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Alcohol Use and Problems at the Event Level: Theory, Methods, and Intervention

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Introduction

Alcohol consumption is a complex behaviour involving the interplay of physiological, psychological, social, and environmental factors. Alcohol science, however, seldom examines these interrelated domains simultaneously. Likewise, preventive and harm reduction approaches to alcohol-related problems often focus on a single domain (e.g. interventions designed to change misperceptions of normative behaviour). Naturally occurring drinking events present a unique opportunity to understand the social ecology of drinking behaviour. From an intervention standpoint, drinking events are temporally proximal to drinking outcomes both good and bad. In theory, understanding drinking events has great potential for preventing and minimizing harm related to acute alcohol problems (e.g. fights, injuries, drunk driving, sexual assaults, etc.). This chapter focuses on the theory, methods, and interventions common to alcohol event research.

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Theoretical and Conceptual Approaches to Understanding Drinking at the Event Level

Historically, research concerning the aetiology of alcohol use and alcohol-related problems has focused on one or two conceptual domains independently or as they relate to one another (e.g. drinking expectancies, social influence, etc.). Historical methodological approaches to studying alcohol consumption have included ethnographic observations (Cavan, 1966), retrospective surveys (Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994), and field studies using breathalyzers and interviews (Clapp et al., 2009; Clapp, Min, Shillington, Reed, & Croff, 2008).

Given the focus of research into drinking events noted above, interventions to limit heavy event-level drinking often fail to focus on individual behaviour or are mistimed (i.e., not during risk behaviour). Currently, there are few attempts to intervene during critical moments such as when individuals make decisions to drink more, drive a car when intoxicated, or engage in risky sexual behaviour (discussed below). More work that addresses drinking at the event level and avenues to intervene is sorely needed.

What Is a Drinking Event?

Operationally, drinking events can be difficult to define. While a drinking event starts with the first sip of alcohol, operationalizing the end of a drinking event can be tricky. For instance, the bulk of research on “pre-gaming”—that is, drinking at home before going out to licensed venues (see Chap. 13)—tends to focus on the earliest part of a drinking event as a predictor of either estimated peak blood alcohol concentration (BAC) or harmful outcomes (Barry, Stellefson, Piazza-Gardner, Chaney, & Dodd, 2013). In our early work, we defined drinking events as beginning with the first sip of alcohol and ending with the last sip, over the course of several hours (Clapp et al., 2018). This definition is limited in that BAC decays long after the last sip. One may argue that drinking events begin with the first sip of alcohol on a given occasion, and end when BAC reaches zero. However, this definition is also problematic for two reasons. First, for people meeting criteria for an alcohol use disorder, BAC may never reach zero. Second, for people who do not have an alcohol use disorder an event (e.g. a party or wedding) might include a few drinks over the course of several hours where BAC hits “zero” more than once. Thus, it is important to consider drinking events as an ecological system where environmental, individual, and social factors are considered in the operational definition. For instance, “a drinking event begins when one takes the first sip of alcohol, drinks over a period of at least one hour, for personal (e.g., to enhance a meal, reduce stress, have fun, etc.) or social reasons (e.g., to celebrate with friends, etc.) in one or more environments where alcohol is available. The drinking event ends when the drinker's BAC reaches zero after all drinking for the event has ended."

Drinking events are direct antecedents to numerous acute alcohol-related problems including burns, crashes, crime injuries, falls, and sexual and other violence (National Institute of Health, 2000). Acute problems have a huge global impact (Rehm et al., 2009); for instance, approximately 25% of all unintentional, and 10% of intentional injuries in the world can be attributed to drinking events. When alcohol-related disease and death are considered, 5% of all deaths in the world and 5% of disability adjusted life years lost are alcohol related (World Health Organization, 2018). In aggregate, drinking events represent patterns of consumption that drive alcohol-related disease and premature death (Holder, 2006).

Over the past five decades, a subfield of alcohol research has emerged with the goal of better understanding the ecology of drinking behaviour as it naturally occurs. Reflecting the inherent multidisciplinary nature of alcohol research, such studies vary in conceptual foci, methods, and operational definitions. Independently, studies on "drinking contexts," "drinking situations," and "drinking environments" (see also Chap. 9) offer related but unique insights into drinking behaviour in situ. Recent work has focused on drinking at the event level (Clapp, Reed, & Ruderman, 2014; Thrul & Kuntsche, 2015; Verster, Benjaminsen, van Lanen, van Stavel, & Olivier, 2015; Wells et al., 2015) as a way of examining drinking as it occurs. For example, Wells et al. (2015) found that drinkers who pre-drank in a bar district, had a higher breath estimates of blood alcohol concentration (BAC) than those drinking in other settings. The study controlled for typical drinking pattern and also found a drinker-by-group interaction in which individual pre-drinkers influenced group-level BAC. In a study of over 1700 partygoers nested in 226 parties, Clapp et al. (2014) found that playing drinking games resulted in a higher likelihood of continued drinking, and that the presence of drinking games at a party predicted intent to drive after drinking—regardless of whether the drinker engaged in them.

Riley et al. (2011, p. 54) noted the importance of developing "health behaviour models that have dynamic, regulatory system components to guide rapid intervention adaptation based on the individual's current and past behaviour and situational context" (p. 54). However, until recently, understanding the aetiology of alcohol related problems at the event level has been rudimentary. Although conceptual models and theory have long guided alcohol studies (Denzin, 1987; Gusfield, 1996), models for drinking events rarely build on previous work or transcend levels of abstraction in ways that integrate theoretical streams or acknowledge dynamics and complexity (e.g. non-linearity, feedback loops—see Sect. 1 of this volume for a description of commonly used alcohol models). Although there is a small body of system dynamics alcohol studies at the community level (Holder, 2006; Scribner et al., 2009), and some recent notable exceptions employing agent-based modelling (Fitzpatrick & Martinez, 2011; Gorman, Mezic, Mezic, & Gruenewald, 2006) at the population and event levels, dynamic modelling in alcohol research is still largely underdeveloped.

The conceptualization of drinking events began over 40 years ago when the US National Institute on Alcoholism and Alcohol Abuse published a monograph titled *Social Drinking Contexts* (Harford & Gaines, 1979). In the introduction to that collection of conference papers, the authors noted, "While context, or frame of reference, may hold the key to understanding drinking behaviour, no single idiom describes context" (p. 1). The authors went on to say that the multidisciplinary nature of alcohol studies related to context reflect a spectrum of terms and units of analysis. The nomenclature and taxonomies used today to frame drinking events still reflect such diversity (see Chap. 9).

In that same monograph, drawing from the basic social psychology theory of Lewin (1951), Harford and Gaines (1979) offered a simple linear multilevel representation (person × environment leads to drinking behaviour).This path model explicitly defined "context" as "environment," and the authors went on to conceptualize environment into five elements: (1) physiogeographical (e.g. geospatial), (2) group level (e.g. demographics, size, gender ratio), (3) social or situational (e.g. a party), (4) theoretical (e.g. alcohol availability, social control, norms), and (5) how it is perceived by the individuals embedded in it (see Chap. 9). They also noted two important considerations. First, "(the environment) persists in being a concept of disturbing *complexity*" (p. 230). And second, "the *dynamics* of situations give rise to changes in situations and behaviour over time … an obvious source of such change is … alcohol ingestion … and its disinhibition effects" (p. 231; emphasis added).

Since the publication of *Social Drinking Contexts* (Harford & Gaines, 1979), there have been numerous publications examining drinking events which have varied in the conceptualization, measurement, and analysis of drinking events. In a mapping review of the existing literature on drinking events, 278 papers published between 2010 and 2019 were identified (Stevely, Holmes, & Meier, 2020). Most studies looked at a very limited set of contextual variables (e.g. affect, timing, number or type of people, venue), were US based, and focused on college students.

The implicit notion of a drinking event is often embedded in another conceptual focus. For instance, a number of studies have examined behaviours conceptually couched in drinking events such as "pre-partying" (Reed et al., 2011) or "drinking games" (Zamboanga et al., 2014). Others have correlated typical drinking settings with drinking behaviours or problem outcomes (Saltz, Paschall, McGaffigan, & Nygaard, 2010). Alcohol epidemiology—quantity, frequency, variability measures (e.g. heavy episodic drinking) (Wechsler et al., 1994)—is also a simple form of enumerating drinking events.

Although segmenting drinking events into time-specific (e.g. pre-gaming), social (e.g. drinking games), or geospatial (e.g. bars) elements allows one to study behaviour more easily, such segmentation obscures an understanding of the systemic and complex nature of events (Miller & Page, 2009), and potentially results in ineffective policy solutions to alcohol-related problems (Wells, Graham, & Purcell, 2009). For instance, over the course of an individual's drinking event, pre-gaming can occur in a small private setting (e.g. a few friends), followed by drinking games in a larger party setting, and culminating in a public setting like a bar. Each activity and setting comes with its own dynamics (Clapp et al., 2008, 2009; Fitzpatrick & Martinez, 2011), resulting in complexity (i.e. multilevel) and transitory risk (and protection) across an entire event (Ally, Lovatt, Meier, Brennan, & Holmes, 2016). The segmentation approach to studying drinking events, however, may soon be changing. For instance, Ally et al. (2016) conducted latent class analyses of over 180,000 drinking events across over 60,000 drinkers to develop a typology of British drinking culture. The study was able to identify risk events, including multi-location events, across population demographics, offering a richer understanding of drinking contexts as they relate to other key factors.

Conceptually, the social ecology of drinking events is complex and dynamic (Clapp et al., 2018; Giraldo, Passino, & Clapp, 2017 ; Giraldo, Passino, Clapp, & Ruderman, 2017). Systems dynamics models (Giraldo, Passino, & Clapp, 2017; Giraldo, Passino, Clapp, & Ruderman, 2017) based on field data have illustrated how biological factors (e.g. gender, body weight, etc.), motives, peer influence and the environment interact in complex feedback systems that influence intoxication (both peak blood alcohol content [BAC] and rate of BAC change). Although such models are useful to guide theory and pre-test potential interventions (Hawe, Shiell, & Riley, 2009), validation and tuning of computational models with empirical data is critical.

Understanding drinking event dynamics and complexity associated with individuals, groups, social context, the built environment, and shifting BAC remains a vexing problem, but recent studies have advanced this literature. Clapp et al. (2018) presented a dynamical model of drinking events including "micro," "mezzo," and "macro" elements that we have provided in Fig. 1. In the model, "environmental wetness" (i.e. the mean level of intoxication in the environment coupled with alcohol availability) was influenced by, and influenced, "group wetness" (i.e. the average level of intoxication in a social group drinking together). In turn, "group wetness" influenced drinkers' desired states of intoxication and drinking. A drinker's level of intoxication was influenced by the rate and amount of drinking (metabolic and elimination factors). In a series of computational systems dynamics studies grounded in empirical field data, the same research team modelled the various aspects of the conceptual drinking event system (Fig. 8.1).

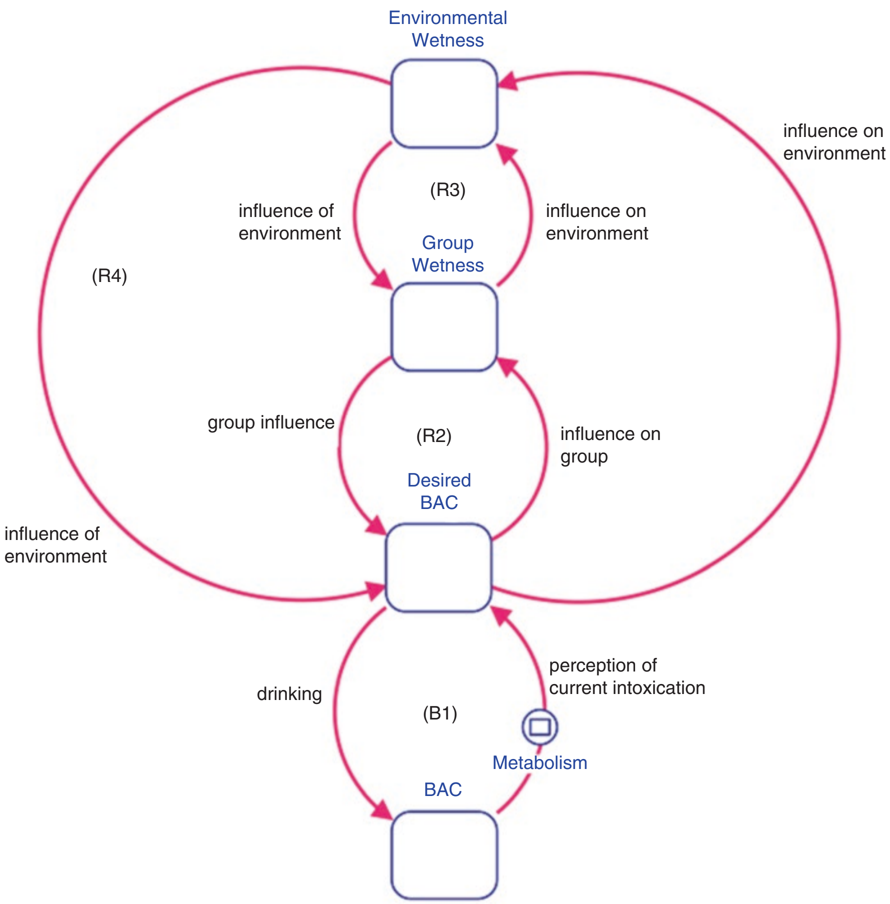

Fig. 8.1 Dynamic model of drinking events ('B' indicates balancing influences, 'R' indicates reinforcing influences)

Giraldo, Passino, and Clapp (2017) illustrated how decision-making concerning drinking influences and is influenced by the rate of alcohol intake, where intoxication accelerates as decision making becomes impaired. Similarly, a second study (Giraldo, Passino, Clapp, & Ruderman, 2017) illustrated the social influence a single heavy drinker at drinking events, where that heavier drinker could pull their lighter drinking peers into heavy drinking at the event level. Wetter environments were also influenced, and were influenced by, social groups.

Methodological Approaches to Studying and Intervening During Drinking Events

Capturing the complexity of drinking events is methodologically challenging. Historically, research into drinking behaviour in situ has relied on retrospective survey methods, observation, or field interviews (Patrick & Lee, 2010; Quinn & Fromme, 2011). Beyond self-reports, many field studies of drinking have used breathalyzers to estimate BAC. Although breathalyzers provide biological estimates of drinking that are arguably better than self-reports, the logistics of collecting breath tests in the field are difficult (Clapp et al., 2007). Logistically, collecting quality breath samples requires calibrated law enforcement grade breathalyzers, respondents who have not consumed alcohol in the past 20 minutes (some argue 10 minutes is adequate) to avoid mouth alcohol contamination, and trained staff. Further, with few exceptions (Clapp et al., 2009; Wells et al., 2015) most studies using breathalyzers collect one sample per participant making them cross-sectional.

Although point-estimates of BAC have utility (as do estimates of peak BAC), they are limited in providing useful data related to blood alcohol curves or how drinking shifts over the course of an event. Computational simulations of the dynamics of drinking events and the pharmacokinetics of BAC (Giraldo, Passino, & Clapp, 2017) strongly suggest that repeated measures of drinking during an event are needed to understand BAC curves and the ecology of drinking events. Understanding the overall dynamics of drinking events and how BAC "behaves over time" is critical to identifying leverage points for intervention (Stokols, 2000) and to avoid interventions based on simplistic models grounded in potentially spurious findings (Miller & Page, 2009). Regarding spurious findings, Miller and Page (Miller & Page, 2009) note that theory based on assumptions of mathematical normality, and cross-sectional studies that make inferences to guide such theory, can result in inaccurate inferences regarding complex phenomena. For example, a cross-sectional study of BAC at a drinking event (i.e. a single breath sample) predicting peak BAC cannot account for variations in the blood alcohol curve over the course of event. For some study participants peak BAC may have already occurred. For others, there may be multiple peaks.

There is a rapidly growing body of research that leverages the widespread use of mobile phones to survey individuals in natural environments ideally as risk behaviour is occurring. Ecological momentary assessments (EMA) are repeated, short, often smartphone-based surveys that allow researchers to sample important temporal features of risk behaviour as it occurs in natural environments (Smyth & Stone, 2003). These studies minimize recall error, maximize ecological validity (Stone & Shiffman, 1994), and help capture complex and dynamic behavioural data. The use of EMA methods seems particularly applicable to the study of event-level risky behaviour as well as event-level social interactions because both are dynamic and difficult to recall (Wray, Merrill, & Monti, 2014). For example, Thrul and Kuntsche (Thrul & Kuntsche, 2015) utilized EMA methods to survey young adult drinkers on weekend evenings to determine if consumption was affected by the number of friends present and interactions with either same-sex or other-sex peers. In this study, men tended to drink at a faster pace than women initially, but group dynamics negated gender differences later in the evening. Larger group size also predicted heavier drinking. The use of EMA allowed these researchers to view drinking as it was occurring over the course of multiple weekends.

EMA studies, however, do have several potential limitations. On the technical side, internet and cellular coverage can cause delays in subjects getting EMA notifications as well as in participants responding. Coupled with participants selectively responding (e.g. response fatigue, etc.), technical issues can result in missing data which can compromise the overall quality of findings. Although there are numerous imputation approaches to handle missing data in EMA studies, drinking event studies benefit from triangulation of data collection approaches (Shiffman, 2009). For instance, drinking event studies might include a retrospective and geo-grounded follow up interview to fill missing values (i.e. "last night at 11:00 pm you were at Bill's Bar, at 9:00 pm you reported having had three rounds of beer, do you recall what you drank between 9:00 and 11:00). Other potential methods include using the subject's recent drinking events or group member data from the same event (if available) to help impute missing values.

Transdermal alcohol monitors represent a potential alternative to breathalyzers, observation or self-reported drinking during drinking events (Marques & McKnight, 2009). Whereas breathalyzers provide BAC, transdermal alcohol monitors provide estimates based on alcohol perspired through the skin (transdermal alcohol content: TAC). One major potential advantage of using transdermal monitors over other methods is their capacity to take repeated TAC samples from the same subject over time. This feature has potential for enhancing event-level research, treatment outcome studies, and the like. In a recent study of a college bar crawl, Clapp et al., (Clapp, Madden, Mooney, & Dahlquist, 2017) tracked a group of college drinkers over the course of an organized drinking event. Using EMA data, transdermal monitors, and observation, the study was able to plot TAC curves for each participant relative to geographic location, perceived intoxication, and motivations related to drinking. Transdermal biosensors can be an improvement over self-report measures, but there are still some caveats. There is not yet a standard approach to reliably convert TAC to comparable BAC values (Luczak et al., 2018). In addition, there is a time lag between alcohol consumption and skin detection that may have subject-to-subject variability or within-person variability at higher doses of alcohol. Although the current reliability of TAC measures is still in development, when coupled with other measures of drinking at the event level, TAC data augments the overall ecological validity of event-level studies. The proliferation of Global Positioning System (GPS) and Bluetooth-equipped smartphones, smart "apps" and newer generations of smaller (wristwatch size) wearable alcohol or "tattoo" like monitors will likely improve our ability to study and intervene in alcohol events in real time.

To date, however, there are only a few notable examples of empirical research that has utilized transdermal monitors to observe everyday drinking contexts (Clapp et al., 2017; Fairbairn, Rosen, Luczak, & Venerable, 2018; Leffingwell et al., 2013). Thus far, research with ethanol biochemical sensors has mostly focused on either estimating BAC based on transdermal data (Luczak et al., 2018) or exploring contingency management interventions that promote abstinence (Barnett et al., 2017; Barnett, Tidey, Murphy, Swift, & Colby, 2011; Dougherty et al., 2014). The devices are more typically utilized as an intervention in a criminal justice setting to decrease the propensity of reoccurring harm such as drink-driving (McKnight, Fell, & Auld-Owens, 2012). Otherwise, event-level studies still fail to include more continuous objective measures of alcohol consumption. Although recent advances in data collection technologies (Leffingwell et al., 2013; Riley et al., 2011) have the potential to advance our understanding of event-level drinking behaviour, Riley et al. (Riley et al., 2011) noted that our ability to collect individualized, context-specific data and to intervene in situ has surpassed our current theories. The authors noted that "health behaviour models that have dynamic, regulatory system components to guide rapid intervention adaptation based on the individual's current and past behaviour and situational context" (p. 54) are greatly needed.

Intervention

Intervening during an event to prevent extreme intoxication makes good sense, because individual decision making can be markedly impaired leading to problems such as interpersonal conflicts, unprepared sexual activity, drunk driving, or violence (Abernathy, Chandler, & Woodward, 2010). In addition, drinking behaviour is contextually bound to one's current situation (Monk, Heim, Qureshi, & Price, 2015). In order to intervene during risk behaviour, recent studies have begun to embrace mobile technology such as smartphones, geolocators, or wearable biosensors (e.g. accelerometers). Internet-connected mobile devices are near ubiquitous and provide feasible instruments for both data collection and intervention delivery (Beckjord & Shiffman, 2014). New "smart" technologies have the potential to complement universal prevention efforts by targeting "leverage points" in events (Stokols, 2000).

Interventions delivered on mobile devices in real-world settings are often referred to as ecological momentary interventions (EMI) or mobile health (mHealth) interventions (Morgenstern, Kuerbis, & Muench, 2014). EMI are based on the notion of consumer self-control or individuals can change their own behaviour when prompted. Mobile-based interventions can be cost-effective options to more traditional in-person methods and have the potential to reach individuals during risk behaviour (Yu, Wu, Yu, & Xiao, 2006). Mobile-based interventions have become increasingly used in related behaviour change efforts (Riley et al., 2011), such as management of depressive symptoms (Agyapong, McLoughlin, & Farren, 2013). Furthermore, smartphone applications are now being utilized to implement interventions for at-risk individuals with drug use issues or other addictions such as gambling (Zhang & Ho, 2016). These types of interventions are also becoming more common for alcohol use particularly in US college student populations (Kauer, Reid, Sanci, & Patton, 2009), though interventions have been conducted with both young and older adults and deployed in educational, clinical, or community-based settings (Song, Qian, & Yu, 2019). In a recently published systematic review, mobile-based interventions have resulted in significant behavioural change such as decreased number of self-reported drinks consumed during an event (Song et al., 2019), fewer self-reported heavy drinking days during the past month (Alessi & Petry, 2013; Gustafson et al., 2014; Hasin, Aharonovich, & Greenstein, 2014), lower prevalence of alcohol-related injury (Suffoletto et al., 2014, 2015), or increased number of days abstinent post-treatment (Agyapong et al., 2013).

mHhealth interventions are generally delivered either by short message service (i.e. text messaging), apps, or interactive voice response (IVR). Text-based interventions primarily remind individuals of protective strategies and risk-based knowledge via repeated messages (Bock et al., 2016; Muench et al., 2017) while app-based and IVR interventions tend to monitor current use, provide personalized visual feedback (Gonzalez & Dulin, 2015; Gustafson et al., 2014), or even generate answers to consumer questions (Hasin et al., 2014). The content of mHealth interventions is typically based on two main theoretical constructs: behavioural change (e.g. planned behaviour, health belief model, cognitive-behavioural therapy, or social learning theory) and psychological motivation (e.g. self-determination, contingency management) (Song et al., 2019). Content is both informational (e.g. general or personalized information about risks of alcohol) and motivational (e.g. encouragement messages, committing to drinking goals) (Heron & Smyth, 2010). Interventions can be delivered at fixed times, on-demand by participants, randomly, or in response to contextual data such as geospatial coordinates (Song et al., 2019). For example, EMIs can be implemented throughout the course of an intervention period (e.g. three months post-treatment), during pre-identified high-risk times (i.e. weekends or holidays), or when an individual enters an area of risk (i.e. geographically close to alcohol outlets (Dulin & Gonzalez, 2017; Gustafson et al., 2014)).

While reviews have generally pointed to the effectiveness of mobile-based substance use interventions (Song et al., 2019), continuous monitoring of risk behaviour as a means of understanding triggers for either relapse or dangerous intoxication is still underdeveloped. We do not yet have a solid theoretical understanding of the underlying relationship between indicators and triggers (Kennedy et al., 2015). In randomized control trials, mHealth interventions for alcohol use tend to be more effective if the intervention period is longer, there are more frequent delivery of prompts or messages, and there are tangible incentives (Fowler, Holt, & Joshi, 2016; Mason, Ola, Zaharakis, & Zhang, 2015; Song et al., 2019). Alarmingly, very few commercially available mHealth apps incorporate empirically based strategies (Cohn, Hunter-Reel, Hagman, & Mitchell, 2011). Furthermore, most mHealth interventions fail to intervene during an event with content that is tailored both to the person and the current context (Fjeldsoe, Marshall, & Miller, 2009).

Ideally, mobile health interventions would be adaptable to individual circumstances in the moment. Just-in-time adaptive interventions (JITAI) hypothetically utilize the power of mobile phone technology, geospatial trackers, and wearables to intervene at *just* the right time to alter the trajectory of an individual's behaviour (Nahum-Shani et al., 2018). JITAI are deployed based on decision rules that are affected by an individual's demographics, past behaviour and their current context (Lagoa, Bekiroglu, Lanza, & Murphy, 2014). Not all mHealth interventions are adaptive however, even though mobile devices provide intensive context-specific longitudinal data. Furthermore, there are few examples of JITAI that have incorporated objective measures of intoxication (Barnett et al., 2011; Dougherty et al., 2014).

The combined use of both transdermal monitors and sensors embedded in smartphones is a promising avenue for preventive applications. Almost all mHealth applications rely on self-reported data from participants, but self-assessed drinking behaviour can be biased or inaccurate (Beckjord & Shiffman, 2014). Inferring drunkenness at any point in time is precluded by the dynamic process of metabolizing ethanol (Clapp et al., 2018). In a small field-based pilot study of drinking behaviour during a bar crawl, subjectively inferring one's intoxication was less reliable when consumption increased (Clapp et al., 2017). A sensor-based application could feasibly detect a dangerous drinking episode before even the drinker is capable of realizing they have consumed too much alcohol or too quickly.

Passively collected smartphone data have been connected to drinking behaviour (Bae, Chung, Ferreira, Dey, & Suffoletto, 2018) but not yet employed in an intervention. Transdermal monitors have been utilized as additions to contingency management interventions to promote overall abstinence (Barnett et al., 2011), but have not yet been included in attempts to intervene during drinking events to decrease event-level intoxication. Commercial-based transdermal companies are already in the process of developing monitors that can be worn on a wrist and can communicate with app-based software (Langley, 2017). Unfortunately, consumer-oriented technology is being crafted and sold to the public before our health-related theories have detailed how factors interact during an event. We were able to find only one example of an mHealth intervention that utilizes biosensor data. The Mind the Moment (MtM) intervention relies on continuous readings from a wrist-worn electrodermal activity (EDA) sensor to intervene at moments when individuals are experiencing heightened emotional arousal (i.e. stress or anxiety) (Leonard et al., 2017) which has been linked to alcohol use disorders (Nees, Diener, Smolka, & Flor, 2012). When EDA rose to a certain threshold, participants were provided with Cognitive Behavioural Therapy (CBT) informed strategies and protective behavioural strategies for drinking (Leonard et al., 2017). Initial findings were promising but it is not yet clear if these types of interventions can mitigate event-level issues such as violence, sexual risk taking, or acute alcohol poisoning.

Despite limited research to date, the real-time delivery of interventions aimed at reducing alcohol consumption shows great promise (Free et al., 2010). In the least, the practice of self-monitoring and the use of real-time assessment during drinking events may result in positive behavioural change (Kazemi et al., 2017). Furthermore, tying geographically explicit information to momentary responses (McQuoid, Thrul, & Ling, 2018) may provide the opportunity to physically map areas of risk in an entertainment district (i.e. "hotspots"). In the future, it will be important to continue to blend engineering principles with intervention design to identify optimal points to intervene and at what frequency (Gonzalez Villasanti, Passino, Clapp, & Madden, 2018; Lagoa et al., 2014). Tools often employed in control engineering could allow researchers to test interventions at various time points with existing data. In this case, interventions are designed based on an algorithm that utilizes an individual's current status and a prediction of the individual's future status and the intervention can be adjusted when individuals deviate (Lagoa et al., 2014). System dynamics frameworks can provide guidelines for behavioural interventions at the individual, group, and environmental levels and how we may be able to complement population-level or environmental interventions (i.e. RBS, increased prices) with personalized individual strategies. Technologies like global positioning systems (GPS), Bluetooth networking, SMS-based ecological momentary assessments, and transdermal alcohol sensors may greatly increase both our understanding of drinking events and our ability to intervene in real time and in a tailored manner (Riley et al., 2011).

In order to design real-time interventions with emergent technologies and engineering principles, it is critical to better understand the conceptualization of drinking events. When considering the field in its current state, several areas of inquiry are needed. First, conceptual work to help understand and frame the complexity of drinking events must continue. Our understanding of interplay between drinking rate, motives, social influence and environment as part of an ecological system is still rudimentary. As noted earlier, such work is critical for identifying leverage points for just-in-time interventions. Second, further development of methods to capture drinking behaviour at the event level is needed. Methods to augment and triangulate EMA and other self-report data might include artificial intelligence approaches using GPS, accelerometer and or other smart-phone data (Bae et al., 2018). Third, as noted earlier, transdermal alcohol monitors have not yet been fully developed, though researchers in the field are moving this important innovation forward (Leffingwell et al., 2013). Finally, as a field, alcohol science would benefit of better understanding drinking at the event level to inform epidemiology (i.e. context to drinking trends), the trajectories of alcohol use disorders, and the development of environmental alcohol prevention policies and programs. To this end, papers, special issue journals, books and conferences that help alcohol researchers and prevention professionals better understand alcohol use across the spectrum of levels of abstraction (i.e. de-segmentation) is greatly needed.

Conclusion

Understanding alcohol use as it naturally occurs remains a relatively understudied but potentially very important area of alcohol science given the prevalence of acute alcohol-related problems. Advances in real-time data collection methods, the transdermal estimation of blood alcohol concentrations, and complex multi-level modelling increase both our understanding of the complex ecology of alcohol use and our potential to strategically intervene to influence drinking in real time. This chapter begins to layout the framework for future work in this area.

References

Abernathy, K., Chandler, L. J., & Woodward, J. J. (2010). Alcohol and the prefrontal cortex. *International Review of Neurobiology, 91*, 289–320. https://doi.org/10.1016/S0074-7742(10)91009-X

Agyapong, V. I. O., McLoughlin, D. M., & Farren, C. K. (2013). Six-months outcomes of a randomised trial of supportive text messaging for depression and comorbid alcohol use disorder. *Journal of Affective Disorders, 151*(1), 100–104. https://doi.org/10.1016/j.jad.2013.05.058

Alessi, S. M., & Petry, N. M. (2013). A randomized study of cellphone technology to reinforce alcohol abstinence in the natural environment: Portable CM for alcohol abstinence. *Addiction, 108*(5), 900–909. https://doi.org/10.1111/add.12093

Ally, A. K., Lovatt, M., Meier, P. S., Brennan, A., & Holmes, J. (2016). Developing a social practice-based typology of British drinking culture in 2009–2011: Implications for alcohol policy analysis. *Addiction (Abingdon, England), 111*(9), 1568–1579. https://doi.org/10.1111/add.13397

Bae, S., Chung, T., Ferreira, D., Dey, A. K., & Suffoletto, B. (2018). Mobile phone sensors and supervised machine learning to identify alcohol use events in young adults: Implications for just-in-time adaptive interventions. *Addictive Behaviours, 83*, 42–47. https://doi.org/10.1016/j.addbeh.2017.11.039

Barnett, N. P., Celio, M. A., Tidey, J. W., Murphy, J. G., Colby, S. M., & Swift, R. M. (2017). A preliminary randomized controlled trial of contingency management for alcohol use reduction using a transdermal alcohol sensor: Contingency management for alcohol use reduction. *Addiction, 112*(6), 1025–1035. https://doi.org/10.1111/add.13767

Barnett, N. P., Tidey, J., Murphy, J. G., Swift, R., & Colby, S. M. (2011). Contingency management for alcohol use reduction: A pilot study using a transdermal alcohol sensor. *Drug and Alcohol Dependence, 118*(2–3), 391–399. https://doi.org/10.1016/j.drugalcdep.2011.04.023

Barry, A. E., Stellefson, M. L., Piazza-Gardner, A. K., Chaney, B. H., & Dodd, V. (2013). The impact of pregaming on subsequent blood alcohol concentrations: An event-level analysis. *Addictive Behaviours, 38*(8), 2374–2377. https://doi.org/10.1016/j.addbeh.2013.03.014

Beckjord, E., & Shiffman, S. (2014). Background for real-time monitoring and intervention related to alcohol use. *Alcohol Research: Current Reviews, 36*(1), 9–18.

Bock, B. C., Barnett, N. P., Thind, H., Rosen, R., Walaska, K., Traficante, R., … Scott-Sheldon, L. A. J. (2016). A text message intervention for alcohol risk reduction among community college students: TMAP. *Addictive Behaviours, 63*, 107–113. https://doi.org/10.1016/j.addbeh.2016.07.012

Cavan, S. (1966). *Liquor license: An ethnography of bar behaviour*. Chicago, IL: Aldine Transaction.

Clapp, J. D., Holmes, M. R., Reed, M. B., Shillington, A. M., Freisthler, B., & Lange, J. E. (2007). Measuring college students' alcohol consumption in natural drinking environments: Field methodologies for bars and parties. *Evaluation Review, 31*(5), 469–489. https://doi.org/10.1177/0193841X07303582

Clapp, J. D., Madden, D. R., Gonzalez Villasanti, H., Giraldo, L. F., Passino, K. M., Reed, M. B., & Fernandez Puentes, I. (2018). A system dynamic model of drinking events: Multi-level ecological approach: A system dynamic model of drinking events. *Systems Research and Behavioural Science, 35*(3), 265–281. https://doi.org/10.1002/sres.2478

Clapp, J. D., Madden, D. R., Mooney, D. D., & Dahlquist, K. E. (2017). Examining the social ecology of a bar-crawl: An exploratory pilot study. *PLoS One, 12*(9), e0185238. https://doi.org/10.1371/journal.pone.0185238

Clapp, J. D., Min, J. W., Shillington, A. M., Reed, M. B., & Croff, J. K. (2008). Person and environment predictors of blood alcohol concentrations: A multi-level study of college parties. *Alcoholism: Clinical and Experimental Research, 32*(1), 100–107. https://doi.org/10.1111/j.1530-0277.2007.00547.x

Clapp, J. D., Reed, M. B., Min, J. W., Shillington, A. M., Croff, J. M., Holmes, M. R., & Trim, R. S. (2009). Blood alcohol concentrations among bar patrons: A multi-level study of drinking behaviour. *Drug and Alcohol Dependence, 102*(1–3), 41–48. https://doi.org/10.1016/j.drugalcdep.2008.12.015

Clapp, J. D., Reed, M. B., & Ruderman, D. E. (2014). The relationship between drinking games and intentions to continue drinking, intentions to drive after drinking, and adverse consequences: Results of a field study. *The American Journal of Drug and Alcohol Abuse, 40*(5), 374–379. https://doi.org/10.3109/00952990.2014.933838

Cohn, A. M., Hunter-Reel, D., Hagman, B. T., & Mitchell, J. (2011). Promoting behaviour change from alcohol use through Mobile technology: The future of ecological momentary assessment. *Alcoholism: Clinical and Experimental Research, 35*(12), 2209–2215. https://doi.org/10.1111/j.1530-0277.2011.01571.x

Denzin, N. K. (1987). *The alcoholic self*. London, England: Sage.

Dougherty, D. M., Hill-Kapturczak, N., Liang, Y., Karns, T. E., Cates, S. E., Lake, S. L., … Roache, J. D. (2014). Use of continuous transdermal alcohol monitoring during a contingency management procedure to reduce excessive alcohol use. *Drug and Alcohol Dependence, 142*, 301–306. https://doi.org/10.1016/j.drugalcdep.2014.06.039

Dulin, P. L., & Gonzalez, V. M. (2017). Smartphone-based, momentary intervention for alcohol cravings amongst individuals with an alcohol use disorder. *Psychology of Addictive Behaviours, 31*(5), 601–607. https://doi.org/10.1037/adb0000292

Fairbairn, C. E., Rosen, I. G., Luczak, S. E., & Venerable, W. J. (2018). Estimating the quantity and time course of alcohol consumption from transdermal alcohol sensor data: A combined laboratory-ambulatory study. *Alcohol, 81*, 111. https://doi.org/10.1016/j.alcohol.2018.08.015

Fitzpatrick, B., & Martinez, J. (2011). Agent-based modeling of ecological niche theory and assortative drinking. *Journal of Artificial Societies and Social Simulation, 15*(2), 4.

Fjeldsoe, B. S., Marshall, A. L., & Miller, Y. D. (2009). Behaviour change interventions delivered by mobile telephone short-message service. *American Journal of Preventive Medicine, 36*(2), 165–173. https://doi.org/10.1016/j.amepre.2008.09.040

Fowler, L. A., Holt, S. L., & Joshi, D. (2016). Mobile technology-based interventions for adult users of alcohol: A systematic review of the literature. *Addictive Behaviours, 62*, 25–34. https://doi.org/10.1016/j.addbeh.2016.06.008

Free, C., Phillips, G., Felix, L., Galli, L., Patel, V., & Edwards, P. (2010). The effectiveness of M-health technologies for improving health and health services: A systematic review protocol. *BMC Research Notes, 3*, 250. https://doi.org/10.1186/1756-0500-3-250

Giraldo, L. F., Passino, K. M., & Clapp, J. D. (2017). Modeling and analysis of group dynamics in alcohol-consumption environments. *IEEE Transactions on Cybernetics, 47*(1), 165–176. https://doi.org/10.1109/TCYB.2015.2509444

Giraldo, L. F., Passino, K. M., Clapp, J. D., & Ruderman, D. (2017). Dynamics of metabolism and decision making during alcohol consumption: Modeling and analysis. *IEEE Transactions on Cybernetics, 47*(11), 3955–3966. https://doi.org/10.1109/TCYB.2016.2593009

Gonzalez, V. M., & Dulin, P. L. (2015). Comparison of a smartphone app for alcohol use disorders with an internet-based intervention plus bibliotherapy: A pilot study.

Journal of Consulting and Clinical Psychology, 83(2), 335–345. https://doi.org/10.1037/a0038620

Gonzalez Villasanti, H., Passino, K. M., Clapp, J. D., & Madden, D. R. (2018). A control-theoretic assessment of interventions during drinking events. *IEEE Transactions on Cybernetics, 49*, 1–12. https://doi.org/10.1109/TCYB.2017.2782010

Gorman, D. M., Mezic, J., Mezic, I., & Gruenewald, P. J. (2006). Agent-based Modeling of drinking behaviour: A preliminary model and potential applications to theory and practice. *American Journal of Public Health, 96*(11), 2055–2060. https://doi.org/10.2105/AJPH.2005.063289

Gusfield, J. R. (1996). *Contested meanings: The construction of alcohol problems*. Madison, WI: University of Wisconsin Press.

Gustafson, D. H., McTavish, F. M., Chih, M. Y., Atwood, A. K., Johnson, R. A., Boyle, M. G., … Shah, D. (2014). A smartphone application to support recovery from alcoholism: A randomized clinical trial. *JAMA Psychiatry, 71*(5), 566–572. https://doi.org/10.1001/jamapsychiatry.2013.4642

Harford, T. C., & Gaines, L. S. (1979). Social drinking contexts. In *Proceedings of a Workshop* (DHHS-ADM-81-1097). National Institute of Alcohol Abuse and Alcoholism. https://files.eric.ed.gov/fulltext/ED227373.pdf

Hasin, D. S., Aharonovich, E., & Greenstein, E. (2014). HealthCall for the smartphone: Technology enhancement of brief intervention in HIV alcohol dependent patients. *Addiction Science & Clinical Practice, 9*. https://doi.org/10.1186/1940-0640-9-5

Hawe, P., Shiell, A., & Riley, T. (2009). Theorising interventions as events in systems. *American Journal of Community Psychology, 43*(3–4), 267–276. https://doi.org/10.1007/s10464-009-9229-9

Heron, K. E., & Smyth, J. M. (2010). Ecological momentary interventions: Incorporating mobile technology into psychosocial and health behaviour treatments. *British Journal of Health Psychology, 15*(1), 1–39. https://doi.org/10.1348/135910709X466063

Holder, H. D. (2006). *Alcohol and the community: A systems approach to prevention*. Cambridge, England: Cambridge University Press.

Kauer, S. D., Reid, S. C., Sanci, L., & Patton, G. C. (2009). Investigating the utility of mobile phones for collecting data about adolescent alcohol use and related mood, stress and coping behaviours: Lessons and recommendations. *Drug and Alcohol Review, 28*(1), 25–30. https://doi.org/10.1111/j.1465-3362.2008.00002.x

Kazemi, D. M., Borsari, B., Levine, M. J., Li, S., Lamberson, K. A., & Matta, L. A. (2017). A systematic review of the mHealth interventions to prevent alcohol and substance abuse. *Journal of Health Communication, 22*(5), 413–432. https://doi.org/10.1080/10810730.2017.1303556

Kennedy, A. P., Epstein, D. H., Jobes, M. L., Agage, D., Tyburski, M., Phillips, K. A., … Preston, K. L. (2015). Continuous in-the-field measurement of heart rate: Correlates of drug use, craving, stress, and mood in polydrug users. *Drug and*

Alcohol Dependence, 151, 159–166. https://doi.org/10.1016/j.drugalcdep.2015.03.024

Lagoa, C. M., Bekiroglu, K., Lanza, S. T., & Murphy, S. A. (2014). Designing adaptive intensive interventions using methods from engineering. *Journal of Consulting and Clinical Psychology, 82*(5), 868–878. https://doi.org/10.1037/a0037736

Langley, H. (2017). *Bactrack's wearable will tell you how drunk you are*. Wareable. https://www.wareable.com/health-and-wellbeing/bactrack-sync-wearable-alcohol-monitor-release-date-price-3735

Leffingwell, T. R., Cooney, N. J., Murphy, J. G., Luczak, S., Rosen, G., Dougherty, D. M., & Barnett, N. P. (2013). Continuous objective monitoring of alcohol use: Twenty-first century measurement using transdermal sensors. *Alcoholism: Clinical and Experimental Research, 37*(1), 16–22. https://doi.org/10.1111/j.1530-0277.2012.01869.x

Leonard, N. R., Silverman, M., Sherpa, D. P., Naegle, M. A., Kim, H., Coffman, D. L., & Ferdschneider, M. (2017). Mobile health technology using a wearable sensorband for female college students with problem drinking: An acceptability and feasibility study. *JMIR mHealth and uHealth, 5*(7), e90. https://doi.org/10.2196/mHealth.7399

Lewin, K. (1951). *Field theory in social science: Selected theoretical papers* (Ed. D. Cartwright). Harpers.

Luczak, S. E., Hawkins, A. L., Dai, Z., Wichmann, R., Wang, C., & Rosen, I. G. (2018). Obtaining continuous BAC/BAC estimates in the field: A hybrid system integrating transdermal alcohol biosensor, Intellidrink smartphone app, and BAC estimator software tools. *Addictive Behaviours, 83*, 48–55. https://doi.org/10.1016/j.addbeh.2017.11.038

Marques, P. R., & McKnight, A. S. (2009). Field and laboratory alcohol detection with 2 types of transdermal devices. *Alcoholism: Clinical and Experimental Research, 33*(4), 703–711. https://doi.org/10.1111/j.1530-0277.2008.00887.x

Mason, M., Ola, B., Zaharakis, N., & Zhang, J. (2015). Text messaging interventions for adolescent and young adult substance use: A meta-analysis. *Prevention Science: The Official Journal of the Society for Prevention Research, 16*(2), 181–188. https://doi.org/10.1007/s11121-014-0498-7

McKnight, A. S., Fell, J. C., & Auld-Owens, A. (2012). *Transdermal alcohol monitoring: Case studies*. Washington, DC: National Highway Traffic Safety Administration.

McQuoid, J., Thrul, J., & Ling, P. (2018). A geographically explicit ecological momentary assessment (GEMA) mixed method for understanding substance use. *Social Science & Medicine, 202*, 89–98. https://doi.org/10.1016/j.socscimed.2018.02.014

Miller, J. H., & Page, S. E. (2009). *Complex adaptive systems: An introduction to computational models of social life*. Princeton, NJ: Princeton University Press.

Monk, R. L., Heim, D., Qureshi, A., & Price, A. (2015). "I have no clue what I drunk last night" using smartphone technology to compare in-vivo and retrospective self-reports of alcohol consumption. *PLoS One, 10*(5). https://doi.org/10.1371/journal.pone.0126209

Morgenstern, J., Kuerbis, A., & Muench, F. (2014). Ecological momentary assessment and alcohol use disorder treatment. *Alcohol Research: Current Reviews, 36*(1), 101–110.

Muench, F., van Stolk-Cooke, K., Kuerbis, A., Stadler, G., Baumel, A., Shao, S., McKay, J. R., & Morgenstern, J. (2017). A randomized controlled pilot trial of different mobile messaging interventions for problem drinking compared to weekly drink tracking. PLoS One, 12(2), e0167900. https://doi.org/10.1371/journal.pone.0167900.

Nahum-Shani, I., Smith, S. N., Spring, B. J., Collins, L. M., Witkiewitz, K., Tewari, A., & Murphy, S. A. (2018). Just-in-time adaptive interventions (JITAIs) in Mobile Health: Key components and design principles for ongoing health behaviour support. *Annals of Behavioural Medicine: A Publication of the Society of Behavioural Medicine, 52*(6), 446–462. https://doi.org/10.1007/s12160-016-9830-8

National Institute of Health. (2000). *10th special report to the U.S. Congress on Alcohol and Health*. Bethesda, MD: U.S. Department of Health and Human Services.

Nees, F., Diener, C., Smolka, M. N., & Flor, H. (2012). The role of context in the processing of alcohol-relevant cues. *Addiction Biology, 17*(2), 441–451. https://doi.org/10.1111/j.1369-1600.2011.00347.x

Patrick, M. E., & Lee, C. M. (2010). Comparing numbers of drinks: College students' reports from retrospective summary, followback, and prospective daily diary measures. *Journal of Studies on Alcohol and Drugs, 71*(4), 554–561.

Quinn, P. D., & Fromme, K. (2011). Predictors and outcomes of variability in subjective alcohol intoxication among college students: An event-level analysis across 4 years. *Alcoholism: Clinical and Experimental Research, 35*(3), 484–495. https://doi.org/10.1111/j.1530-0277.2010.01365.x

Reed, M. B., Clapp, J. D., Weber, M., Trim, R., Lange, J., & Shillington, A. M. (2011). Predictors of partying prior to bar attendance and subsequent BAC. *Addictive Behaviours, 36*(12), 1341–1343. https://doi.org/10.1016/j.addbeh.2011.07.029

Rehm, J., Mathers, C., Popova, S., Thavorncharoensap, M., Teerawattananon, Y., & Patra, J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *Lancet, 373*(9682), 2223–2233.

Riley, W. T., Rivera, D. E., Atienza, A. A., Nilsen, W., Allison, S. M., & Mermelstein, R. (2011). Health behaviour models in the age of mobile interventions: Are our theories up to the task? *Translational Behavioural Medicine, 1*(1), 53–71. https://doi.org/10.1007/s13142-011-0021-7

Saltz, R. F., Paschall, M. J., McGaffigan, R. P., & Nygaard, P. M. O. (2010). Alcohol risk management in college settings: The safer California universities randomized trial. *American Journal of Preventive Medicine, 39*(6), 491–499. https://doi.org/10.1016/j.amepre.2010.08.020

Scribner, R., Ackleh, A. S., Fitzpatrick, B. G., Jacquez, G., Thibodeaux, J. J., Rommel, R., & Simonsen, N. (2009). A systems approach to college drinking: Development of a deterministic model for testing alcohol control policies. *Journal of Studies on Alcohol and Drugs, 70*(5), 805–821.

Shiffman, S. (2009). Ecological momentary assessment (EMA) in studies of substance use. *Psychological Assessment, 21*(4), 486–497. https://doi.org/10.1037/a0017074

Smyth, J. M., & Stone, A. A. (2003). Ecological momentary assessment research in behavioural medicine. *Journal of Happiness Studies; Dordrecht, 4*(1), 35–52. http://dx.doi.org.libproxy1.usc.edu/10.1023/A:1023657221954

Song, T., Qian, S., & Yu, P. (2019). Mobile health interventions for self-control of unhealthy alcohol use: Systematic review. *JMIR mHealth and uHealth, 7*(1). https://doi.org/10.2196/10899

Stevely, A. K., Holmes, J., & Meier, P. S. (2020). Contextual characteristics of adults' drinking occasions and their association with levels of alcohol consumption and acute alcohol-related harm: A mapping review. *Addiction, 115*(2), 218–229. https://doi.org/10.1111/add.14839

Stokols, D. (2000). Social ecology and behavioural medicine: Implications for training, practice, and policy. *Behavioural Medicine (Washington, D.C.), 26*(3), 129–138. https://doi.org/10.1080/08964280009595760

Stone, A. A., & Shiffman, S. (1994). Ecological momentary assessment (Ema) in behavioural medicine. *Annals of Behavioural Medicine, 16*(3), 199–202. https://doi.org/10.1093/abm/16.3.199

Suffoletto, B., Kristan, J., Callaway, C., Kim, K. H., Chung, T., Monti, P. M., & Clark, D. B. (2014). A text message alcohol intervention for young adult emergency department patients: A randomized clinical trial. *Annals of Emergency Medicine, 64*(6), 664–672.e4. https://doi.org/10.1016/j.annemergmed.2014.06.010

Suffoletto, B., Kristan, J., Chung, T., Jeong, K., Fabio, A., Monti, P., & Clark, D. B. (2015). An interactive text message intervention to reduce binge drinking in young adults: A randomized controlled trial with 9-month outcomes. *PLoS One, 10*(11), e0142877. https://doi.org/10.1371/journal.pone.0142877

Thrul, J., & Kuntsche, E. (2015). The impact of friends on young adults' drinking over the course of the evening-an event-level analysis: Impact of friends on young adults' drinking. *Addiction, 110*(4), 619–626. https://doi.org/10.1111/add.12862

Verster, J. C., Benjaminsen, J. M. E., van Lanen, J. H. M., van Stavel, N. M. D., & Olivier, B. (2015). Effects of mixing alcohol with energy drink on objective and subjective intoxication: Results from a Dutch on-premise study. *Psychopharmacology, 232*(5), 835–842. https://doi.org/10.1007/s00213-014-3715-y

Wechsler, H., Davenport, A., Dowdall, G., Moeykens, B., & Castillo, S. (1994). Health and behavioural consequences of binge drinking in college: A National Survey of students at 140 campuses. *JAMA, 272*(21), 1672–1677. https://doi.org/10.1001/jama.1994.03520210056032

Wells, S., Dumas, T. M., Bernards, S., Kuntsche, E., Labhart, F., & Graham, K. (2015). Predrinking, alcohol use, and breath alcohol concentration: A study of young adult bargoers. *Psychology of Addictive Behaviours, 29*(3), 683–689. https://doi.org/10.1037/adb0000065

Wells, S., Graham, K., & Purcell, J. (2009). Policy implications of the widespread practice of "pre-drinking" or "pre-gaming" before going to public drinking establishments: Are current prevention strategies backfiring? *Addiction (Abingdon, England), 104*(1), 4–9. https://doi.org/10.1111/j.1360-0443.2008.02393.x

World Health Organization. (2018). *Global status report on alcohol and health 2018*. Geneva, Switzerland: World Health Organization.

Wray, T. B., Merrill, J. E., & Monti, P. M. (2014). Using ecological momentary assessment (EMA) to assess situation-level predictors of alcohol use and alcohol-related consequences. *Alcohol Research: Current Reviews, 36*(1), 19–27.

Yu, P., Wu, M. X., Yu, H., & Xiao, G. Q. (2006). The challenges for the adoption of M-health. In *2006 IEEE International Conference on Service Operations and Logistics, and Informatics* (pp. 181–186). https://doi.org/10.1109/SOLI.2006.329059

Zamboanga, B. L., Kenney, S. R., Van Tyne, K., Olthuis, J. V., Correia, C. J., Ham, L. S., & Borsari, B. (2014). Not just fun and games: A review of college drinking games research from 2004 to 2013. Psychology of Addictive Behaviours: Journal of the Society of Psychologists in Addictive Behaviours, 28(3), 682–695. https://doi.org/10.1037/a0036639.

Zhang, M. W. B., & Ho, R. C. M. (2016). Tapping onto the potential of smartphone applications for psycho-education and early intervention in addictions. *Frontiers in Psychiatry, 7*. https://doi.org/10.3389/fpsyt.2016.00040