



Review Article

Cannabis and its effects on driving skills



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ABSTRACT

Traffic policies show growing concerns about driving under the influence of cannabis, since cannabinoids are one of the most frequently encountered psychoactive substances in the blood of drivers who are drug-impaired and/or involved in accidents, and in the context of a legalization of medical marijuana and of recreational use. The neurobiological mechanisms underlying the effects of cannabis on safe driving remain poorly understood. In order to better understand its acute and long-term effects on psychomotor functions involved in the short term ability and long-term fitness to drive, experimental research has been conducted based on laboratory, simulator or on-road studies, as well as on structural and functional brain imaging. Results presented in this review show a cannabis-induced impairment of actual driving performance by increasing lane weaving and mean distance headway to the preceding vehicle. Acute and long-term dose-dependent impairments of specific cognitive functions and psychomotor abilities were also noted, extending beyond a few weeks after the cessation of use. Some discrepancies found between these studies could be explained by factors such as history of cannabis use, routes of administration, dose ranges, or study designs (e.g. treatment blinding). Moreover, use of both alcohol and cannabis has been shown to lead to greater odds of making an error than use of either alcohol or cannabis alone. Although the correlation between blood or oral fluid concentrations and psychoactive effects of THC needs a better understanding, blood sampling has been shown to be the most effective way to evaluate the level of impairment of drivers under the influence of cannabis. The blood tests have also shown to be useful to highlight a chronic use of cannabis that suggests an addiction and therefore a long-term unfitness to drive. Besides blood, hair and repeated urine analyses are useful to confirm abstinence.

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1. Introduction

Growing concerns are emerging worldwide regarding cannabis policies reforms that involve the legalisation of cannabis for therapeutic and recreational uses in the context of a regulated commercial cannabis market with major consequences on the incidence on driving while intoxicated and in assessment of the fitness to drive. An example is the situation in Colorado State as reported in the World Drug Report 2015 [1]. According to the Colorado State Patrol, marijuana was related to 12.2% of all citations for driving under the influence of any substance in 2014, while among road accidents involving fatalities the number of drivers who tested positive for marijuana doubled from 37 in 2006 to 78 in 2012. However, the authors indicate in their report that several years will be required before any change specifically attributable to retail marijuana sales and traffic deaths is evident. Moreover it has been shown that early onset of cannabis use, in adolescence or young adulthood, could lead to impairing effects on brain structures including the precuneus (integrated functions), the hippocampus (learning and memory), the prefrontal networks (executive function) and the subcortical networks (habits and routines) [2,3], and is associated with both cannabis dependence and driving under the influence of cannabis [4].

In this context, specific criteria must be established for assessing drivers' ability and fitness to drive. Therefore, field and/or laboratory experimental studies on the acute and long-term effects of cannabis on psychomotor skills are crucial to improve road safety. According to the recommendations provided by the

guidelines for research on Driving Under the Influence of Drugs [5] (Table 1), experimental studies have first assessed the acute effects of cannabis on neurocognitive functions required in normal driving tasks on the automative, control and executive planning levels of behaviour, using neuropsychological, simulator and on-road testing. Several studies have then also suggested that, in case of heavy cannabis use, a long-term impairment in neuropsychological tests performance could be observed after cannabis use [6–8], and may persist even after a period of abstinence [9–11]. In this non-systematic review, PubMed, Google Scholar and Web of Science databases were used to identify and select publications up to year 2016 dealing with driving and cannabis.

2. Observational epidemiology studies

According to the project “Driving Under the Influence of Drugs, Alcohol and Medicines (DRUID)” [12] co-funded by the European Commission, the proportion of positive cannabis drivers involved in accidents vary from 4% to 14%. In comparison, delta-9-tetrahydrocannabinol (THC) was detected in the blood of a lower 1–7% of drivers not involved in a traffic accident. In Switzerland, a study conducted by Senna et al. [13] estimated that cannabinoids were present in 48% of blood samples gathered from suspected drug impaired drivers, being the most frequently encountered illicit drugs. A meta-analysis based on 9 studies, including 49,411 participants, concluded that the risk of a motor vehicle collision was almost twice in drivers under the influence of a recent cannabis use compared to sober drivers [14]. Moreover, car crash injuries after an acute marijuana intake appeared strongly associated with a regular (at least once a week) use during the previous 12 months [15], although the increased risk was no longer significant in occasional users after adjustment for confounders. However, the prevalence of drivers under the influence of cannabis involved in traffic accidents, as well as in the general driving population, remains poorly estimated. Knowing not only the frequency of crashes involving and not involving cannabis use and positive THC blood tests but also the frequency of noncrashes involving and not involving cannabis use and positive THC blood tests allows for the calculation of an odds ratio as an estimate of the crash risk. Selection bias of the different groups, confounding factors such use of other drugs may result in a distortion of the true relationship between cannabis exposure and crash risk. In addition to methodological choices, limitations of such epidemiological studies are due to the low reliability of self reported data collected from sober and drug-impaired drivers, and strongly depend on subject's consent and public policies.

3. Acute cannabis effects on driving ability

As epidemiological data show a more frequent involvement of cannabis users in car accidents, researchers used experimental studies, including laboratory, simulator and on-road testing, to assess the influence of cannabis effects on driving ability. Since the 70's experimental studies have shown that acute cannabis inhalation alters specific psychomotor skills or cognitive functions involved in normal driving tasks [16–19], and in a dose-related

Table 1

Recommended neuropsychological tests to assess executive functions and the related levels of behavior involved in crash risks according to the International Council on Alcohol, Drugs, and Traffic Safety.

Executive functions	Tests
Attention and information processing (<i>executive planning</i>)	Choice reaction-time Selective attention task Focused attention task
Cognition and judgment (<i>executive planning</i>)	Tower of London task
Divided attention (<i>control behavior</i>)	Dual attention task
Motor performance and maneuvers (<i>control behavior</i>)	Reaction time Car following
Perception (<i>control behavior</i>)	Time-to-collision task
Risk-taking and impulsivity (<i>executive planning</i>)	Stop signal task Iowa gambling
Sustained attention (<i>automotive behavior</i>)	Mackworth Clock Test
Tracking and steering (<i>automotive behavior</i>)	Road tracking Critical tracking Compensatory tasks

Adapted from Walsh et al. [5].

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