

Proceeding Paper

# Proceedings of the First Irish Alcohol Hangover Research Seminar <sup>†</sup>

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**Abstract:** On 19 November 2021, the first Irish Alcohol Hangover Research Seminar was held at the Atlantic Technological University, Donegal. In these proceedings, the presentations of the seminar are summarized. Topics discussed included the pathology and treatment of the alcohol hangover, cognitive and functional consequences, and the impact of the COVID-19 pandemic and associated lockdowns on alcohol consumption and experiencing hangovers.

**Keywords:** alcohol; intoxication; hangover; COVID-19; cognitive effects; attention; emotional processing; learning; academic functioning; treatment



**Citation:** Devenney, L.E.; Stock, A.-K.; Merlo, A.; Hendriksen, P.A.; Gunn, C.A.; Opitz, A.; Bruce, G.; Verster, J.C. Proceedings of the First Irish Alcohol Hangover Research Seminar. *Proceedings* **2022**, *80*, 5. <https://doi.org/10.3390/proceedings2022080005>

Academic Editor: Dimitar Prodanov

Published: 15 September 2022

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## 1. Introduction

The first Irish Alcohol Hangover Research Seminar was held in Letterkenny, Ireland, on 19 November 2021. The seminar was hosted by the Atlantic Technological University, Donegal (formerly known as the Letterkenny Institute of Technology), and endorsed by the Alcohol Hangover Research Group. The aim of the seminar was to provide an up-to-date overview of the current knowledge on the alcohol hangover, and initiate future research collaboration among the attendants. Here, an overview of the scientific presentations that were given at the seminar is presented.

## 2. Pathology and Treatment

Joris Verster (Utrecht University, the Netherlands) provided an overview of the pathology and functional consequences of the alcohol hangover, and the quest for an effective treatment. The alcohol hangover is defined as ‘the combination of negative mental and physical symptoms which can be experienced after a single episode of alcohol consumption, starting when blood alcohol concentration (BAC) approaches zero’ [1]. It was discussed that whether a drinker will experience a hangover, and its severity, depends on a variety of factors including, but not limited to, the amount of alcohol consumed, beverage type, and tolerance. Recent research revealed that there is no lower limit for alcohol intake to provoke

a hangover in some individuals [2], whereas another subsample claims never experiencing hangovers [3]. The amount of alcohol needed to elicit a hangover thus varies greatly between drinkers, and the severity of the hangover can also differ from one drinking occasion to the other, despite drinking the same amount of alcohol. It is important to investigate the alcohol hangover, as it can have serious socioeconomic consequences. Examples of research were discussed that demonstrated the negative impact of hangovers on academic functioning and on job performance [4], and on driving a car [5,6]. A recent study revealed that employees in the Netherlands reported absenteeism and presenteeism related to the alcohol hangover [7]. With regard to presenteeism, the participants reported productivity at work to be reduced by 26% when hungover. The costs for the Dutch economy, related to absenteeism and presenteeism, were estimated at EUR 1.29 billion for the year 2019 [7]. Given its functional consequences, it is worrying that research on the alcohol hangover is still rather limited.

With regard to the pathology of the alcohol hangover, significant advances have been made during the past decade. These advances provide more insight into the relationship between hangovers and alcohol metabolism [8], as well as into the involvement of the immune system in eliciting hangovers [9]. Research was discussed showing that drinkers with a faster alcohol metabolism usually report less severe hangovers [10]. In addition, several studies revealed elevated concentrations of cytokines and free radicals during the hangover state [11,12]. Finally, ongoing research concerning the possible involvement of the microbiome and genetics was discussed. It was stressed that more precise information is needed on the pathology of the alcohol hangover to enable the development of safe and effective treatments to prevent or cure the condition. While there is a clear need among alcohol consumers for an effective and safe hangover treatment [13], a recent evaluation of marketed products revealed that scientific evidence on their efficacy is lacking [14]. Currently, most products marketed for the treatment of alcohol hangover are dietary supplements. However, given its new status as a separate entity in the International Classification of Diseases, 11th Revision (ICD-11) [15], the alcohol hangover is treated equally as a disease, and as a consequence, hangover treatments should be registered as medicinal drugs. It was discussed that when enforced, this development will have significant consequences for the hangover product market. At this moment, there are no medicinal drugs approved for the treatment of an alcohol hangover.

### 3. Cognitive Effects of Alcohol Hangover

Craig Gunn (University of Bath, UK) discussed the cognitive effects of an alcohol hangover. Previous research had reported mixed results in relation to the cognitive effects of alcohol hangover and had focused on 'core' cognitive functions such as memory, psychomotor speed, and sustained attention. In a series of studies, Gunn et al. aimed to provide clarity as to the effects of the alcohol hangover on core cognitive functions, to investigate the effects of a hangover on executive functions, and explore the influence of a hangover on emotions and emotion regulation [16]. The systematic review of the literature and meta-analysis of studies suggested that a hangover impairs short-term memory, long-term memory, sustained attention, and psychomotor speed, but not divided attention. Three within-participant experimental studies investigating executive functions and emotions during a hangover were conducted, utilizing a naturalistic hangover design, where participants were free to drink the amount and type of alcohol that they usually would. Participants attended a laboratory session the day following a night of pre-planned heavy drinking and following 24 h of alcohol abstinence. The results from these studies indicate that a hangover causes poorer response inhibition, more errors when switching attention, more errors when updating information in working memory, and poorer goal maintenance. The results from these studies also indicate that a hangover worsens mood and produces a negative shift in emotions experienced when appraising stimuli. The extent to which a person can regulate emotions appears unaffected by a hangover, although participants report greater difficulty and increased effort when doing so. Overall, the findings from this

series of studies indicate that thought processes that are integral for everyday behaviors are impaired whilst a person is experiencing a hangover. This occurs alongside a general negative shift in emotions, possibly giving rise to greater difficulties in regulating emotions when hungover.

Lydia Devenney (Atlantic Technological University, Ireland) discussed the effects of alcohol hangover on attention and emotional processing. Attention is made up of a series of multicomponent processes, which have long been under-represented in hangover research. The presented study aimed to gain a more comprehensive understanding of attentional processes by looking beyond the standard attention tasks employed in hangover research. In addition, the study applied Ecological Momentary Assessment (EMA) of alcohol consumption to explore the relationship of these real-time assessments with next-day self-reported measures of alcohol consumption. Twenty-five young adults participated in a naturalistic study. A within-participants design was applied comparing a hangover testing session with a control session. Participants in the hangover session reported consuming a mean of 12.8 alcoholic drinks the night before testing. A series of cognitive tests were completed, and analyses revealed significant next-day effects on the emotional Stroop test, the Eriksen flanker test, five-choice serial reaction time, psychomotor vigilance, and the attentional blink task. A signal detection analysis indicated that participants needed significantly longer to respond to attention tasks, because their ability to identify targets (signals) from distractors (noise) was impaired during the hangover. The number of errors, however, did not differ significantly between the hangover and control day for any of these tasks. Mood assessments revealed significantly lower levels of alertness and tranquility on the hangover test day. Finally, EMA resulted in a significantly higher number of drinks consumed compared to next-day self-report, suggesting that the latter is less accurate, and future research should therefore not solely rely on retrospective self-report, but include real-time assessments of alcohol consumption. Such assessments can be achieved through smartphone applications and by validated devices that record blood alcohol concentration through transdermal alcohol sensors.

Ann-Kathrin Stock (TU Dresden, Germany) presented an assessment methodology to record possible brain damage during the hangover state. While it has become abundantly clear that aberrant alcohol consumption results in brain damage, especially to the white matter [17], it is not known what a safe threshold for consumption would be, or at what levels of drinking functionally relevant brain/white matter damage becomes apparent. Consequently, it is debated within the scientific community as to whether binge drinking may lead to brain damage and associated cognitive impairments in people who do not meet the diagnostic criteria for an alcohol use disorder (AUD). The main reason for this lack of knowledge is that commonly used brain imaging techniques allow the diagnosis of advanced stages of AUD-related brain damage, but are not sensitive enough to properly detect small early changes in otherwise healthy individuals. A novel and groundbreaking blood test could help to overcome this problem: so-called single molecule array (SIMOA) analyses are a new way of analyzing blood samples. This methodology allows researchers to detect neurofilaments that are released into the bloodstream whenever the white matter of the brain is damaged. Given its sensitivity, SIMOA is the first clinical assessment that truly allows scientists to investigate even the slightest changes in the structural integrity of white matter. Stock et al. applied this blood test to investigate whether young healthy men show any signs of brain damage during and after a single night of binge drinking. It was further investigated how this relates to cognitive and behavioral dysfunctions during drinking and during a hangover. The analysis revealed that white matter integrity was not compromised during acute alcohol intoxication, but mild detrimental effects could be detected during the alcohol hangover. The opposing effects of intoxication and (acute) tolerance on glutamatergic signaling may provide the most plausible explanation for this differential finding. Further research is, however, required to substantiate (or refute) this claim.

Antje Opitz (TU Dresden, Germany) discussed behavioral automatization during alcohol intoxication and the hangover state. Behavioral automatization allows for more efficient and less error-prone actions, but has also been suspected to foster dysfunctional behavior such as alcohol abuse [18,19]. To date, it has remained unclear as to whether alcohol itself causes the shift from controlled to habitual behavior, as commonly observed in alcohol use disorder (AUD). Opitz et al. [20] conducted a study to investigate how the acute and post-acute effects of binge drinking affect the automatization of motor response sequences and the execution of automated vs. controlled motor response sequences. For this purpose,  $n = 70$  healthy young men performed a newly developed automatization paradigm once sober and once after binge drinking (half of them intoxicated and half of them hungover). The analyses revealed no significant effects of an alcohol hangover, but that acute intoxication (at a breath alcohol concentration  $\sim 0.12\%$ ) impaired the automatization of complex motor response sequence execution and eliminated learning effects in response selection and pre-motor planning processes. The results demonstrate that alcohol intoxication, but not a hangover, differentially impaired the learning and automatization of complex motor response sequences.

#### 4. Impact of COVID-19

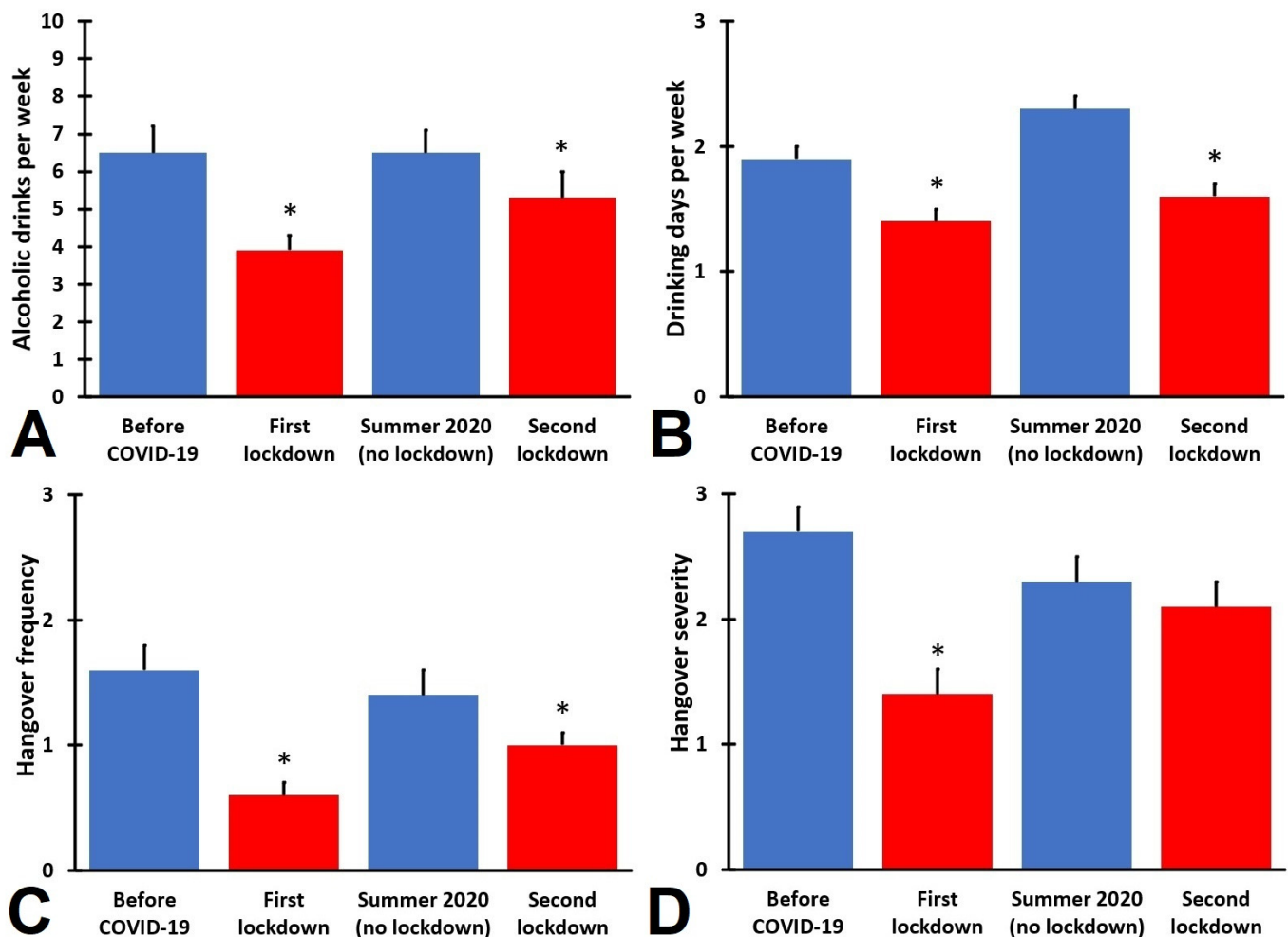
The 2019 coronavirus disease (COVID-19) pandemic and associated lockdowns had a significant impact on the possibilities to conduct research, but also had psychological, socioeconomic, and behavioral consequences that affected the entire population. During the COVID-19 pandemic, lockdown periods were implemented in many countries to counteract the spread of the virus. In the Netherlands, bars, restaurants, and nightlife were closed during the lockdown periods. Several studies have investigated the impact of the pandemic and associated lockdowns on alcohol consumption. However, research in relation to the alcohol hangover remains limited.

Agnese Merlo (Utrecht University, The Netherlands) presented the results of a study investigating the effects of the first COVID-19 lockdown in the Netherlands (15 March to 11 May 2020) on alcohol consumption, mood, and perceived immune fitness. Data from  $n = 761$  participants who reported consuming alcohol before the COVID-19 pandemic and during the first lockdown period in 2020 were evaluated [21]. A first analysis revealed that during the lockdown, participants reported significantly poorer mood and reduced perceived immune fitness. A model was developed to describe how changes in mood and alcohol consumption had a negative impact on perceived immune fitness, and how they were associated with the increased presence and severity of COVID-19 symptoms [22]. A significant decrease in weekly alcohol consumption during the COVID-19 lockdown was observed only among younger participants (18 to 35 years old). No significant effects on weekly alcohol consumption were found in older participants. However, further analyses of the data revealed that whereas about half of the participants did not alter their weekly alcohol consumption during lockdown (50.4%), 25.9% of drinkers reported drinking less alcohol, and 23.8% reported drinking more alcohol per week during the first lockdown period [23]. Drinkers who increased their alcohol consumption displayed a significantly poorer mood and greater levels of stress, which were associated with significantly greater reductions in perceived immune fitness and a high presence and severity of COVID-19 symptoms, as compared to drinkers who consumed less alcohol or those who did not alter their drinking behavior during the first lockdown. These findings underline that there is a substantial subgroup of drinkers that increased their alcohol consumption, even though no apparent differences in weekly alcohol consumption were observed for the sample as a whole. Given these negative associations between drinking behavior and immune fitness and experiencing COVID-19 symptoms, this sub-group deserves more attention. Prevention should focus on the development of alternative strategies to cope with stress and mood changes instead of increasing alcohol consumption.

A third analysis examined alcohol consumption and hangovers on the heaviest drinking occasion before and during the first COVID-19 lockdown [24]. For young adults (18 to

35 years old), but not the older age groups, there was a significant reduction in the number of alcoholic drinks consumed on the heaviest drinking occasion during lockdown, as compared to before the lockdown. In line with this, drinking duration was shorter and the estimated BAC was significantly lower. A significant reduction was also observed for subjective intoxication, along with the frequency and severity of reported hangovers.

Pauline Hendriksen (Utrecht University, The Netherlands) reported findings on the impact of COVID-19 lockdowns in the Netherlands on alcohol consumption and academic functioning. The study comprised assessments for before the COVID-19 pandemic, during the first lockdown, summer 2020, and during the second lockdown. In addition to the closure of most businesses, the pandemic led to an abrupt transition from face-to-face to online education for university students. A survey was conducted among Dutch pharmacy students and PhD candidates to investigate the impact of COVID-19 lockdowns on alcohol consumption, hangovers, and academic functioning [25–27]. The analysis revealed a significant reduction in both the quantity and frequency of alcohol consumption during the COVID-19 lockdown periods, and a significant reduction in the frequency and severity of hangovers (see Figure 1).



**Figure 1.** Alcohol consumption and hangovers before and during the COVID-19 pandemic. Data are presented for number of alcoholic drinks per week (A), number of drinking days per week (B), hangover frequency (C), and hangover severity (D). Significant differences compared to before COVID-19 ( $p < 0.017$ , applying a Bonferroni’s correction for multiple comparisons), are indicated by \*.

Although there was considerable variability between students, the COVID-19 pandemic had no significant overall impact on academic functioning in terms of academic

output (e.g., grades) and input (e.g., time spent on study). However, a significant reduction in interactions with teachers and other students was consistently found. Participants who reported the highest levels of weekly alcohol consumption, most hangovers, and most severe hangovers before COVID-19 benefited most from the lockdown periods in terms of improved academic performance.

## 5. Discussion

Gillian Bruce (University of the West of Scotland, UK) chaired the discussion. It was noted that the presentations at this seminar provided a variety of quality data illustrating the negative effects associated with the alcohol hangover, such as cognitive, psychomotor, and memory deficits, as well as the negative impact on academic functioning and job performance. While it is clear that the knowledge on the pathology of the alcohol hangover has significantly increased over the past decade, it is evident that more research is needed both to fully understand the mechanisms and consequences of the alcohol hangover and in particular because currently, none of the market hangover treatments have proven effective. The studies on the COVID-19 pandemic revealed significant relationships between changes in mood, stress and alcohol consumption during the COVID-19 lockdown. They support a model that links these changes to perceived immune fitness and susceptibility to experiencing COVID-19 symptoms, and their severity. Furthermore, the COVID-19 lockdown periods were also associated with reduced alcohol intake on the heaviest drinking occasions and a reduction in hangovers, particularly among men and young adults. The reduction in alcohol consumption and associated hangovers is likely related to a combination of characteristics of the lockdown period measures in the Netherlands, such as the closure of venues where alcohol could be consumed (e.g., bars, restaurants), the closure of the nightlife economy and absence of festivals, and limitations on the number of visiting guests that were allowed at home during the lockdown periods [21]. The overall reduction in alcohol consumption and the number of hangovers among students was associated with improved academic functioning during the COVID-19 pandemic. Future research should evaluate whether alcohol consumption and hangover experiences return to pre-pandemic levels after the COVID-19 pandemic.

**Author Contributions:** Conceptualization, L.E.D., A.-K.S., A.M., P.A.H., C.A.G., A.O., G.B. and J.C.V.; writing—original draft preparation, L.E.D., A.-K.S., A.M., P.A.H., C.A.G., A.O., G.B. and J.C.V.; writing—review and editing, L.E.D., A.-K.S., A.M., P.A.H., C.A.G., A.O., G.B. and J.C.V. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by Atlantic Technological University.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** Over the past 3 years, J.C.V. has acted as a consultant/advisor for KNMP, Mentis, More Labs, Red Bull, Sen-Jam Pharmaceutical, and Toast! A.-K.S. has received funding from Daimler and Benz. The other authors declare no conflict of interest.

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