Longitudinal effects of acute cannabis exposure on automobile driving behavior in a naturalistic simulated environment

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Background

• Driving is a complex day-to-day activity that employs a variety of cognitive and psychomotor functions in harmony, many of which are known to be affected acutely by cannabis (CNB) intoxication.

• The recent legalization of both recreational and/or medicinal marijuana in several states has thus created an urgent need to better understand the effects of CNB on such functions in the context of driving.

• The present study employs a longitudinal, double-blind, placebo-2 active dose study to investigate the effects of CNB on a variety of driving-related behaviors in a controlled, naturalistic simulated environment.

Methods

Study Sample

• The current study employed N=37 subjects, frequent cannabis users (N=25 male, mean age 24.25+7.01 and N=12 female, mean age 23.5+5.48)

Experiment Design

• Each subject was exposed to a placebo, low and high dose of CNB on three separate days.

• On each day, following a single acute inhaled dose of either 0%, 3% or 5-7% of THC via a desktop vaporizer, subjects drove a virtual driving simulator (RTI Sim Vehicle platform; See Fig 1a) three times inside an MRI scanner (Fig 1b) and once out of scanner, randomized, and dispersed throughout an eight hour daily period.

• Each driving session consisted of 3 distinct 10-minute scenarios designed to measure specific aspects of driving that were predicted to be impaired following CNB use. These included

   a) lane-keeping following simulated wind gusts (operational)
   b) lead car following (tactical) and
   c) safe overtaking (strategic)

Statistical Analysis

• Data were analyzed using a mixed model framework in SPSS v24 which included dose, session, instrument (desktop v MRI), dose*session, dose*instrument and session*instrument as primary factors, covarying for age and sex.
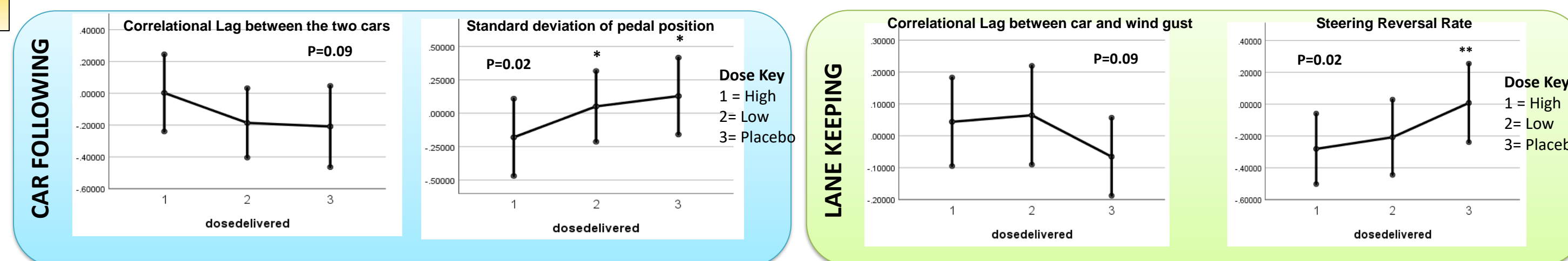
Methods

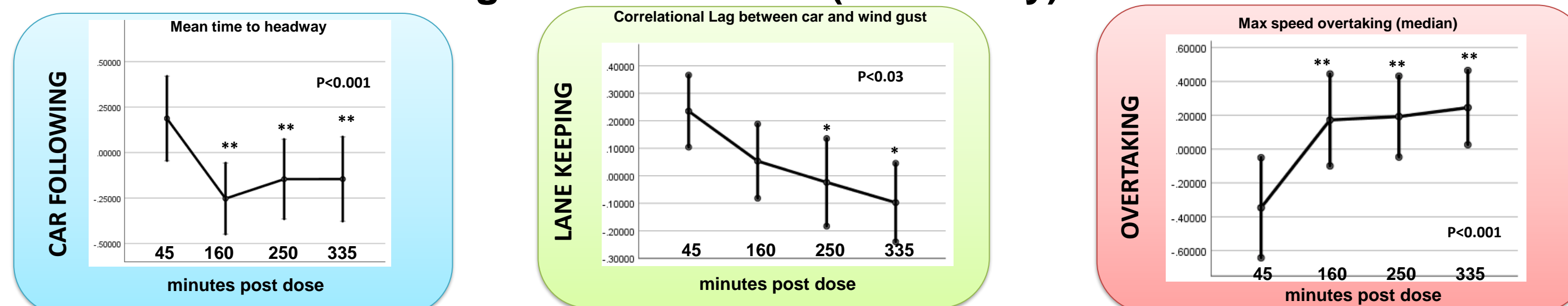Figure 1a: In scanner setup of virtual driving simulator

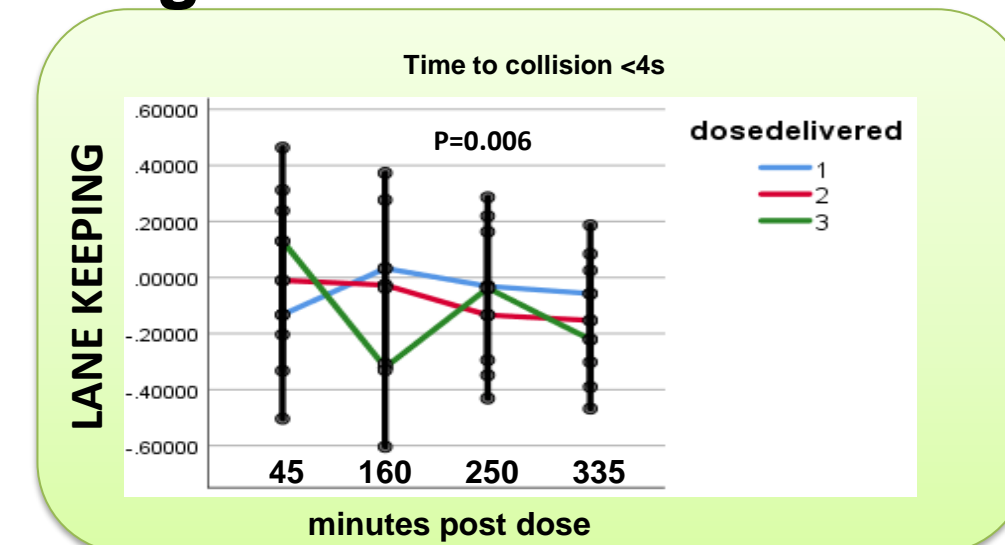Figure 1b: Snapshot of RTI driving simulator naturalistic environment

Results

Significant Dose Effects

Significant Session (within-day) Effects

Significant dose*session

• Many other behavioral variables showed a significant within-day effect (not shown here due to space limitations) following similar driving impairment trends as demonstrated above

• within-day (session) effects remained significant even after removal of placebo condition

• Although many driving measurements differed depending on whether driving was done in MRI or at a desktop setting (significant effect of instrument), these differences had no relationship to different drug dose levels (dose*instrument).

Discussion/Conclusions

• In summary, operational and tactical driving operations were most compromised under acute cannabis exposure, largely in line with current literature.

• In general, daily variations in driving behavior suggest that most of the impaired driving (reduced attention and/or motor planning) took place within 3 hours of drug exposure, which might have important implications on real life driving situations.

• Our preliminary analyses yield numerous metrics that changed throughout the day, suggesting broad-based risk on many metrics commonly used to quantify driving performance and risk.