single missed treatment of Mixed Amphetamine Salts Extended Release (MAS-XR), also known as *Adderall XR*.[5] There are relatively few studies of MAS-XR and none with samples where this medication is the treatment of choice. To determine the effects of missing a single medication, each driver was tested once with the MAS-XR and once with a placebo, with half of the drivers starting with the medication and the other half starting with the placebo.

A second goal of this study was to determine whether missing a dose of MAS-XR has different effects on different aspects of driving performance. One reason that teen drivers are at such high risk of collision is that their driving skills are not fully developed. As skills develop the processes involved demand fewer attentional resources.[6] If MAS-XR works by enhancing attentional function, there is reason to expect that missing a treatment would have especially deleterious effects on performance in domains where drivers exhibit the least skill. As a group, novice drivers are quite different from one another, possibly because they may have differential exposure to different types of driving challenge. Consequently, in a baseline drive that took place the night before the experimental manipulations began, several indices of faulty driving skill were measured.

Research question 1: How does driving performance in teen drivers with ADHD change as a function of a single missed treatment of MAS-XR?

Research question 2: Does MAS-XR have different effects on different aspects of driving performance as a function of how skilled drivers are in that domain of performance?

Method

Participants. Participants were 14 healthy teen drivers recruited from a pediatrician's office (M age = 17 years: 2 months, 2 females). None had a full driver's license. Instead 11 had an Ontario G1 "learner's permit", which is obtained through a written test and only allows driving under the supervision of a licensed driver, and 3 had a G2, which is obtained 1 year after the G1 with an on-road test and permits unsupervised driving under restricted conditions. All drivers had been diagnosed with ADHD: Combined type and co-morbid Oppositional Defiant Disorder. MAS-XR was their treatment of choice. (MAS-XR was prescribed only after it became apparent that other more common medications were ineffective.) All had been using MAS-XR for 2 or more years: Males M dosage = 55 grams (SD = 8.2) and M weight = 73 kg; Females M dosage = 45 grams (SD = 7.1), M weight = 63 kg.

Apparatus. Testing was carried out in a fixed base driving simulator that had a 300 degree wrap-around field of view (*Figure 1*). The study involved a 10-minute training drive and 7 unique 25-minute drives (a baseline drive and 6 experimental drives). All involved traveling through the country on a two-lane highway that featured scenery (hills, farms, trees, service stations, small towns), road signs, and leading and trailing traffic. Drives contained the same number of corners but the scenery and specific order of events varied (*Figure 2*). In each drive, speed limits varied between 50 and 90 kph. Hazards emerged periodically from the periphery (cyclists, vehicles, pedestrians, and animals that went into the path of the vehicle).

Figure 1. Driving simulator

Figure 2. Driving scene with hazard

Procedure. The testing occurred over one evening and two successive days. The first evening participants did the 10-minute training drive and then they did the (25 minute) baseline drive. The next morning, at breakfast participants were given the placebo or their usual dose of MAS-XR, and then they were tested in the simulator 1, 8 and 12 hours later. The same sequence of events occurred on the following day except individuals who were given MAS-XR on the first day were given placebo on the second, and vice versa. Both participants and those testing them were kept blind to when the medication was given. To ensure there was no confusion about instructions, a technician accompanied the participants during the drive.

Results

Performance on the baseline drive was used to calculate indices of each driver's skill as compared to others in the sample. By averaging z scores across the performance metrics listed in parentheses below, 3 measures of faulty driving skill were derived.

> **Delayed hazard response** (# collisions, *median* hazard RT)

> **Erratic braking** (SD hazard RT, #unnecessary stops, #rolling stops)

> **Erratic steering** (SD of lateral position: straight & winding sections)

There were no significant correlations among these indices (p > .05), This indicates that individuals with strengths in one domain (e.g. steering) might have weakness in another (delayed hazard response).

Effects of the medication condition (medication: MAS-XR, placebo) was measured as a function of test (1, 8, 12 hours post-administration of the medication or placebo). Preliminary analyses were carried out to determine whether driving speeds were faster on placebo than on medication. They weren't (M difference in speed = 0.5 kph, F < 1).

When deprived of their usual dosage of MAS-XR, does the number of collisions go up in teen drivers with ADHD? YES, by late in day
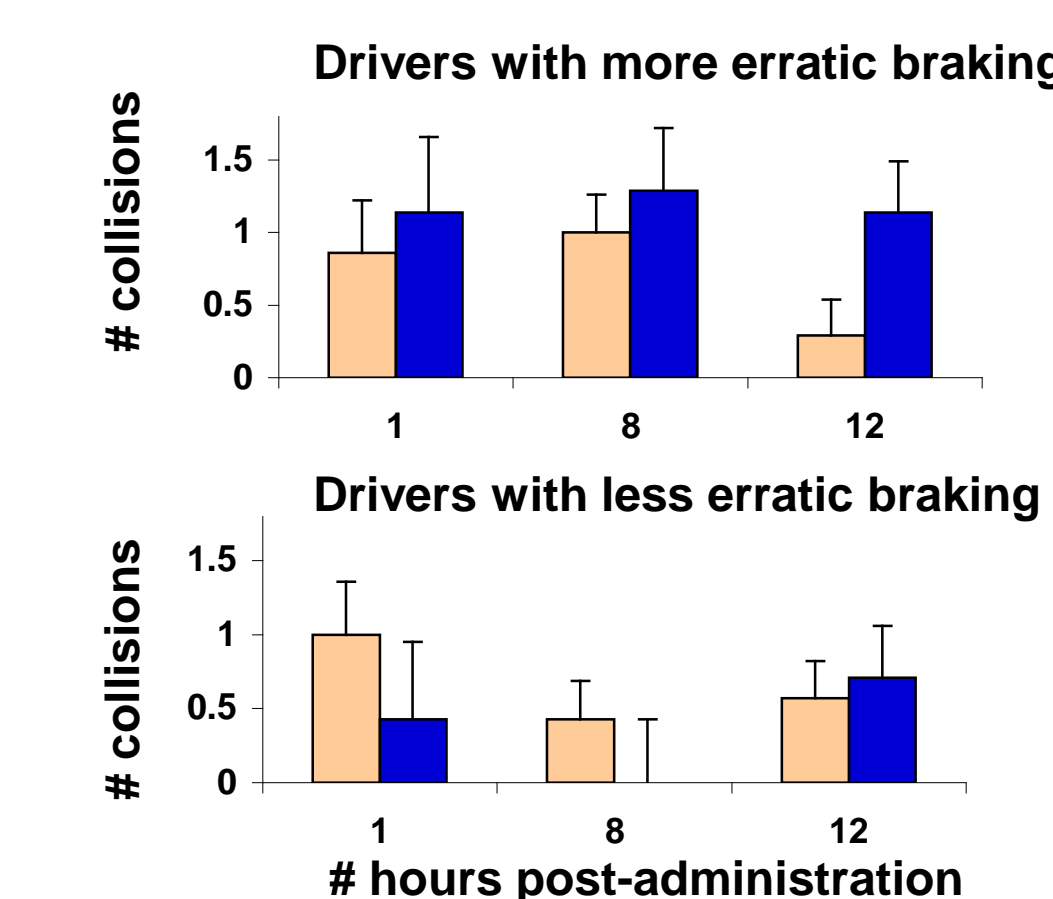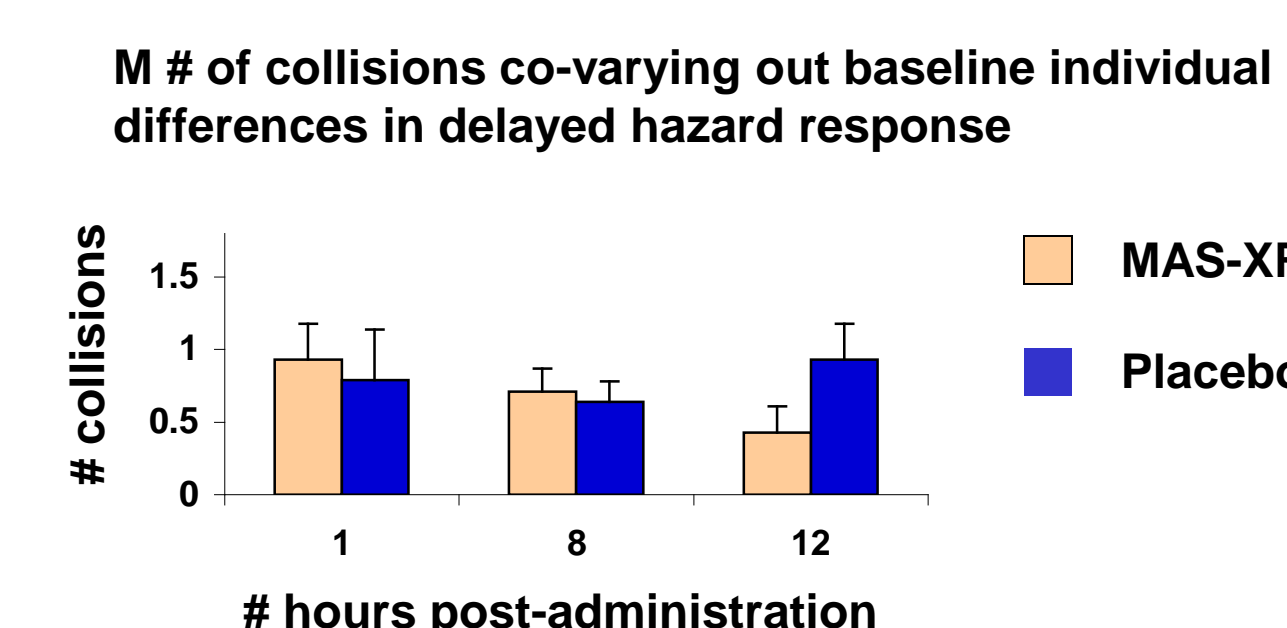
When deprived of their usual dosage of MAS-XR, does median hazard RT go up in teen drivers with ADHD? YES, by late in day
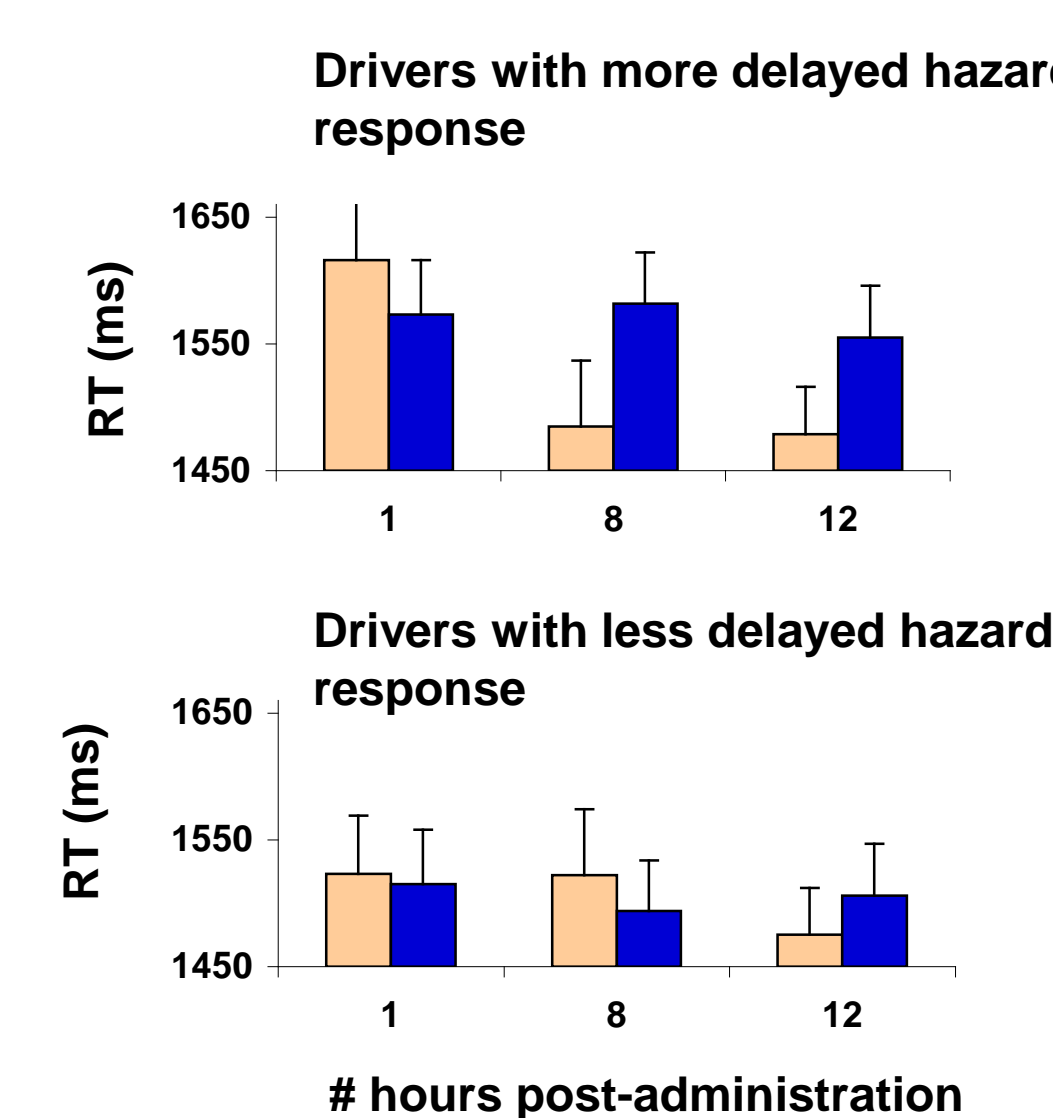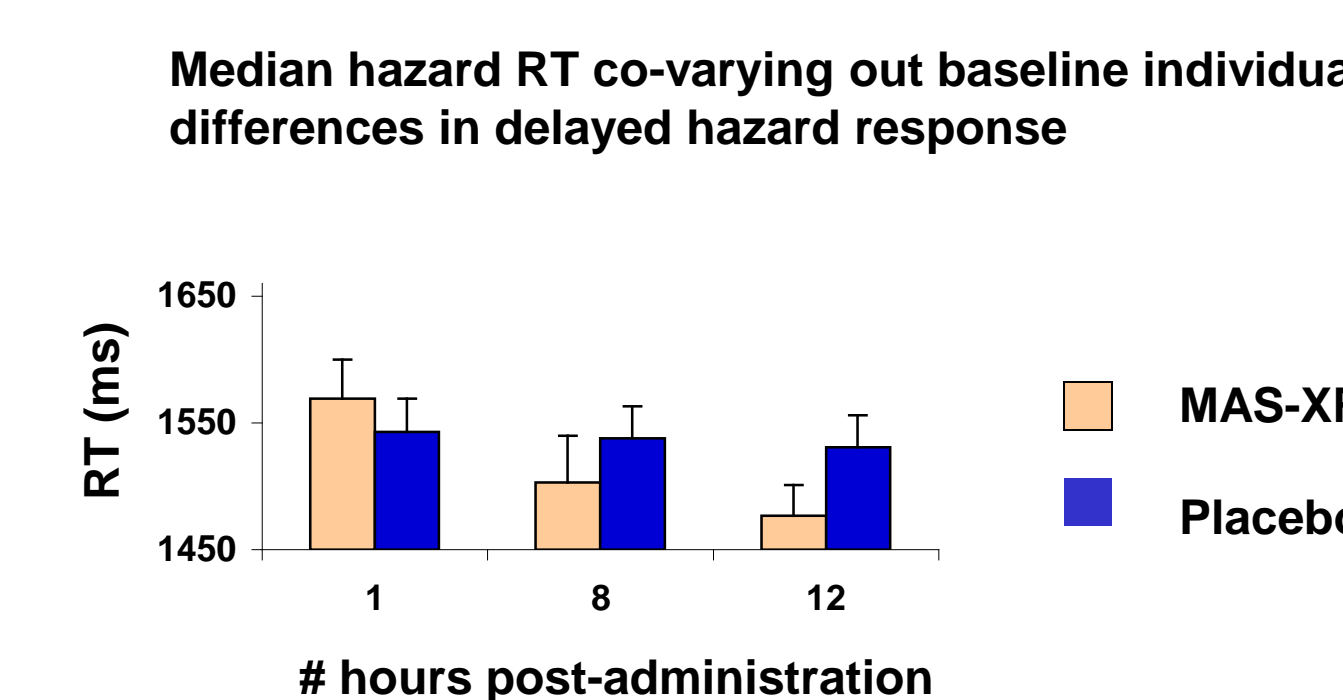
Driving performance suffered more from missed medications 12 hours post-placebo in domains where the drivers had the least skill

Conclusions

Research question 1: How does driving performance in teen drivers with ADHD change as a function of a single missed treatment of MAS-XR?

Over the course of the day off medication, both collisions and hazard RT increased. By 12 hours after the administration of the placebo there were significantly more collisions and significantly higher hazard RT on the placebo day than the day when the teen drivers received their normal dosage of MAS-XR.

Research question 2: Does MAS-XR have different effects on different aspects of driving performance as a function of how skilled drivers are in that domain of performance?

Three domains of faulty driving performance were assessed on the baseline drive: delayed hazard response, erratic braking, and erratic steering. Correlations among these three domains were not significant. Individual differences between drivers in the sample on these three measures predicted the degree to which performance deteriorated off-medication. Performance deteriorated most in domains where the drivers exhibited the least skill. Thus, hazard RT deteriorated most off-medication for the participants with the most delayed hazard response on the baseline drive. Similarly, the number of collisions increased most off-medication for the participants with the most erratic braking on the baseline drive. This finding was not due to ceiling effects because performance was far from optimal for any of the drivers in this sample. Thus, in any given teen with ADHD, some aspects of performance may suffer more than others when they miss a single dose of MAS-XR.

Two main conclusions can be taken from these findings.1). Faulty driving skills in one domain need not predict those in another. 2) For teen drivers with ADHD, missing a single dose of MAS-XR was enough to degrade performance, though the effects are strongest at the end of the day and in domains where the drivers exhibited the least skill. The highlights the importance of consistent medication use in teen drivers with ADHD when they are learning to drive.

References

1. Transport Canada (2011). *Road safety Canada: Rethink road safety.* Ottawa, Ontario.

2. Barkley, R. (2004). Driving impairments in teens and adults with ADHD. *Psychiatric Clinics of North America.*
3. Cox, D.J., Davis, M., Mikami, A.Y., Singh, H., Merkel, R.L., & Burket, R (2012). Long-acting Methylphenidate reduces collision rates of young adult drivers with Attention-Deficit/ Hyperactivity disorder. *Journal of Clinical Psychopharmacology. 32*, 225-230.
4. Kay, G., Michaels, M., & Pakull, B. (2009). Simulated driving changes in young adults with ADHD receiving mixed amphetamine salts extended release and atomoxetine. *Journal of Attention Disorders.*
5. Shire Pharmaceuticals Canada (2012). Product monograph: *Adderall XR*: Mixed salts amphetamine extended-release capsules.
6. Shiffrin, R., & Schneider, W. (1977). Controlled and automatic human information processing: Perceptual learning, automatic attending, and a