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Title:
The use of choice architecture interventions to reduce alcohol consumption in bar-like settings

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A dissertation submitted to the University of Bristol in accordance with the requirements for award of the degree of Master of Science by Research in the Faculty of Science, School of Psychological Science, August 2023.

Word count: 15417

ABSTRACT

Alcohol is commonly consumed despite being one of the top risk factors for disease globally. While traditional approaches to health interventions aim to change this by targeting individuals' conscious decision-making, a complementary approach, called choice architecture, focuses on altering the environment in which drinking occurs to reach the same goal. There is a growing body of literature suggesting the benefits of choice architecture interventions in various fields, but their use in relation to alcohol remains understudied. This thesis has explored the capacity of such interventions to influence the consumption of alcohol. A pilot laboratory study with naturalistic elements was conducted to inform the design of a full-scale randomised control trial to estimate the impact of drinking position (sitting vs standing) on the rate of alcohol consumption and to determine whether it is moderated by the presence of a table. It demonstrated that with detailed planning, this manipulation can be feasibly integrated into a realistic setting. Study 2 was carried out online, and its main task was gamified to potentially improve its ecological validity and participants' engagement. It assessed the impact of altering the proportion of alcohol-free drinks to their alcoholic counterparts, and the availability of calorie information for both types of drinks, on the selection of alcohol-free alternatives. The results provided further evidence on the effectiveness of the former, while obtaining no evidence in favour of the latter. The overall findings of this thesis suggest the feasibility and potential effectiveness of choice architecture interventions to reduce drinking, while highlighting the issues with conducting such studies in laboratory and online settings instead of a more naturalistic environment. Thus, the thesis offers insights into the role of environmental cues in shaping behaviour, but ultimately emphasises the need to clarify if these changes in behaviour can translate to the real-world consumption of alcohol.

ACKNOWLEDGEMENTS

First and foremost, I wish to express my deepest gratitude to my primary supervisor Olivia Maynard, who oversaw this everlasting journey of mine and did not lose hope in my ability to reach the end even when I was doubting it myself. Her confidence, optimism and support were what ultimately motivated me to resume this work.

Another individual who deserves special mention is Jennifer Ferrar, who was kind enough to take me under her wing when my primary supervisor was away. She provided me with invaluable advice and breathed tranquillity into me when I needed it most.

I was also lucky to have an incredibly supportive research group in the form of the Tobacco and Alcohol Research Group (TARG) at the University of Bristol with highly capable and critically minded experts in similar fields. I am especially thankful to Angela Attwood, Marcus Munafò and Anna Blackwell who contributed greatly to the designs of my studies, and my thesis overall.

Further, I am grateful to my elder sister, Alina, and my parents, Natalia and Vladimir, for always being there for me and not letting me fall whenever I was about to stumble. I am grateful to all my beautiful, incomparable, irreplaceable friends who were understanding and ready to leave me alone with my work, but otherwise kept me distracted and entertained when I actually needed a break.

But most importantly, I am expressing my eternal, infinite gratitude to Roman Nikolajev, my soulmate and so-called partner in crime in our common pursuit of an academic career. Per aspera ad astra, as they say. What I can say with upmost confidence is that I would not be able to make even a single step to in the direction of finishing up this thesis if he was not by my side, radiating genuine belief in me and all the positive emotions that I myself was lacking. I dedicate all these pages of text to him. Thank you for being in my life.

AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: JANA LUTUS DATE: 04.08.2023

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: GENERAL INTRODUCTION

Alcohol consumption

Alcohol has been deeply ingrained in society since ancient times (Hanson, 2013), and it remains so even in modern history. In 2016 alone, its average consumption in the world's population over the age of 15 years was equal to 6.4 litres per capita (World Health Organization, 2019). In the same year, 11.4 litres of pure alcohol were consumed per person of the same age group in the United Kingdom (UK). Even though this number dropped to 9.7 litres by 2020 in the UK (OECD & European Union, 2020), it remained vastly higher than the world average. It places a considerable strain on public services, such as more than 1 million hospital admissions and £3.5 billion in costs to the NHS every year (Health and Social Care Information Centre, 2015). The annual economic cost of excessive alcohol consumption to society is estimated to be £21 billion in the UK (Home Office, 2012) and €125 billion in the European Union (Anderson & Baumberg, 2006).

Alcohol has long been established as one of the most prominent contributors to the burden of disease both globally (Lim et al., 2012) and in the United Kingdom (Steel et al., 2018) where it is only preceded by such lifestyle risk factors as smoking and obesity (Home Office, 2012). Since the mid-1990s, it has been ranked as one of the top 10 risk factors for disease regardless of how many risk factors were compared (Rehm & Imtiaz, 2016). The consumption of alcohol is linked to over 200 health conditions, both physical and mental (World Health Organisation, 2014). Among these, it directly causes more than 60, such as various cancers, gastrointestinal conditions, cardiovascular diseases and immunological disorders (Anderson & Baumberg, 2006). The annual mortality associated with alcohol consumption is estimated to amount to around 3 million deaths (Shield et al., 2020). For example, liver disease is the fifth most common cause of death, and the majority of cases are induced by excessive use of alcohol (Williams et al., 2014).

For most conditions, the risk of alcohol-related harms is proportional to an individual's pattern of alcohol consumption (World Health Organization, 2009). For example, the likelihood and severity of certain cardiovascular diseases (e.g. coronary heart disease and stroke) increases with the frequency and volume of episodic heavy drinking (Anderson & Baumberg, 2006). However, any degree of alcohol use is believed to contribute to negative health outcomes. For instance, an elevated risk of female breast cancer has been associated with drinking as little as ten grams of pure alcohol per day (Shield, Soerjomataram, & Rehm,

2016). As such, interventions which aim to reduce the consumption of alcohol at the population level are vital to achieving positive changes in public health and the economy.

Choice architecture

It is clear from alcohol consumption trends that although people should value their health, their actual behaviour often undermines it. This gap between values and behaviour is often explained using a dual process model, according to which human behaviour is shaped by two systems, one conscious and one automatic (Strack & Deutsch, 2004). The first system is goal-oriented and driven by an individual's known preferences, while the second one is cued by environment and controlled by an individual's acute feelings.

Traditional approaches to health interventions are often built around the first system, as they assume that people continuously analyse costs and benefits of all potential outcomes to identify the most favourable option (Becker, 1976). For them, behaviour is the result of a conscious decision-making process which weighs and incorporates an individual's belief systems, values, attitudes, and social norms (Ajzen, 1991; Stern, 2000). Interventions that follow this approach therefore aim to heighten the utility of the desired option through such methods, as educating people about the costs and benefits of a given behaviour or establishing novel incentive structures with the introduction of taxes, fines, or other similar economic measures (Albarracin, 2018). Nonetheless, despite producing considerable impact at the population level, the effectiveness of such interventions in alternating behaviour at the individual level has generally been modest (World Health Organization, 2008).

Contrary to the assumptions of traditional behaviour change approaches, much human behaviour is actually triggered automatically by environmental cues rather than based on conscious deliberation (Marteau, Hollands, & Fletcher, 2012). By requiring little to no cognitive engagement, it creates a computationally less rigorous form of decision making that enables navigation through the demands of daily life in spite of limited time and available information (Evans, 2008). Preferences are therefore constructed using cognitive biases and shortcuts, making people susceptible to ostensibly irrational contextual influences (Gigerenzer & Gaissmaier, 2011). For example, unhealthy behaviour is more likely to occur due to the combination of contextual factors and the strength of immediate gratification compared to a larger but a more distant one (Marteau, Ogilvie, Roland, Suhrcke, & Kelly,

2011). It has been suggested that health interventions targeting this susceptibility to environmental cues might be used complementary to traditional approaches, as they allow decisions to be influenced by simple changes in the context in which they are made (Thaler, Sunstein, & Balz, 2013).

This complementary approach, known as choice architecture or "nudging", was first introduced by Thaler and Sunstein in their book *Nudge: Improving Decisions about Health, Wealth, and Happiness* (Thaler & Sunstein, 2008). Although it has emerged from the field of behavioural economics (Leone, 2016), its aim is to alter people's behaviour by redesigning physical, social, and/or psychological aspects of the environment in which decisions are made instead of relying on substantial economic incentives or education (Thaler, Sunstein, & Balz, 2013). This is achieved by making decision-relevant information more easily accessible, promoting evaluation and comparison of alternatives, or reinforcing previously established behavioural intentions (Münscher, Vetter, & Scheuerle, 2016). As such, choice architecture interventions attempt to encourage desirable behaviour without constraining an individual's freedom of choice. Since it enables decision-making processes to be affected through simple changes in the so-called choice architecture, the appeal of this approach is self-evident.

The Typology of Interventions in Proximal Physical Micro-Environments (TIPPME; Hollands, et al., 2017) classifies choice architecture interventions into six broad types: availability (e.g. reducing the number of unhealthy food options), position (e.g. moving unhealthy food out of the attention focus), functionality (e.g. making packages of unhealthy food less user-friendly), presentation (e.g. making unhealthy food packages less visually pleasing), size (e.g. making the portion size of unhealthy food smaller) and the information shown on products (e.g. providing nutritional information for unhealthy food).

Literature review

Health research

Altering the environment to cue certain behaviour holds promise in the area of health interventions, but it has been frequently used to undermine our wellbeing. Advances in food engineering focused upon targeting the automatic system are considered to be one possible cause of the long-term rise in obesity (Ruhm, 2012). For example, overconsumption is suggested to stem from the sheer number of readily available foods that are packed,

displayed, and designed to trigger our automatic system, which is further encouraged by advertisements (Harris, Bargh, & Brownell, 2009). The rise in young people's alcohol consumption over the past 50 years has also been attributed to some extent to how alcohol is marketed and easily accessible (Health Committee, 2010), thus contributing to the idea that nudging can lead to behaviours detrimental to our health. Nonetheless, making changes to the environment can be just as effective in cueing behaviours that improve our wellbeing.

The popularity of choice architecture interventions has seen an immense increase over the past years (Mertens, Herberz, Hahnel, & Brosch, 2022), predominantly in the area of food purchasing and consumption. Altering such aspects of the environment as atmosphere or aesthetics (e.g. decor, lighting and music volume) was found to affect eating behaviour. North, Shilcock and Hargreaves (2003) demonstrated that – compared to pop music and a lack of music – playing classical music in a restaurant setting led to increased spending. Further, the majority of studies manipulating the size of a package, a portion contained inside the package, or a single unit within a portion reported effects on eating behaviour. For instance, increasing the portion size of the main course in a restaurant resulted in increased energy intake (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004). Likewise, altering the size of serving utensils and subsequent reduction of portion sizes was found to cause unintentional adjustments to actual calorie intake (Skov, Lourenco, Hansen, Mikkelsen, & Schofield, 2013) and meal composition (Libotte, Siegrist, & Bucher, 2014). In general, recent systematic reviews and *meta*-analyses (e.g. Vecchio, & Cavallo, 2019; Arno & Thomas, 2016; Bauer, & Reisch, 2019) identified predominantly positive outcomes of nudging on healthy food choices. Nonetheless, it is important to note that the interpretation of the results is somewhat limited by the low to moderate quality of most studies included in these analyses, which is mainly caused by varied outcome measures, heterogeneity in context and population, and low external validity.

In terms of the effects of nudging on other health behaviours, fewer studies have been conducted. For example, Hammond, Fong, McDonald, Cameron, and Brown (2003) found a link between graphic warning signs on cigarette packs and subsequent quitting, attempting to quit or cutting down smoking three months later (Hammond, Fong, McDonald, Cameron, & Brown, 2003). It was proposed that warning labels larger in size and with pictures would be more effective compared to smaller text-only labels (Hammond, 2011). On the other hand, halving the length of a cigarette did not lead to the reduction in tobacco smoke intake (Chait & Griffiths, 1982). Physical activity interventions generally encouraged behaviour change

through standardised explicit information, such as promoting stair use in shopping malls (Kerr, Eves, & Carroll, 2000), and they were broadly successful in altering behaviour. In more general terms, framing goals with an explicit clause for emergency situations was found to mitigate detrimental effects of failure on goal attainment (Sharif, & Shu, 2021).

Alcohol-related research

A number of aspects of the physical environment seem to be associated with increased alcohol consumption. A systematic review of observational studies found that crowding, poor cleanliness, loud music and a focus on dancing were often linked to higher alcohol use and aggression (Hughes et al., 2011). Other potential contributing factors identified in the follow-up study (Hughes et al., 2012) were use of plastic glassware, poor restrooms, promotion of certain non-alcoholic drinks, and the presence of a dancefloor.

Several studies investigated the effects of sound in particular on drinking behaviour. The sole presence of music was found to impact alcohol consumption as Drews, Vaughn and Anfiteatro (1992) discovered that males drank higher volumes of beer when the music was on compared to when it was off. Such structural components as sound level and tempo were also associated with changes in drinking, albeit the results were inconsistent. For example, more alcoholic beverages were consumed when the music was playing louder than usual in a bar (Guéguen, Hélène, & Jacob, 2004; Guéguen, Jacob, Le Guellec, Morineau, & Lourel, 2008). The speed with which a drink was consumed also increased in response to increased music tempo (McElrea & Standing, 1992). Conversely, other studies found that people drank faster (Bach & Schaefer, 1979) and spent more money (Milliman, 1986; Caldwell & Hibbert, 1999) when music tempo was slower. These findings should be interpreted with caution, as neither study was conducted in a controlled laboratory setting.

Perception of the taste of alcohol is another area where the influence of music was observed. People rated wine as more mellow/soft if mellow/soft music was playing (North, 2012; Spence, Velasco, & Knoeferle, 2014; Wang & Spence, 2015a). Similar effects were found in relation to beer (Carvalho, Wang, Van Ee, & Spence, 2016), whisky (Velasco, Jones, King, & Spence, 2013) and vodka (Wang & Spence, 2015b). As such, it can be suggested that alcohol flavour is evaluated in congruence with the type of music played in the environment.

Visual presentation of the glassware in which alcohol is served might be another factor influencing drinking behaviour. For example, in laboratory studies, its shape was found to affect the rate of alcohol consumption, as social alcohol drinkers took longer to consume

lager from a straight glass than from a curved one (Attwood, Scott-Samuel, Stothart, & Munafò, 2012). It is important to note, however, that these effects had not been replicated in a real-life context (Cliceri, Petit, Garrel, Monteleone, & Giboreau, 2018). Other visual aspects of alcoholic drinks which seem to alter standard patterns of consumption are volume markings (Troy et al., 2017) and graphic health warning labels (Pechey et al., 2020; Grummon, Ruggles, Greenfield, & Hall, 2023), as both were effective in reducing said consumption.

Thesis overview

Overall, an increasing number of studies in the field of public health has been focusing on choice architecture interventions because if implemented correctly, they allow for healthier behaviour without undermining an individual's right to make decisions. As alcohol is still commonly consumed despite its clear harms (World Health Organization, 2019), it is vital to explore ways to impede such behaviour. Yet, research on this topic is still scarce compared to such areas as food consumption, and many components remain under-investigated. Since the physical environment is an important contributor to the increased alcohol intake (Hughes et al., 2011), novel methods of hindering it may benefit existing health interventions.

The present thesis aims to examine how alcohol consumption may be affected by the implementation of choice architecture interventions. The initial focus was intended to be on changes to the functionality of the physical environment only, such as presence of seating spaces and access to tables. However, examining this was no longer possible due to the COVID-19 outbreak. As such, the scope of the thesis was broadened to include a different type of choice architecture interventions, which could manipulate the ratio of alcohol-free alternatives to alcoholic beverages. To evaluate the effectiveness of these interventions in altering drinking behaviour, two separate studies were conducted.

CHAPTER 2: THE IMPACT OF SITTING VS. STANDING ON THE RATE OF ALCOHOL CONSUMPTION: A PILOT STUDY

Introduction

An observational study of licensed premises in Australia identified four key variables related to violent behaviour: patron type, drinking patterns, behaviour of doormen, and social atmosphere (Homel & Tomsen, 1993). Within the latter, boredom and lack of comfort seemed to be especially strong contributors to the increase in violence. For example, the presence of large crowds often led to customer discomfort, which was further exacerbated by a lack of seating. Unless they were sufficiently entertained, individuals were inclined to alleviate this uneasiness by consuming their alcoholic beverages faster. These observations are in line with the results of Turner, Annis and Sklar (1997), which showed that drinking in response to physical discomfort was associated with alcohol use problems. Further, consuming alcohol to manage psychological distress was found to mediate the effects of expectancies (i.e. what was expected to be obtained from alcohol) on alcohol use (Galen, Henderson, & Coovert, 2001).

A more recent observational study in California (Lee, Pagano, Morrison, Gruenewald, & Wittman, 2018) concluded that approximately one in six venues changed their physical environment to increase alcohol sales. This was achieved by removing tables and chairs, reducing lighting and increasing music volume in order to 'morph' into a different drinking context in the evening, such as from restaurant to bar, or from bar to nightclub. A systematic review of environmental factors related to increased alcohol use and harm, identified that crowding was an important aspect of the physical environment that was often linked to increased aggression (alongside poor cleanliness, loud music and a focus on dancing), although there was some variation across studies depending on other aspects of the environment in venues, such as permissive (i.e. 'anything goes') atmosphere (Hughes et al., 2011). These observations were later supported by other studies which found that having a dance floor, fewer chairs and floor plans promoting crowding were physical characteristics of venues linked to alcohol-related problems (Graham, Bernards, Osgood, & Wells, 2012; Carlini et al., 2014).

One way that consumers' comfort may be improved is by facilitating greater enjoyment of the physical environment in which drinking occurs (Homel & Tomsen, 1993), such as

providing a place to rest a glass between sips. As such, increasing the availability of seating spaces and tables in bars may promote reduced alcohol consumption. Health and safety guidelines already highlight the need to provide sufficient seating spaces in licensed premises as part of a layout to mitigate violence (Health and Safety Executive, 2018). Nonetheless, there are currently no known laboratory studies which aimed to measure the effects of such implementation.

Present study

Due to the lack of previous research to reliably base the sample size calculation on, a pilot study instead of a larger randomised controlled trial (RCT) was conducted. It aimed to inform the design of a full-scale RCT to estimate the impact of drinking position on the rate of alcohol consumption and to determine whether it is moderated by the presence of a table. This was examined by manipulating drinking position (sitting vs standing) and availability of a table (present vs absent), and randomly assigning pairs of participants to one of the four resulting conditions.

There were two primary objectives to the study. The first one was to guide the choice of sample size for a future study by estimating the standard deviation (SD) of the primary outcome measure (i.e. total drinking time). The second one was to measure the similarity of participants within a pair to assess whether the scales used were prone to measurement error, such as drinking time of one participant within a pair being affected by the drinking time of their study partner. Its secondary objectives were to assess the feasibility of the study and its fidelity to protocol.

Methods

Participants

Pairs of participants were enlisted from the staff and students at the University of Bristol, as well as the general population, via existing email lists, group websites, poster, and flyer advertisements, and by word of mouth. Each pair consisted of two individuals who knew each other, met the inclusion criteria, and came to the testing session together. Participants' eligibility was determined using the following criteria:

Inclusion criteria

- Aged 18 years or over;
- Regular alcohol consumer (i.e. drinks alcohol at least once a week);
- Likes lager;
- Attends the study in a pair with someone they know;
- Has a breath alcohol reading score of 0 before the study session;
- English as a first language or equivalent level of fluency.

Exclusion criteria

- Self-reported personal history of alcoholism;
- Regularly consumes more than 35 units of alcohol* per week;
- Pregnant or breastfeeding (self-report, but all female participants are offered a urine-based pregnancy test if there is any doubt).

* One unit equals one 25 ml single measure of spirit (ABV 40%), or a third of a pint of beer (ABV 5-6%) or half a standard (175 ml) glass of red wine (ABV 12%).

Ethics approval was obtained from the School of Psychological Science Research Ethics Committee at the University of Bristol (ethics approval code: 31101994945).

In total, 48 pairs of regular social alcohol drinkers (i.e. those who consume alcohol at least once per week) were planned to be recruited. Due to the absence of prior information to base a sample size on, this sample size was selected following the guideline recommending to recruit '12 per group' (Julious, 2005). With 95% confidence, estimates of the standard deviation were likely to range from underestimating by 17% to overestimating it by 25%. This sample size would also allow to estimate a true retention rate of 80% to within 12% of its true value, with 95% confidence. However, as the study was discontinued due to the COVID-19 pandemic, recruitment and testing occurred between the 21st of January and the 17th of March 2020, and data from only 23 pairs was collected. On study completion, each participant within a pair received £7.00 as reimbursement.

Study design

This experiment used a 2 x 2 factorial study design, with between-subjects factors of drinking position (sitting, standing) and availability of a table (present, absent). Participants attended sessions in pairs, and pairs were randomly assigned to one of four conditions (i. sitting with a table, ii. sitting without a table, iii. standing with a table, iv. standing without a table; Table 1). Both members of a pair were assigned to the same condition. The study protocol and

analysis plan were pre-registered on the Open Science Framework: https://osf.io/wx246/?view_only=4e77fb0db5e84815b918f7663b9eea6b.

Table 1. *Four drinking conditions.*

		Drinking position	
		Standing	**Sitting**
Table	**Absent**	Standing without a table	Sitting without a table
	Present	Standing with a table	Sitting with a table

Interventions

Availability of seating and tables

Each drinking session took place in a space that either had seating for two people or no seating, and either a table or no table, depending on what condition participants were randomised to. Participants were asked to sit or stand accordingly, and to remain in that position for the duration of the session. To avoid bringing undue attention to this requirement, participants were told that this was necessary due to the positioning on the camera. All other surfaces were removed, and participants were asked not to place their glass on the floor, claiming that this would not comply with the University Health and Safety guidance.

Measures

Primary outcome measure

Total drinking time in minutes (330ml lager) for each individual participant

Participant pairs were videoed while drinking. The video was coded to identify initiation of the first sip and completion of the last sip to extract data on total drinking time (in minutes) for each participant.

Secondary outcome measures

Feasibility

Feasibility of recruiting and retaining eligible participants was measured by recording recruitment rates, retention rates, and the number of incomplete pairs who were unable to take part in the study (i.e. the second person in the pair did not attend the study).

Fidelity to protocol

Fidelity of the study protocol was measured by reporting descriptive statistics for the number of protocol breaches recorded by the coordinating researcher:

1. If a participant is randomised to a 'standing' study arm and sits down.
2. If a participant is randomised to a 'sitting' study arm and stands up.
3. If a participant is randomised to a 'table absent' study arm but uses another surface to rest their drink on.
4. If a participant is randomised to a 'table present' study arm but holds their drink and does not use a table to rest the drink on.
5. If it is not possible to record the first or last sip based on the position of a participant.

This information was coded after the study, using camera footage, by an independent researcher who was blind to the aim of the study. A second researcher did a reliability check for 10% of the recordings.

Additional measures

Screening and demographics

Age, sex and highest qualification attained were recorded (ONS, 2015). The following options were provided to measure participants' educational attainment:

- Higher Education or professional / vocational equivalents;
- A levels or vocational level 3 or equivalents (i.e. secondary education typically taken at the age of 16-18, prerequisite for university);
- GCSE / O Level grade A*-C or vocational level 2 or equivalents (i.e. subject-specific qualifications in the UK that are typically completed over 3 years towards the end of secondary school education, prerequisite for A levels);
- Qualifications at level 1 and below;
- Other qualifications: level unknown;
- No qualifications.

Drinking behaviour risk

The Alcohol Use Disorders Identification Test (AUDIT) (Bohn, Babor, & Kranzler, 1995) consists of 10 questions assessing the level of risk associated with participants' drinking behaviour. The total score ranges from 0 to 40, with the following categories: 0-7 (low risk), 8-15 (increasing risk), 16-19 (higher risk), and 20+ (possible dependence).

Alcohol Urge Questionnaire (AUQ)

The AUQ (Bohn, Krahn, & Staehler, 1995) is an eight-item measure to assess current urge to consume an alcoholic drink to assess whether any differences in drinking rate are influenced by differences in initial urge to drink. Each question is scored using a 7-point ordinal scale from 'Strongly disagree' (1) to 'Strongly agree' (7).

Relationship closeness

The following questions measured the closeness of the relationship between participants:

- How long have you known the other person that is participating in the study with you?
- In what capacity (e.g. friend, colleague) do you know the other person that is participating in the study with you?
- The other person I am participating with is a friend of mine (Strongly Disagree, Somewhat disagree, Unsure, Somewhat agree, Strongly agree);
- I know the other person I am participating with well (Strongly Disagree, Somewhat disagree, Unsure, Somewhat agree, Strongly agree);
- I spend quite a lot of time with the other person I am participating with (Strongly Disagree, Somewhat disagree, Unsure, Somewhat agree, Strongly agree);
- I would say I was similar to the person I am participating with (Strongly Disagree, Somewhat disagree, Unsure, Somewhat agree, Strongly agree).

The last four questions were combined to give a mean score of 'relationship closeness' on a scale of 1 (not close) to 5 (very close).

Drink enjoyment

Five questions (order randomised) measured liking and choice, using visual analogue scales (VAS) 0-100, from 'not at all' to 'extremely':

- How tasty was the drink? (LIKING)
- How enjoyable was the drink? (LIKING)
- How pleasant was the drink? (LIKING)
- How refreshing was the drink? (LIKING)
- How likely would you be to buy the drink? (CHOICE)

These five questions were averaged to give a total drink enjoyment score of 0 (most negative) to 100 (most positive) for each participant.

Overall experience

Six questions (order randomised) measured drinking experience, based on the previous study by Troy and colleagues (2017), and one question measured quality of conversation, using visual analogue scales (VAS) 0-100, from 'not at all' to 'extremely':

- How energetic did you feel during the drinking session?
- How happy did you feel during the drinking session?
- How comfortable did you feel during the drinking session?
- How anxious did you feel during the drinking session?
- How irritable did you feel during the drinking session?
- How depressed did you feel during the drinking session?
- How interesting was your conversation during the drinking session?

The first three questions were averaged to give a total 'positive experience' score, the second three questions were averaged to give a total 'negative experience' score, and the final question was a 'conversation' score, each of which ranged from 0 (low) to 100 (high).

Number of times glass placed on a surface

The videos were also coded to identify the number of times each participant placed their glass on: i) the table when available, or ii) another surface (other than their own hand), to determine whether the table is used when present and whether any other surfaces are used (e.g. participant's lap, armrest, floor).

Manipulation check

At the end of the study session, participants were asked the following question to determine whether they identified the true nature of the study: 'What do you think the purpose of this study was?'

Open text: impact of standing vs sitting

After submitting responses to all other questions, participants were given a brief description of the study aims and asked to give their opinion on whether the availability of seating or tables would impact their own and other people's drinking behaviour, using an open-text response.

Procedure

Participants' basic eligibility was confirmed using a pre-screening questionnaire, after which a study session was arranged. Participant pairs were randomised into one of four experimental conditions, and a member of the research team set up the testing space accordingly prior to their arrival.

Participants attended said sessions in pairs with someone they knew. They were told that the purpose of the study was to examine the impact of alcohol on sociability and that sessions were video recorded to capture their conversation. At the start of the study session, participants were given the information sheet, asked to give written informed consent, and were further screened for alcohol abstinence and pregnancy. Once the eligibility was confirmed, they completed the demographic, pair relationship information and AUQ questionnaires, on a mobile tablet device. Participants were given the option to drink a small glass of water (approximately 150 ml) before the session to reduce between-subjects differences in baseline thirst.

Participants were taken to the drinking site where they were placed diagonally opposite each other to provide a comfortable position for the conversation while allowing the video recorder to capture their drinking behaviour. They were asked to finish the drink at their own pace and were given optional conversation starters (e.g. 'Tell me about your last holiday'), which were attached to the wall to avoid participants' use of their hands for anything other than holding the drink.

The researcher then turned the video-recorder on, gave participants their drinks, and asked them to start their conversation. Video recording was stopped once either both participants within a pair finished their drinks, or after 30 minutes (whichever was sooner).

The participants were asked to complete questions on drink enjoyment, overall experience, the AUQ, the AUDIT, the study purpose, and their perspective on the impact of available seating and tables on drinking behaviour, on a mobile tablet. Participants were then fully

debriefed, asked to give final consent and reimbursed for their time. Study sessions took up to 60 minutes to complete.

Statistical plan

Reliability check

When the reliability check on 10% of data was performed, the error rate was less than 1% for all the data points but one where the output differed drastically from what was recorded by the second researcher. As such, the reliability check of additional 10% of the data was performed. It was determined that the full data check was not required due to the imprecise instructions that left too much subjectivity for the measurement being recorded (i.e. the number of times a drink was placed on any surface besides a table).

Descriptive statistics

A CONSORT flow chart showed numbers of individuals assessed for eligibility, recruited, randomised, unable to participate due to the second person in the pair not attending the study and who completed the study.

A table presented demographic data, outcome data and additional measures in the four study arms: means and SDs were shown for continuous variables, with numbers and percentages within each category of nominal or ordered categorical variables.

Primary objectives

Once the descriptive statistics had been provided, the primary outcome (total drinking time in minutes) was assessed for normality using normality plots and statistical tests (Kolmogorov-Smirnov and Shapiro-Wilk). If normality was violated, the bootstrap method with bias correction would be used to calculate results of the primary objectives.

The pooled SD, for all four study arms, of the primary outcome (total drinking time in minutes) was reported alongside the 95% confidence intervals (CI) of the pooled SD. The obtained parameters would guide the choice of sample size for a future study. The pooled SD was also recalculated after the exclusion of the outcome variables which differed from the mean by more than 3 SDs.

Intra pair correlation was calculated (i.e. correlation of drinking time between individuals within a pair) using a reliability analysis via a one-way analysis of variance (ANOVA).

Secondary objectives

Feasibility measures (i.e. recruitment rates, retention rates, and the number of incomplete pairs who were unable to take part in the study) were reported using descriptive statistics and this was used to assess progression to a full trial.

Fidelity measures (i.e. the numbers of protocol breaches) were reported using descriptive statistics.

Sensitivity analysis

The first sensitivity analysis repeated the above primary analysis without participants who correctly identified the true nature of the study. A further sensitivity analysis repeated the primary analysis but excluded any individual who: i) did not place their glass on the table in the conditions where one was available, or ii) placed their glass on another surface than a table provided by the research team at any point during the study.

Qualitative analysis

Themes from the open-text explanations regarding perspectives on the availability of seating and tables were to be identified by applying thematic analysis (Braun & Clarke, 2006). Initial codes were to be extracted from participant responses, such as words or short phrases describing key elements and their potential interpretations. A list of codes with brief explanations would be kept, similar codes would be combined, and initial themes would be established based on groups of codes. These themes would then be checked and refined by examining the relevant text in each theme and creating distinct names and definitions for different themes. However, this part of the analysis plan could not be executed due to time constraints.

Results

Descriptive statistics

The CONSORT flow chart (Figure 1) provides information on different stages of participant testing, with *n* referring to the number of pairs and not the number of participants. There were 46 individuals forming 23 pairs who attended the session, were randomised to one of the four conditions (Table 1) and completed the study. On average, they were 22 years old (SD = 3.9, range 18-34) and had the AUDIT score of 10 (SD = 4.3, range 3-20). Slightly more than half

of participants were males (n = 25, 54%), and almost all had completed either A levels (54%) or higher education (41%) as their highest educational attainment. As shown on Table 2, there was no difference in participants' demographic information and scores between conditions. Drinking time was slightly shorter in conditions without a table compared to those with one. However, no changes in drinking time were observed as a result of seating space manipulation. There was also no major difference in their AUQ scores before and after drink consumption.

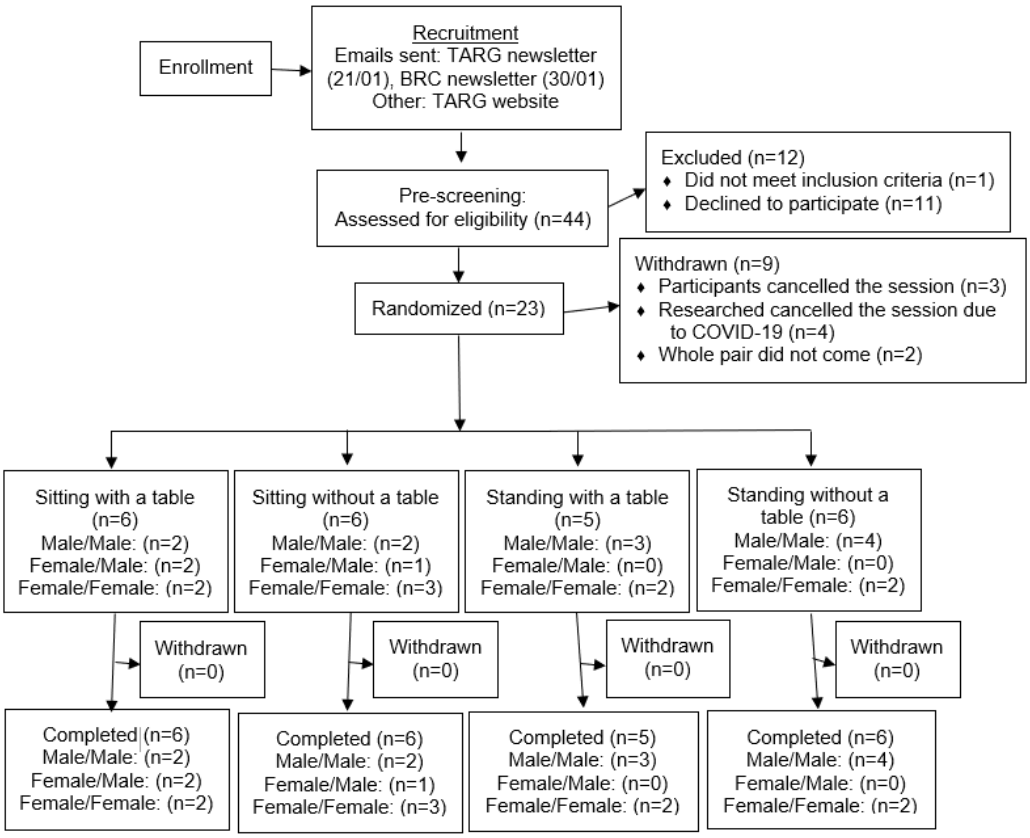

Figure 1. *CONSORT Flow Diagram for Study 1*

Table 2. *Demographic information and questionnaire scores between the four conditions*

	Sitting without a table (n = 12)	Sitting with a table (n = 12)	Standing without a table (n = 12)	Standing with a table (n = 10)
Age (M, SD)	22.0 (3.3)	22.4 (5.4)	21.3 (3.7)	22.3 (2.7)
Gender (n, %)				

Female	7 (58%)	6 (50%)	4 (33%)	4 (40%)
Male	5 (42%)	6 (50%)	8 (67%)	6 (60%)
Education (n, %)				
A levels or vocational level 3 or equivalents	8 (67%)	5 (42%)	9 (75%)	3 (30%)
Higher Education or professional / vocational equivalents	4 (33%)	5 (42%)	3 (25%)	7 (70%)
Other qualifications: level unknown	0 (0%)	2 (17%)	0 (0%)	0 (0%)
Drinking time in minutes (Mean, SD)	14.4 (5.9)	17.0 (10.3)	16.7 (8.6)	17.0 (6.1)
Number of times drink placed on a table (Mean, SD)	0.0 (0.0)	17.4 (7.9)	0.0 (0.0)	18.6 (5.5)
Number of times drink placed on another surface (Mean, SD)	15.2 (13.8)	0.0 (0.0)	7.0 (11.5)	0.0 (0.0)
Questionnaire score (Mean, SD)				
AUDIT	9.8 (5.4)	11.8 (4.3)	10.2 (3.6)	9.1 (3.7)
Initial AUQ	3.2 (1.2)	3.3 (0.7)	2.5 (0.9)	3.0 (0.9)
Final AUQ	3.1 (1.3)	3.1 (1.1)	2.9 (1.1)	3.3 (0.8)
Closeness	4.6 (0.5)	4.8 (0.2)	4.7 (0.2)	4.8 (0.3)
Enjoyment	71.5 (13.8)	61.1 (16.8)	67.2 (8.6)	62.2 (21.2)
Positive experience	49.1 (12.3)	46.9 (9.8)	53.1 (7.3)	51.0 (5.7)
Negative experience	29.4 (3.2)	30.4 (6.7)	27.3 (7.3)	29.8 (4.5)
Conversation	74.3 (15.4)	80.0 (15.3)	81.0 (17.8)	77.0 (12.2)

Primary outcomes

Distribution of the total drinking times was assessed for normality using Shapiro-Wilk statistical tests and normality plots. As there was a strong departure from normality (p = .002), pooled standard deviation, F-value and 95% confidence intervals were calculated using the bootstrap method with bias correction.

The initial pooled standard deviation for all four conditions was 7.7, which became 7.6 (95% CI 5.8, 9.4) after the application of the bootstrapping, indicating that if the distribution was

normal, all data points would be spread close to the mean. After the exclusion of two outliers, the calculation was repeated and yielded the bootstrapped pooled standard deviation of 6.3 (95% CI 5.1, 7.4).

The intra pair correlation was calculated using a bootstrapped one-way ANOVA, which resulted in the F-value of -0.005 with the bootstrapped 95% confidence intervals of -0.02 and 0.00.

Secondary outcomes

There were 44 individuals who underwent pre-screening in the period from the 21st of January to the 17th of March 2020 (at which point COVID-19 restrictions prevented any further testing), and one was excluded because they did not meet all the criteria. Out of the remaining 43 participants, 32 booked the time slot for the testing session that they could attend with their study partner. As such, the recruitment rate was 72%. Out of those, 3 sessions were cancelled by participants, 4 were cancelled by the researcher due to COVID-19, and 2 due to the absence of both participants. This produced the retention rate of 72%. There were no instances of incomplete pairs of participants attending the study session.

Out of the five predetermined fidelity measures, there was only one with observed protocol breaches as participants in the 'table absent' conditions were using other surfaces to rest their drink on. The mean number of breaches was 0.75 (SD = 0.45) for seated participants and 0.50 (SD = 0.52) for standing participants.

Two sensitivity analyses were performed which excluded participants who: i. identified the true nature of the study (n = 1), ii. did not place their glass on the table where available (n = 0) or placed it on another surface if the table was absent (n = 15). However, the updated calculations produced results similar to the original analysis (see Appendix 1).

Discussion

This pilot study was conducted to inform the design of a future full trial which would examine the influence of drinking position and the presence of a table on the rate of alcohol consumption.

Sample size is typically calculated using power to detect an effect of a certain size while correctly rejecting the null hypothesis (Gelman & Carlin, 2014). However, one of the main

problems with this approach is that said effect size is often based on preliminary data which is likely to be misleading due to small samples. Even if the sample is sufficient to have enough power, the obtained effect may not accurately represent the population value if its confidence interval is too wide (Kelley, Maxwell, & Rausch, 2003). The alternative is thus to ensure that the resulting effect has a narrow enough confidence interval to valuable insights into the parameter of interest. This can be achieved through the use of precision which takes the width of the confidence interval into account when calculating sample size (Cumming & Calin-Jageman, 2016). Based on the 95% confidence intervals observed after the exclusion of outliers, the overall of 224 participants (i.e. 112 pairs) would need to be recruited in a full-scale study to obtain estimates for the effects of drinking position and the presence of a table on alcohol consumption with the 37% margin of error.

The similarity of participants within a pair was measured to assess whether the scales used were prone to measurement error (i.e. if drinking time of one participant within a pair affected the other one). One of the obtained confidence intervals had a negative value, suggesting a possibility of a negative correlation between the drinking times within pairs (e.g. as one person in a pair increases their drinking time, the other person tends to decrease their drinking time). However, as the reliability analysis found no such correlation, it can be concluded that this measured outcome was not prone to variation in human judgement.

Protocol breaches were only observed for one fidelity measure, as participants in the ‘table absent’ conditions were using other surfaces to rest their drink on. This protocol breach suggests that in the absence of a table, people might compensate for it by using other surfaces, such as their legs. However, it was difficult to measure the exact instances of this behaviour due to how data was collected and subsequently coded. In the future, it is vital to produce more in-depth instructions which would include what does and does not count as a separate incident of resting a glass on a surface. For example, every time the bottom of the glass is fully removed from the surface to subsequently be placed on some surface (i.e. including the same one) should be counted as 1.

During the data collection stage of the study, some additional challenges were identified. First, prior to every testing session, the researcher set up the testing space accordingly by separating it from the rest of the cafe and removing other surfaces where a glass could be placed. This required some level of physical strength as both the barrier and the cafeteria furniture were difficult to lift. However, the risks of manually moving heavy objects were not

originally considered in the protocol. For the future study, this issue should be addressed, and the alternatives should be offered which would minimise the harm to the researcher. One way this could be achieved is by ensuring that all the necessary equipment is light enough not to pose a considerable physical challenge to the researcher. It might also be practical to delegate setup responsibilities to an individual with sufficient physical prowess. Regardless, creating a detailed action plan in case an injury is sustained (e.g. a strained muscle) is crucial to mitigating the risks associated with physical activity.

Additionally, only a very limited number of sessions could be held per day due to time constraints. All of them had to be scheduled in the afternoon due to ethical constraints, which created an interval of 6 hours, since the building closed at 18:00. Limiting the time frame for potential testing even further, any two sessions could not be scheduled close to each other, as the next pair of participants were likely to observe the rearrangement of furniture and get an insight into the true purpose of the study. This problem can be solved by finding a location with longer opening hours in the evening, which would allow for testing outside the standard working hours and increase the overall rate of data collection.

Beyond that, all testing equipment was stored in the pantry of the department's common room which posed additional logistical challenges. Since the room itself was used for meetings, lectures, and other events on a regular basis, it was frequently inaccessible. Thus, testing times had to be arranged in accordance with the room's schedule and were limited to when the researcher was allowed in to first collect and then store the equipment. Since the systematic inability to access the equipment further impaired the speed with which data was collected, this is important to consider when planning the transition to a full-scale trial. Finding a testing site with the dedicated storage space or other options of keeping the equipment accessible at all times might ensure that avoidable outside factors do not impede the data collection process. As the full-scale study would require 224 participants based on precision calculations, it may also be beneficial to explore alternative testing sites, such as actual drinking establishments, and directly manipulate their physical environment to test future hypotheses.

Conclusion

In conclusion, it has been demonstrated that, with detailed planning, a full-scale study of this nature is plausible. However, certain issues within the protocol, such as inefficient study setup, short testing times and insufficiently clear guidelines for data coding, need to be

addressed prior to progression to a definitive trial. Proposed solutions to the aforementioned issues will inform the design of future naturalistic studies, as this type of choice architecture intervention holds the potential to contribute to the reduction of excessive alcohol consumption at the population level.

COVID-19 disclaimer

These limitations were intended to be addressed in the next study which would further explore the ideas raised in this feasibility study and empirically assess how drinking position and the presence of a table impacted the rate of alcohol consumption. However, it was no longer possible to conduct this study in a realistic setting due to the outbreak of COVID-19, causing amendments to the initial design. Further research into the effects of this intervention was discontinued as there was no reliable way to manipulate seating positions in an online setting. Instead, another study was created that evaluated the effects of a type of choice architecture intervention which could be measured online.

CHAPTER 3: THE IMPACT OF ALCOHOL-FREE DRINK AVAILABILITY AND CALORIE INFORMATION ON DRINK SELECTION: AN ONLINE STUDY

Introduction

Alcohol-free availability

Based on the TIPPME typology (Hollands et al., 2017), availability interventions are intended to alter the number of instances of a product, and they can be categorised into those that alter the overall number of a product (i.e. absolute availability), their proportion (i.e. relative availability), or both simultaneously. It has been suggested that increasing the availability of healthier products may facilitate healthier consumption (Allan, Querstret, Banas, & de Bruin, 2017). For example, a systematic review of nutrition intervention studies discovered that increasing the availability of healthy food options in vending machines led to their amplified selection (Grech & Allman-Farinelli, 2015). In addition, a recent online study indicated that individuals were more likely to select a healthier snack when the selection of them was more abundant (Pechey & Marteau, 2018). A Cochrane review also found that altering the availability of targeted food products can reduce their selection and consumption (Hollands, et al., 2019), albeit with evidence being limited in both quality and quantity.

In terms of alcohol, no suitable studies were identified in either the aforementioned Cochrane review (Hollands, et al., 2019), or a recent search update (Marteau, Hollands, Pechey, Reynolds, & Jebb, 2022). One known study (Blackwell, et al., 2020) assessed the effectiveness of availability interventions in the area of alcohol consumption, but it was not included in the meta-analysis by Marteau and colleagues (2022) due to the lack of data on participants' socioeconomic status. Its results indicated that increasing the proportion of alcohol-free drinks compared to alcoholic drinks led to increased selection of the former. Since then, another study observed similar results in a simulated online supermarket (Clarke, et al., 2023). As such, it can be suggested that reducing relative availability of alcoholic drinks has the potential to encourage the selection of alcohol-free alternatives and to decrease the overall alcohol consumption. Nonetheless, further research is needed to provide more confidence in the presence of the observed effect of availability and to draw more generalisable conclusions.

Calorie information

In the UK, all restaurants and cafes with over 250 employees are now required to include calorie information to their menus (Department of Health & Social Care, 2021). Nonetheless, alcohol drinks above 1.2% ABV are excluded from the aforementioned legislation despite alcohol being known to contain almost as many calories a gram as pure fat (NHS, 2020). The majority of adults either underreport or are unaware of how energy dense alcohol is (Royal Society for Public Health, 2014), even though it constitutes approximately 10% of calorie intake (Shelton and Knott, 2014). As alcoholic drinks tend to contain higher amounts of calories than their alcohol-free equivalents, another strategy to facilitate healthier choices may be the provision of calorie information.

Research on the effects of calorie labelling on alcohol is scarce, with the majority of studies concluding that labelling did not affect drinking behaviour (e.g. Maynard, Blackwell, et al., 2018; Maynard, Langfield, et al., 2018). This may be caused by a lack of studies which measured actual purchasing behaviour or were conducted in real-world settings (Robinson, Humphreys, & Jones, 2021). When it comes to food consumption, a Cochrane review (Crockett et al., 2018) identified that labels with calorie information adjacent to products have the potential to reduce how many calories people purchase and/or consume. Further, Cawley, Susskind and Willage (2020) recently found that menu labelling led to the reduction of calories ordered by 3% when the study was conducted in a sit-down, full-service restaurant rather than a fast-food chain. Due to the energy density of alcoholic drinks, it can be suggested that providing people with accurate information about calories may contribute to the selection of lower/non-alcoholic alternatives over alcoholic drinks.

Gamification

The Internet is a convenient means of reaching large numbers of people, which is particularly advantageous to researchers, as it allows for efficient data collection at a relatively low cost (Griffiths, Lindenmeyer, Powell, Lowe, & Thorogood, 2006). Nonetheless, such a format can only be effective as long as users find it engaging in the short and/or long term, and studies rarely succeed at creating suitable tasks. Instead, it is common for the implemented tasks to be perceived as boring and repetitive, thus hindering participants' ability to sustain their attention (DeRight & Jorgensen, 2015). This is especially problematic for online studies where participants can withdraw by simply exiting the website if they do not feel motivated

to continue (Eysenbach, 2005). Such high dropout rates in online studies highlight the need to explore the concept of engagement and existing ways of maintaining it.

Engagement can be defined as an emotional investment in participating and completing certain activities (Skinner & Belmont, 1993). While some online services concentrate on sustaining an individual's engagement once to encourage their completion of an online survey (Huotari & Hamari, 2012), others aim to maintain it over time for the purposes of behavioural interventions or online educational courses (Allam, Kostova, Nakamoto, & Schulz, 2015). Alternatively, the interest may lie in the quality of user engagement instead of its duration. For example, the main focus of Huotari and Hamari's study (2012) was on increasing the quality of answers in online surveys while Vaibhav and Gupta (2014) attempted to improve academic performance in online courses. As such, the precise definition of online engagement depends on the context and purpose it is intended to serve. It has, however, been noted by Schlechty (2001) that it is more beneficial to define it through the enthusiasm and diligence with which a task is performed rather than time spent on it.

Psychological studies regularly recruit student participants. Between 1975 and 1995 alone, more than 1,100 lab-based studies were conducted on undergraduate students (Gallander, Wintre, North, & Sugar, 2001), indicating that utilisation of such samples has been a common practice for a long time. However, obtaining accurate results depends on the engagement of this cohort in tasks at hand. The lack of participant motivation to perform at the best of their abilities has been shown to cause reduced intervention effects and overall lower quality data (DeRight and Jorgensen, 2015). As conclusions are often drawn based on the expectation that participants have exerted their best effort (Kirkwood, Kirk, Blaha, & Wilson, 2010), it becomes crucial to confirm the validity of this assumption.

There are many reasons why an individual might fail to comply with the requirements of a task, such as intentional poor performance for external gain, lack of effort to follow instructions, and boredom (Donders, 2005; Green & Merten, 2013). It has been noted by DeRight and Jorgensen (2015) that students rarely have an external incentive to underperform on a study, suggesting that they might disregard the quality of their performance and prioritise completing said study quicker to receive research credit. Hence, noncompliance and boredom become more prominent explanations for underperformance in student participants.

According to Eastwood and colleagues (2012), boredom appears when certain conditions are met. The first one is an individual's inability to engage their attention in a satisfying activity.

The second one is a said individual's unawareness of their personal lack of engagement. Third, the individual should attribute their lack of engagement to this activity. Once these conditions are met, individuals experience effects typically associated with boredom, such as executive function failure and difficulty concentrating. In line with this assumption, it has been shown that participants report being bored when they struggle to sustain their attention on a monotonous task and attribute that difficulty to the task at hand (Damrad-Frye & Laird, 1989; Fisher, 1998; Hunter & Eastwood, 2016). On the other hand, individuals tend to successfully maintain their involvement in an activity if they find it enjoyable and/or rewarding (Nakamura & Csikszentmihalyi, 2003). As such, increasing the enjoyability of the task might be one way to improve participants' engagement with it.

Increased engagement could be achieved through the use of gamification, which has been broadly defined as the application of game design elements (e.g. competition, graphics, narrative) in a non-game environment or context (Attali & Arieli-Attali, 2015; Dale, 2014). The use of gamified cognitive tasks has been previously linked to increased enjoyment and engagement (Hamari, Koivisto, & Sarsa, 2014). Further, a recent systematic review found that if gamification is carefully applied, cognitive tasks become more engaging without negatively affecting their scientific value (Lumsden, Edwards, Lawrence, Coyle, & Munafò, 2016). As such, incorporating game-like features may improve both participant engagement and data quality without undermining the scientific validity of a task.

Present study

The study assessed the impact of altering the proportion of alcohol-free and alcoholic drinks, and the availability of calorie information for both types of drinks, on the selection of an alcohol-free drink (vs an alcoholic drink), under controlled conditions in a gamified simulation of a bar experience or non-gamified control task. The results of this study would inform future laboratory and field studies in the area and online study methodology more generally.

The primary aim of this study was to assess how altering the relative availability (proportion) of alcohol-free drinks compared to alcoholic drinks and the provision of calorie information affected drink selection. Based on similar studies previously conducted (e.g. Blackwell, et al., 2020), it was hypothesised that increasing the relative availability of alcohol-free drinks would increase the likelihood of selecting an alcohol-free drink compared to an alcoholic drink. Further, since alcohol-free drinks should contain less calories than their alcoholic

counterparts (Shelton and Knott, 2014), the provision of calorie information on the menu should increase the likelihood of selecting an alcohol-free drink compared to an alcoholic drink.

The secondary aim was to examine the impact of gamifying the main task on participants' engagement with an online study. Thus, the hypothesis was formulated that participants' degree of engagement would be higher for those receiving a gamified task than those with a non-gamified control task.

Methods

Participants

Participants (n = 1,412) were recruited using the Prolific online crowdsourcing platform, and the study was advertised exclusively to individuals who met the following inclusion criteria:

- Aged 18 years or over;
- Lives in the UK;
- Regular alcohol consumer (i.e. drinks alcohol at least once a week).

Each participant completed the study within 10 minutes and was reimbursed £1.00. Ethics approval has been obtained from the Faculty of Science Research Ethics Committee at the University of Bristol (ethics approval code: 107442).

The sample size calculation was completed using G*Power, for a logistic regression model, with beta of 0.2 (i.e. a power of 0.8) and alpha of 0.01. An odds ratio and a reference probability were based on the data from increased alcoholic and increased non-alcoholic conditions in Blackwell, et al. (2020), as these conditions resembled low alcohol-free availability and high alcohol-free availability conditions in the current study. Since information about the effects of calorie labelling on alcohol selection is limited, the effects of the provision of calorie information were estimated to be half as effective as increased alcohol-free availability. Thus, the difference from the experimental probability compared to the reference from Blackwell, et al. (2020) was halved, resulting in a probability of 0.38 in the experimental group. With a binomial distribution and balanced groups, this resulted in a conservative odds ratio of 1.74, indicating a sample size of 710 for a two-group comparison

(i.e. 355 per group). Since the primary aim was split into two parts, the sample size of 1420 for 4 groups was required.

Study design

This experiment used a 2 x 2 x 2 factorial study design, with between-subjects factors of alcohol-free drink availability (high, low), calorie information (present, absent), and task type (gamified, control). Participants were randomly assigned to one of eight conditions shown in Table 3 via the Qualtrics online survey platform on which the study was hosted. The study protocol and analysis plan were pre-registered here: https://osf.io/5tfzb/?view_only=56df7377df6142c1b1488d01b370ba09.

Table 3. *Eight conditions in the selection task*

		Alcohol-free availability			
		Low (25%)		**High (75%)**	
		Control	**Gamification**	**Control**	**Gamification**
Calorie information	**Absent**	Low proportion of alcohol-free drinks, calorie information absent, control task	Low proportion of alcohol-free drinks, calorie information absent, gamified task	High proportion of alcohol-free drinks, calorie information absent, control task	High proportion of alcohol-free drinks, calorie information absent, gamified task
	Present	Low proportion of alcohol-free drinks, calorie information present, control task	Low proportion of alcohol-free drinks, calorie information present, gamified task	High proportion of alcohol-free drinks, calorie information present, control task	High proportion of alcohol-free drinks, calorie information present, gamified task

Interventions

Relative alcohol-free drink availability and calorie information

Within their randomised condition, each participant was asked to select one drink that they would like to consume. A virtual drinks menu displayed either high alcohol-free drink availability – consisting predominantly of (75%) alcohol-free drinks compared to alcoholic drinks (25%) – or low alcohol-free drink availability – consisting predominantly of (75%) alcoholic drinks compared to alcohol-free drinks (25%). In addition, the drinks menu either contained calorie information or not, depending on a participant's randomisation allocation.

In all conditions, the virtual drinks menu displayed 16 drink options, including both alcoholic and alcohol-free drinks. Beer and cider brands were chosen based on whether they produced alcohol-free alternatives to their alcoholic drinks. Alcohol-free alternatives to wines and spirits were matched with alcoholic options based on drink type. In the high alcohol-free condition, the ratio of alcohol-free drinks to alcoholic drinks was 3:1, with three different alcohol-free brand options for each type of drink (i.e. alcohol-free beer, cider, wine and spirit) and one alcoholic brand option for each type of drink. In the low alcohol-free condition, the ratio of alcohol-free drinks to alcoholic drinks was 1:3, with one alcohol-free brand option for each type of drink and three different alcoholic brand options for each type of drink. In all conditions, a virtual drinks menu also included names of brands, short descriptions (e.g. white wine), alcohol by volume (ABV) and approximate volume (e.g. pint). All four virtual drinks menus (i.e. each corresponding to one of the conditions) created for the experiment can be found in Appendix 2, with number of calories in each drink added to menus from the 'calorie information present' conditions.

Gamification

Within their randomised condition, each participant was presented with either a gamified or a non-gamified version of the main task. In a gamified condition, the task was presented in the form of a text-based game (i.e. interactive fiction) simulating a typical bar experience as it has been argued that an interactive story can be highly engaging to those playing it (Dow, 2008). This was achieved through a series of multiple-choice questions (see Appendix 3 for the list of questions specific to the gamified task). Order of response options – but not questions – was randomised. Each answer fed into subsequent questions, with some questions only being present if certain answers were selected beforehand. These multiple-choice questions were only presented in a gamified task and not in the non-gamified control task.

Measures

Primary outcome measure

The primary outcome measure was the proportion of participants selecting an alcohol-free drink over an alcoholic drink.

Subjective engagement

Participants' subjective experience with the task was assessed with five questions (order randomised), using visual analogue scales (VAS) 0-100, from 'not at all' to 'extremely':

1. How much did you enjoy the task?
2. How scientifically important was the task?
3. Would you be willing to participate in this task again?
4. Would you be willing to recommend this task to a friend?
5. How boring did you find the task?

Questions were adapted from the previous literature on assessing motivation and engagement in gamified tasks (Miranda & Palmer, 2014), with the difference of using VAS in the present study. The first and the fifth questions aimed to capture the same underlying construct despite having the opposite directionality. Favourable ratings on the first four questions and the reversed rating on the fifth question served as an indication of participants' subjective engagement.

Objective engagement

Participant's engagement was assessed objectively using the following measures:

1. The length of a free-text explanation of the drink choice (higher number of characters written indicates higher engagement);
2. Response times (milliseconds) in the drink selection task (higher response times indicate higher engagement as participants make their decision more thoroughly);
3. Number of failed answers (across participants in each condition) to the second attention check question (lower number will indicate higher engagement).

The length of a free-text explanation of the drink choice was treated as the primary indication of objective engagement as it was less likely to be affected by factors outside engagement. The other two objective engagement measures were considered supplementary.

Demographics

Each participant was asked to provide their age, biological sex, current residency and highest qualification attained. All participants were asked to choose their residency from the following options: 'England', 'Wales', 'Scotland', 'Northern Ireland', 'Other (please specify)', or 'I do not live in the UK'. There were six available options for the highest

educational attainment obtained from the Office for National Statistics categories (ONS, 2015):

- Higher Education or professional / vocational equivalents;
- A levels or vocational level 3 or equivalents (i.e. secondary education typically taken at the age of 16-18, prerequisite for university);
- GCSE / O Level grade A*-C or vocational level 2 or equivalents (i.e. subject-specific qualifications in the UK that are typically completed over 3 years towards the end of secondary school education, prerequisite for A levels);
- Qualifications at level 1 and below;
- Other qualifications: level unknown;
- No qualifications.

Drinking behaviour risk

The Alcohol Use Disorders Identification Test (AUDIT) (Bohn, Babor, & Kranzler, 1995) consists of 10 questions assessing the level of risk associated with participants' drinking behaviour. The total score ranges from 0 to 40, with the following categories: 0-7 (low risk), 8-15 (increasing risk), 16-19 (higher risk), and 20+ (possible dependence).

Drinking habits

During the study, participants were asked how many units of alcohol they normally consume per week and whether they usually drink in bars/pubs.

Explanation of drink choice

Participants were asked to explain how they decided which drink to choose via an open text response box.

Calorie selection

Number of calories that each participant selected was recorded based on their drink of choice in the selection task.

Manipulation check

At the end of the study, participants were asked the following question via an open-text response box to determine whether they identified the true nature of the study: ‘What do you think the purpose of this study was?’.

Responses were assessed for participants’ correct identification of the following manipulations: alcohol-free availability, provision of calorie information and gamification of the task. For each type of manipulation, numbers of participants who correctly identified it were recorded.

Further, each participant’s response was classified as one of three categories: ‘No awareness’ (no manipulations were identified), ‘Partial awareness’ (one or two manipulations were identified) and ‘Full awareness’ (all three manipulations were identified).

Attention check

Two attention checks were hidden within the study due to concerns about participants’ attention in online settings. The first attention check was presented at the beginning of the study and included the following information: ‘It is important that you pay attention to the study. Please choose 'No' for this question’. Only ‘No’ responses were considered satisfactory.

The second attention check was presented after the main task, as the last question in the subjective engagement questionnaire: ‘It is important that you pay attention to the study. Please rate '100' for this question’ (VAS 0-100). Only ‘100’ responses were considered satisfactory.

Procedure

Participants were recruited through Prolific online crowdsourcing platform and were provided a link to the Qualtrics platform where the study was held. Participants were shown an information screen explaining the study and what was required from them and were asked to complete a tick-box consent form. After completing the demographic questionnaire, they were randomly but evenly assigned to one of the eight conditions.

Participants assigned to a gamified task answered a series of multiple-choice questions to set the scene for their typical bar attendance experience. Among these questions, they were presented with a virtual drinks menu and asked to choose a drink they would like to have from the selection of alcoholic and alcohol-free drinks. Participants in a non-gamified control task were instead asked to simply imagine being in a bar and were forwarded to a drink selection task straight away. After selecting a drink, participants were asked to explain the reasoning behind their choice.

At the end of the study, participants answered questions about their typical drinking behaviour and task enjoyment and were asked to identify the purpose of the study. Once the study was completed, they were presented with a debriefing screen which informed them how to find more information and to contact the study team.

Statistical plan

Descriptive statistics

A CONSORT flow chart was constructed to show numbers of individuals assessed for eligibility, recruited, randomised and who completed the study.

A table demonstrated demographic information, AUDIT scores and outcome data between the eight study arms, with means and SDs for continuous variables, and with numbers and percentages for nominal or ordered categorical variables.

A separate table demonstrated percentages of participants who chose each of the options in the drinks menus between the four study arms. All options were listed in the table in the order they were presented to participants.

Primary outcome

For the primary analysis, data collected from both types of tasks (gamified and non-gamified control) was combined. The odds of selecting an alcohol-free drink (vs. an alcoholic drink), were calculated. This was done using a logistic regression model utilising a 2 (high alcohol-free availability vs. low alcohol-free availability) x 2 (calorie information present vs. calorie information absent) design.

The initial model only included the main effects of high vs. low alcohol-free availability and present vs. absent calorie information, respectively. Each main effect was reported as an odds ratio (OR) with 95% CI, along with an associated p-value. Possible interaction effects of

alcohol-free availability (high vs. low) and calorie information (present vs. absent) were explored.

Secondary outcomes

All continuous outcomes were assessed for normality using normality plots and statistical tests (Kolmogorov-Smirnov and Shapiro-Wilk). If there was any indication of a strong departure from normality, the p-value and 95% confidence interval would be calculated using the bootstrap method with bias correction.

Engagement

A mean 'subjective engagement' variable was created from the five choice questions. This gave a combined 'mean choice' score of 0 to 100, where high scores indicated high levels of subjective engagement. A one-way ANOVA was used to compare the differences in the mean 'subjective engagement' variable between the two groups (gamified vs. control). The effect was reported as a difference in means with 95% CIs, F statistics and p-values. An effect size (Cohen's d) was also calculated and presented alongside 95% CI of the effect size.

Three one-way ANOVAs were used to compare the differences in the mean 'response times', 'text length' and 'attention check fail' variables between the two groups (gamified vs. control). The effects were reported as differences in means with 95% CIs, and p-values. Effect sizes (Cohen's d) were also calculated and presented alongside 95% CI of the effect sizes. The effects of gamification on the length of a free-text explanation of the drink choice were prioritised if the three measures of objective engagement did not produce similar results.

Number of calories chosen

We ran a 2 (alcohol-free availability) x 2 (calorie information) ANOVA (analysis of variance) to compare the differences in the number of calories selected. The effects were reported as a difference in means with 95% CIs, F statistics and p-values. Effect sizes (Cohen's d) were also calculated and presented alongside 95% CI of the effect size.

Sensitivity analysis

Two sensitivity analyses of the primary and secondary outcomes repeated the above analyses without participants who: i. partially identified the true nature of the study, ii. fully identified the true nature of the study.

A further sensitivity analysis repeated the above analysis for the primary and secondary outcomes but excluded any participant who: i. consumed more than 35 units of alcohol per week, ii. did not usually drink in bars/pubs.

Qualitative analysis

Thematic analysis (Braun & Clarke, 2006) was planned to be used to identify themes from the open-text explanations regarding why a certain drink was selected. This would be achieved by capturing initial codes from participant responses and establishing themes with distinct names and definitions based on groups of codes. Necessary coding could not be completed in time due to time constraints, but the analysis will be performed prior to publication.

Results

Descriptive statistics

Out of 27,477 UK adults eligible for the study, 1,427 participants were recruited and randomised to one of the eight conditions (Figure 2). There were 2 participants who failed an attention check question and were replaced post-randomisation. One participant indicated 17 as their age and therefore was excluded post-randomisation. After seven more participants were excluded because they failed at least one of the two attention checks, data from the remaining 1419 participants was analysed.

The mean age was 35.7 years (SD = 12.3, range 18-83) and half of the participants (710, 50%) were males. Participants had varying educational backgrounds, but the majority (64%) reported higher education qualifications. The mean AUDIT score was 8.1 (SD = 5.2), suggesting harmful drinking, but as it ranged from 0-33, the risk of alcohol dependence among participants was very low. There was no difference in participants' demographic information and AUDIT scores between conditions (Table 4), implying that the observed effects between conditions should not be attributed to the differences in the selected cohorts. Percentages of participants who chose each of the options in the drinks menus between the four conditions can be seen in Table 5, with all options listed in the order they were presented to participants. Although a general preference for the first option of each of the drink types was observed in conditions with alcohol-free availability, this was not the case for conditions where most options were alcoholic.

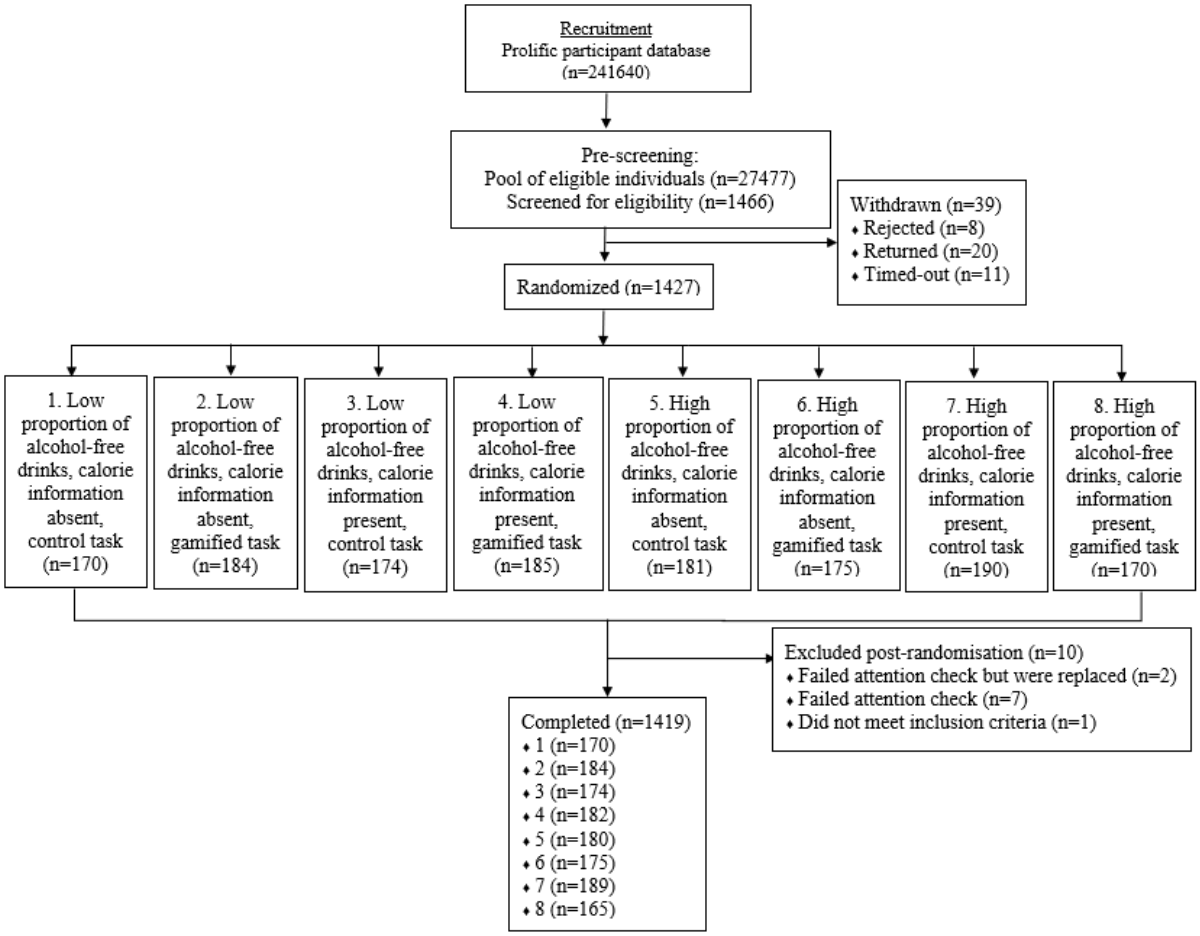

Figure 2. *CONSORT Flow Diagram for Study 2*

Table 4. *Demographic information and AUDIT scores between the eight conditions*

	Low alcohol-free availability (1/4 drinks alcohol-free)				High alcohol-free availability (3/4 drinks alcohol-free)			
	Calorie information absent		Calorie information present		Calorie information absent		Calorie information present	
	Non-gamified (*n = 170*)	Gamified (*n = 184*)	Non-gamified (*n = 174*)	Gamified (*n = 182*)	Non-gamified (*n = 180*)	Gamified (*n = 175*)	Non-gamified (*n = 189*)	Gamified (*n = 165*)
Age (M, SD)	36.1 (12.3)	36.3 (12.2)	35.5 (12.2)	36.5 (11.5)	34.8 (12.9)	36.0 (13.1)	34.2 (11.7)	36.1 (12.5)
Gender (n, %)								
Female	89 (52%)	85 (46%)	96 (55%)	84 (46%)	89 (49%)	89 (51%)	95 (50%)	82 (50%)
Male	81 (48%)	99 (54%)	78 (45%)	98 (54%)	91 (51%)	86 (49%)	94 (50%)	83 (50%)
Education (n, %)								
A levels	31 (18%)	38 (21%)	40 (23%)	36 (20%)	41 (23%)	32 (18%)	36 (19%)	34 (21%)
GCSE / O level A*-C	29 (17%)	22 (12%)	15 (9%)	23 (13%)	22 (12%)	33 (19%)	18 (10%)	17 (10%)
Higher education	106 (62%)	116 (63%)	111 (64%)	116 (64%)	112 (62%)	108 (62%)	133 (70%)	111 (67%)
No qualifications	2 (1%)	2 (1%)	1 (1%)	0 (0%)	1 (1%)	1 (1%)	1 (1%)	1 (1%)
Other qualifications, level unknown	2 (1%)	2 (1%)	5 (3%)	4 (2%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)
Qualifications level ≤ 1	0 (0%)	4 (2%)	2 (1%)	3 (2%)	4 (2%)	1 (1%)	0 (0%)	2 (1%)
Residency (n, %)								
England	143 (84%)	158 (86%)	157 (90%)	160 (88%)	156 (87%)	145 (83%)	160 (85%)	144 (87%)
Northern Ireland	3 (2%)	3 (2%)	2 (1%)	3 (2%)	3 (2%)	2 (1%)	2 (1%)	2 (1%)
Scotland	18 (11%)	17 (9%)	13 (8%)	11 (6%)	14 (8%)	16 (9%)	19 (10%)	10 (6%)
Wales	6 (4%)	6 (3%)	2 (1%)	8 (4%)	7 (4%)	12 (7%)	8 (4%)	9 (6%)
AUDIT score (M, SD)	7.9 (5.0)	7.8 (5.0)	8.5 (5.7)	8.2 (5.3)	8.4 (5.4)	7.9 (5.2)	8.1 (5.3)	8.1 (5.1)

Table 5. *Percentages of participants who chose each of the options in the drinks menus between the four study arms*

		Low alcohol-free availability		High alcohol-free availability	
	Drink nr	Calorie information absent	Calorie information present	Calorie information absent	Calorie information present
Type of drink: Beer	1	13	11	20	22
	2	7	7	1	1
	3	15	13	4	1
	4	2	2	7	5
Cider	5	7	8	12	13
	6	11	10	5	4
	7	2	1	1	0
	8	1	0	0	0
Wine	9	7	7	11	10
	10	6	5	4	5
	11	3	5	3	3
	12	1	3	3	4
Spirit	13	9	12	15	19
	14	7	6	7	4
	15	9	7	5	4
	16	2	3	5	5

* Drinks which were alcoholic in all conditions are highlighted in pink.

** Drinks which were alcohol-free in all conditions are highlighted in blue.

Primary outcomes

Across the four conditions varying in the proportion of alcohol-free availability and the presence of calorie information, the percentage of participants who selected an alcohol-free drink ranged from 5% to 43% (Figure 3). As hypothesised, the percentage of participants who selected an alcohol-free drink was largest when the availability of these drinks was high and calorie information was absent (43%) and smallest when the proportion of alcohol-free drink availability was low and calorie information was absent (5%).

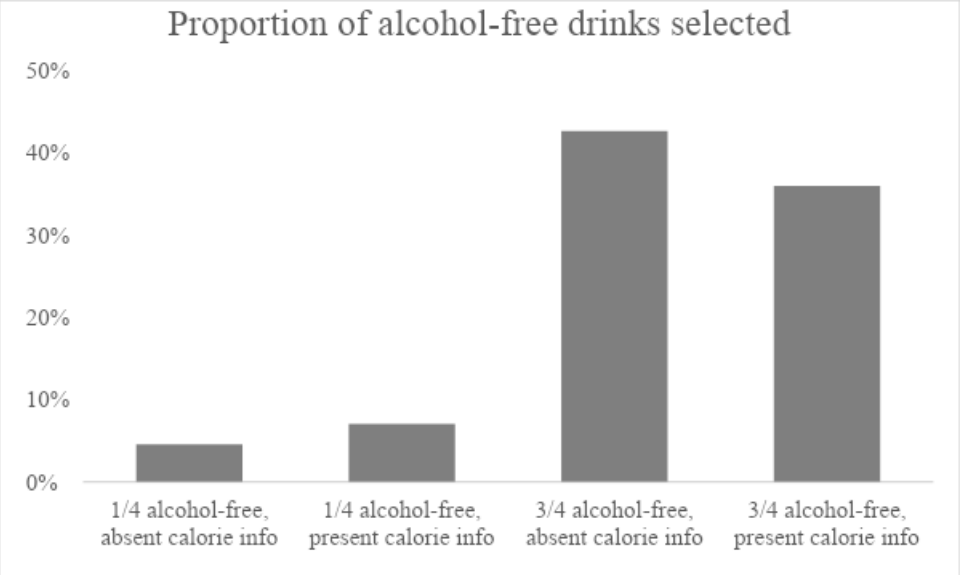

Figure 3. *Proportion of participants selecting an alcohol-free drink in four conditions*

The logistic regression model provided evidence of the impact of the proportion of alcohol-free drinks in a menu on drink selection. Compared to low alcohol-free availability, the odds of selecting an alcohol-free drink were ten times higher when there were proportionally more alcohol-free than alcoholic drinks to choose from (OR = 10.5, 95% CI = 7.5 to 15.1, $p <$ .001). In contrast, the selection of an alcohol-free drink was not affected by the provision of calorie information on a menu (OR = 0.87, 95% CI = 0.66 1.14, $p >$ .30). When sensitivity analyses were performed, the results were not substantially affected.

Secondary outcomes

Engagement

Since only four participants (three in gamified and one in non-gamified control) failed to correctly answer the second attention check question, this measure was not used in the analysis of participants' objective engagement. Distributions of the remaining engagement measures (both subjective and objective) were assessed for normality using Shapiro-Wilk statistical tests and normality plots. As there was a strong departure from normality for all these outcomes, *p*-values and 95% confidence intervals were calculated using the bootstrap method with bias correction.

A correlation matrix was applied to assess whether the three engagement measures used in the study correlated with each other. The results showed small correlation coefficients (Table 6), indicating that these measures could not be used to capture the same outcome.

Table 6. *Correlation coefficients between engagement measures*

Measure	Subjective score	Reaction times	Text length
Subjective score	1.00	0.06	0.08
Reaction times	0.06	1.00	0.13
Text length	0.08	0.13	1.00

A one-way ANOVA (analysis of variance) was used to compare the differences in the mean 'subjective engagement' variable between the two groups (gamified vs. non-gamified control). The results demonstrated no difference in mean subjective engagement scores between conditions as t(1415) = 1.78, MD = 1.31, 95% CI = -0.12 2.79, p = .081, and no improvement with the introduction of gamification (Cohen's d = 0.10, 95% CI = -0.01 0.20).

Two one-way ANOVAs were used to compare the differences in objective engagement between the two groups (gamified vs. non-gamified control). Among objective engagement measures, gamification was found to affect neither response times in the drink selection task (t(1392) = -1.26, MD = 1469, 95% CI = -3767 771, p = .19), nor the length of a free-text explanation of the drink choice (t(1412) = 0.93, MD = 2.60, 95% CI = -2.65 8.17, p = .35). The respective effects sizes were -0.07 (95% CI = -0.17 0.04) and 0.05 (95% CI = -0.06 0.15).

These results were partially affected by the sensitivity analysis which excluded participants who consumed more than 35 units of alcohol per week and did not usually drink in bars/pubs. While neither objective engagement measure produced divergent results in the sensitivity analysis, the effect of gamification on subjective engagement became significant (t(735) = 2.13, MD = 2.15, 95% CI = 0.13 4.15, p = .04) but the effect size remained small (Cohen's d = 0.16, 95% CI = 0.01 0.30). In contrast, the results were not affected by exclusion of participants who partially identified the true nature of the study.

Number of calories in drinks selected

When assessed for normality using the Shapiro-Wilk statistical test and a normality plot, the distributions of the number of selected calories demonstrated a strong departure from normality. As such, p-value and 95% confidence intervals were calculated using the bootstrap method with bias correction.

A 2 (alcohol-free availability) x 2 (calorie information) ANOVA was used to compare the differences in the number of calories selected. The provision of calorie information produced a trivial effect size (Cohen's d = -0.04, 95% CI = -0.14 0.07) and was not found to influence how many calories were selected (MD = 3.21, 95% CI = -11.6 5.10, F-value = 0.60, p = .45). In contrast, manipulating the proportion of alcohol-free drinks in a menu produced a medium sized effect in the number of calories selected (Cohen's d = -0.68, 95% CI = -0.78 -0.57) as less calorific drinks were selected in a high alcohol-free availability condition (MD = 54.6, 95% CI = -62.9 -46.1, F-value = 162, p < .001). These results were not affected by the sensitivity analyses.

Discussion

This study examined the effects of altering the proportion of alcohol-free drinks and the presence of calorie information on the drink menu, on alcohol-free drink selection in a controlled online environment. Further, the impact of gamifying the drink selection task on participants' engagement with it was also assessed.

In line with the first hypothesis, increasing the relative availability of alcohol-free drinks led to their heightened selection, compared to alcoholic drinks. Decreasing their relative availability produced the opposite results, reducing noticeably the selection of alcohol-free beverages. These results are consistent with existing literature on alcohol selection, since the

previous two online studies observed similar effects (Blackwell et al., 2020; Clarke et al., 2023), suggesting that reducing the proportion of alcoholic drinks may decrease the overall consumption of alcohol by encouraging selection of alcohol-free alternatives. They also fit the broader literature on the impact of manipulating the availability of healthier options on their subsequent selection. Similar to the present findings, Grech and Allman-Farinelli (2015) discovered that participants were more likely to choose healthy foods when their availability in vending machines was higher, while Pechey and Marteau (2018) observed the same tendency with regards to healthier snacks in a manipulated array of foods. Consistency of the combined literature further strengthens the standpoint that availability interventions can be usefully applied to a variety of products to promote healthier behaviour.

Contrary to the initial assumption, participants' selection of alcohol-free drinks was not affected by the provision of calorie information, suggesting no impact of calorie labelling on drinking behaviour. These findings are in accordance with previous research on alcohol consumption which also identified no such effects (Maynard et al., 2018a; Maynard et al., 2018b). As controlled studies on food consumption demonstrated the benefit of the presence of calorie information (e.g. Cawley et al., 2020), it may be important to consider potential causes of this difference. Observational studies on eating behaviours in fast food settings produced mixed results (Bleich, et al., 2017), as most of them had been powered to only detect large changes in calories purchased (e.g. Finkelstein et al., 2011; Elbel et al., 2009). Since alcoholic drinks contain considerably fewer calories than food sources, it is possible that the presence of calorie information may produce results even smaller in size, thus indistinguishable with the power of existing studies.

With regards to gamification, it produced no observable effects on the overall engagement as neither subjective engagement scores, nor response times in the drink selection task, nor the length of a free-text explanation were affected by its introduction. These results contradict existing literature on gamification, as the majority of studies showed its effects on engagement (e.g. Hamari et al., 2014; Lumsden et al., 2016). Nonetheless, when participants who consumed more than 35 units of alcohol per week and did not usually drink in bars/pubs were excluded, the effect of gamification on subjective engagement, albeit small, became observable. It is of particular importance since the selected measures of engagement were found to fail at capturing the same outcome. Hence, their combination should not be used as a reliable assessment of participants' engagement with the task. Since the difference in subjective engagement between conditions became noticeable after the exclusion of

participants who rarely went to bars, it might be the case that the remaining participants were more capable of imagining themselves in the setting portrayed. Evidence for the importance of context in the effectiveness of gamification was recently provided by Rodrigues and colleagues (2021) who found that participants' familiarity with a given activity moderated the extent to which gamification affected their intrinsic motivation. In particular, this moderation was positive for those who were familiar with the topic of the task, and non-existent or negative for those with no prior familiarity. As such, creating relevance to the target audience might be critical to the successful implementation of gamification.

Limitations

Nonetheless, several limitations of this study need to be addressed. First, due to its online nature, the selection of hypothetical rather than actual drinks was measured. As such, choices made by the participants might not represent the actual behaviour they would have exhibited in the real world if they were able to consume their selected drink afterwards. Evidence from field or laboratory studies is therefore essential to providing greater external validity of the results.

Further, a rough estimate of the effectiveness of calorie labelling was used to determine the sample size as no similar studies were published at a time. Hence, it is possible that the present study was underpowered to detect the effects of calorie information. As discussed in the previous section, it is a common issue for research on calorie labelling where studies are often powered to only detect large effects (e.g. Finkelstein et al., 2011). Future studies need to be adequately powered to detect smaller effects.

While the subjective engagement questionnaire was adopted from existing literature on gamification (i.e. Miranda & Palmer, 2014), measures of objective engagement were based on anecdotal rather than empirical evidence. A recent systematic review of engagement measures in educational games (Hookham & Nesbitt, 2019) highlighted that different studies tend to apply different methods. This lack of consistency across studies makes it difficult to select an appropriate approach which would capture the intended outcome. Thus, the creation and subsequent application of more standardised approaches of measuring engagement would lead to more consistent and generalisable results in future studies.

Conclusion

Altering relative availability of alcohol-free drinks but not providing calorie information was found to impact drink selection. Further, participants' engagement with the task did not seem to be affected by gamification. As such, the results of the current study provide evidence in favour of one of its hypotheses, while failing to reject the remaining two null hypotheses. While these findings highlight one possible avenue for mitigating alcohol consumption at the population level, further studies of sufficient power are essential to establishing whether these effects are applicable to the real-world settings.

CHAPTER 4: GENERAL DISCUSSION

Summary

Alcohol consumption is a prevalent societal issue with numerous adverse consequences, including health risks, social problems, and economic burden (Home Office, 2012; World Health Organization, 2019). While traditional approaches to reducing alcohol consumption have primarily focused on conscious decision-making processes, this thesis explored an alternative approach – altering the context in which drinking takes place to influence the behaviour itself. It aimed to provide valuable insights into effective strategies for reducing alcohol consumption rates and promoting healthier choices. This was examined in relation to changes to specific aspects of the environment.

Study 1 informed the design of a future RCT which would assess the impact of drinking position on the rate of alcohol consumption and determine whether it is moderated by the presence of a table. This entailed guiding the choice of sample size for a future study, assessing whether the scales used were prone to measurement error, investigating the overall feasibility of carrying out a full-scale study, and determining its fidelity to protocol. The findings demonstrated that with detailed planning, this manipulation can be feasibly integrated into the real-world setting, highlighting the plausibility of conducting a full-scale study. Study 2 assessed the impact of altering the proportion of alcohol-free drinks to their alcoholic counterparts, and the availability of calorie information for both types of drinks, on the selection of alcohol-free alternatives. It provided further evidence on the effectiveness of altering the proportion of alcohol-free drinks as a means of reducing alcohol consumption, while obtaining no evidence in favour of the provision of calorie information.

While choice architecture has shown promise in various domains, its application to alcohol has been somewhat limited, which is evident from the lack of relevant studies on availability interventions, compared to such domains as food consumption (Hollands, et al., 2019). However, the findings presented here provide further evidence that even subtle modifications, such as increasing the availability of alcohol-free drinks, may have a positive effect on consumers' drinking behaviour. By designing environments in ways that facilitate healthier choices, choice architecture interventions complement existing strategies and potentially enhance their effectiveness. Traditional interventions aimed at reducing alcohol consumption have often overlooked environmental contribution to this behaviour, focusing more on raising awareness and addressing alcohol-related issues (Albarracin, 2018). On the other hand,

choice architecture interventions offer an innovative approach which addresses this particular gap by leveraging the power of environmental cues to shape behaviour (Hollands, et al., 2017). By creating an environment that encourages healthier choices and responsible drinking, choice architecture interventions may reinforce the impact of interventions focusing on conscious decision making. This synergistic application of the two approaches will address alcohol consumption issues while acknowledging the dual role of individual decision-making and environmental influences in shaping behaviour (Strack & Deutsch, 2004). The potential of combining the two approaches to improve health outcomes have first been highlighted by Thaler and colleagues (2013) and later adapted to tobacco control (Crosbie, Sosa, & Glantz, 2018) and physical activity promotion (Marteau et al., 2012). By understanding how the environment influences drinking behaviours, policymakers and health practitioners can design more tailored and impactful interventions. Thus, implementation of choice architecture interventions in real-world settings, such as bars and restaurants, alongside traditional interventions may serve as a promising path towards an overall reduction in alcohol consumption.

Future research

The studies conducted in this thesis provided valuable short-term insights into the impact of choice architecture interventions on alcohol consumption. However, a commonly recognized limitation of these interventions is the unknown duration of their effectiveness, primarily due to the scarcity of studies assessing their long-term outcomes (Bucher et al., 2016). Although studies tend to show positive changes in behaviour soon after the intervention is implemented, they often fail to follow up on and evaluate how this behaviour evolves over time. The influence of nudging in altering behaviours in the short term may be attributed to novelty (Just & Price, 2013) and such effects are only temporary as they are related to the newness of an intervention rather than the intervention itself (Allcott & Rogers, 2014). When first introduced, it may capture individuals' attention and change the behaviour of interest, but after the initial novelty factor wears off, people might revert to their previous behaviours (Elston, 2021). As such, to truly understand the sustainability of choice architecture interventions, future research needs to examine how they influence choices at various time points, beyond just the immediate effects. Conducting follow-up studies over extended periods will help determine whether the observed changes in drinking behaviour are

maintained over time or if they diminish with repeated exposure to the manipulated environment. Further, comparing the results of short-term and long-term studies can shed light on the factors contributing to these effects.

While the studies conducted in controlled experimental settings provided valuable insights into the effects of choice architecture interventions on alcohol consumption, their artificial nature may not have fully captured the complexity of real-world decision-making in bars and restaurants. As such, it is essential to validate these findings in real-world scenarios. Naturalistic studies are known to provide a higher degree of ecological validity (i.e. generalisation of the results to real-life settings) compared to laboratory studies (Andrade, 2018). Since they allow researchers to observe behaviours in more realistic conditions, conducting research on choice architecture interventions in drinking establishments, such as bars, pubs, and restaurants, offers certain advantages in understanding the effectiveness of these interventions directly in the context where alcohol consumption naturally occurs. Drinking establishments have a more dynamic environment that can influence individuals' behaviour, emotions, and decision-making processes (Bitner, 1992) in ways that may not be fully captured in artificial settings. More naturalistic settings which mimic typical drinking environments (e.g. bar laboratories) have already been successfully adapted to alcohol consumption research (Kersbergen, et al. 2018). Further, effects seen in online and laboratory studies do not always reflect behaviour that naturally occurs in their naturalistic alternatives (Clarke, et al., 2021). Future research needs to clarify whether changes in behaviour observed in this thesis can translate to the real-world consumption of alcohol.

Conclusion

This thesis has explored the capacity of choice architecture interventions to influence alcohol consumption by directly altering the environment in which it occurs. The findings highlight the feasibility and effectiveness of such interventions, particularly through increasing the availability of alcohol-free drinks. Although they offer valuable insights into the role of environmental cues in shaping behaviour, the ultimate goal is to identify strategies that not only yield immediate improvements in decision-making but also promote lasting positive behaviours. As such, it is vital to assess the long-term sustainability of choice architecture interventions and validate results in naturalistic settings. This will enhance the applicability and generalizability of the findings, thus providing a robust evidence base for promoting

healthier drinking habits in real-world scenarios. Combining choice architecture interventions with traditional approaches presents a comprehensive and synergistic strategy to address alcohol-related issues. As policymakers and health practitioners strive to combat the consequences of excessive alcohol consumption, this thesis calls attention to interventions which have the potential to be both effective and sustainable.

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APPENDIX

Appendix 1. *Results of the sensitivity analyses of Study 1*

	Initial pooled SD	Bootstrapped pooled SD	Lower 95% CI	Upper 95% CI
Sensitivity analysis 1	7.6	7.6	5.9	9.3
Sensitivity analysis 2	8.3	8.1	5.7	10.3

Appendix 2. *Four drinks menus created for the experiment*

a) High alcohol-free availability, calorie information present

	NAME	DESCRIPTION	ABV	VOLUME	CALORIE INFO
1	CARLSBERG EXPORT	LAGER	4.8%	PINT	244KCAL
2	CARLSBERG ZERO	LAGER	0.0%	PINT	125KCAL
3	ERDINGER ALKOHOLFREI WEISSBIER	WHEAT BEER	0.5%	PINT	142KCAL
4	BREWDOG NANNY STATE	HOPPY ALE	0.5%	PINT	45KCAL
5	THATCHERS GOLD	MEDIUM DRY CIDER	4.8%	PINT	261KCAL
6	KOPPARBERG ALCOHOL-FREE MIXED FRUIT	FRUIT CIDER	0.0%	PINT	216KCAL
7	THATCHERS ZERO	MEDIUM DRY CIDER	0.0%	PINT	170KCAL
8	SHEPPY'S CLASSIC LOW ALCOHOL	MEDIUM DRY CIDER	0.5%	PINT	159KCAL
9	ERRAZURIZ ACONCAGUA COSTA SAUVIGNON BLANC	WHITE WINE	13%	MEDIUM GLASS	159KCAL
10	FRE MERLOT	RED WINE	0.5%	MEDIUM GLASS	49KCAL
11	EISBERG SAUVIGNON BLANC	WHITE WINE	0.5%	MEDIUM GLASS	39KCAL
12	TORRES NATUREO ROSADO	ROSÉ WINE	0.5%	MEDIUM GLASS	42KCAL
13	BEEFEATER GIN & TONIC	GIN & TONIC	40%	SINGLE+MIXER	107KCAL
14	STRYYK 'VODKA' & LEMONADE	VODKA & LEMONADE	0.0%	SINGLE+MIXER	60KCAL
15	SEEDLIP 'GIN' & TONIC	GIN & TONIC	0.0%	SINGLE+MIXER	50KCAL
16	RONSIN 'RUM' & COKE	RUM & COKE	0.0%	SINGLE+MIXER	70KCAL

b) Low alcohol-free availability, calorie information present

	NAME	DESCRIPTION	ABV	VOLUME	CALORIE INFO
1	CARLSBERG EXPORT	LAGER	4.8%	PINT	244KCAL
2	ERDINGER WEISSBIER	WHEAT BEER	5%	PINT	250KCAL
3	BREWDOG PUNK IPA	INDIA PALE ALE	5.6%	PINT	278KCAL
4	CARLSBERG ZERO	LAGER	0.0%	PINT	125KCAL
5	THATCHERS GOLD	MEDIUM DRY CIDER	4.8%	PINT	261KCAL
6	KOPPARBERG MIXED FRUIT	FRUIT CIDER	4.0%	PINT	341KCAL
7	SHEPPY'S OAKWOOD	MEDIUM DRY CIDER	4.8%	PINT	205KCAL
8	THATCHERS ZERO	MEDIUM DRY CIDER	0.0%	PINT	170KCAL
9	ERRAZURIZ ACONCAGUA COSTA SAUVIGNON BLANC	WHITE WINE	13%	MEDIUM GLASS	159KCAL
10	OTRA TIERRA MERLOT	RED WINE	13%	MEDIUM GLASS	160KCAL
11	BIRD IN HAND PINOT NOIR ROSÉ	ROSÉ WINE	12%	MEDIUM GLASS	147KCAL
12	EISBERG SAUVIGNON BLANC	WHITE WINE	0.5%	MEDIUM GLASS	39KCAL
13	BEEFEATER GIN & TONIC	GIN & TONIC	40%	SINGLE+MIXER	107KCAL
14	ABSOLUT VODKA & LEMONADE	VODKA & LEMONADE	40%	SINGLE+MIXER	118KCAL
15	CAPTAIN MORGAN SPICED RUM & COKE	RUM & COKE	35%	SINGLE+MIXER	113KCAL
16	SEEDLIP 'GIN' & TONIC	GIN & TONIC	0.0%	SINGLE+MIXER	50KCAL

c) High alcohol-free availability, calorie information absent

	NAME	DESCRIPTION	ABV	VOLUME
1	CARLSBERG EXPORT	LAGER	4.8%	PINT
2	CARLSBERG ZERO	LAGER	0.0%	PINT
3	ERDINGER ALKOHOLFREI WEISSBIER	WHEAT BEER	0.5%	PINT
4	BREWDOG NANNY STATE	HOPPY ALE	0.5%	PINT
5	THATCHERS GOLD	MEDIUM DRY CIDER	4.8%	PINT
6	KOPPARBERG ALCOHOL-FREE MIXED FRUIT	FRUIT CIDER	0.0%	PINT
7	THATCHERS ZERO	MEDIUM DRY CIDER	0.0%	PINT
8	SHEPPY'S CLASSIC LOW ALCOHOL	MEDIUM DRY CIDER	0.5%	PINT
9	ERRAZURIZ ACONCAGUA COSTA SAUVIGNON BLANC	WHITE WINE	13%	MEDIUM GLASS
10	FRE MERLOT	RED WINE	0.5%	MEDIUM GLASS
11	EISBERG SAUVIGNON BLANC	WHITE WINE	0.5%	MEDIUM GLASS
12	TORRES NATUREO ROSADO	ROSÉ WINE	0.5%	MEDIUM GLASS
13	BEEFEATER GIN & TONIC	GIN & TONIC	40%	SINGLE+MIXER
14	STRYYK 'VODKA' & LEMONADE	VODKA & LEMONADE	0.0%	SINGLE+MIXER
15	SEEDLIP 'GIN' & TONIC	GIN & TONIC	0.0%	SINGLE+MIXER
16	RONSIN 'RUM' & COKE	RUM & COKE	0.0%	SINGLE+MIXER

d) Low alcohol-free availability, calorie information absent

	NAME	DESCRIPTION	ABV	VOLUME
1	CARLSBERG EXPORT	LAGER	4.8%	PINT
2	ERDINGER WEISSBIER	WHEAT BEER	5%	PINT
3	BREWDOG PUNK IPA	INDIA PALE ALE	5.6%	PINT
4	CARLSBERG ZERO	LAGER	0.0%	PINT
5	THATCHERS GOLD	MEDIUM DRY CIDER	4.8%	PINT
6	KOPPARBERG MIXED FRUIT	FRUIT CIDER	4.0%	PINT
7	SHEPPY'S OAKWOOD	MEDIUM DRY CIDER	4.8%	PINT
8	THATCHERS ZERO	MEDIUM DRY CIDER	0.0%	PINT
9	ERRAZURIZ ACONCAGUA COSTA SAUVIGNON BLANC	WHITE WINE	13%	MEDIUM GLASS
10	OTRA TIERRA MERLOT	RED WINE	13%	MEDIUM GLASS
11	BIRD IN HAND PINOT NOIR ROSÉ	ROSÉ WINE	12%	MEDIUM GLASS
12	EISBERG SAUVIGNON BLANC	WHITE WINE	0.5%	MEDIUM GLASS
13	BEEFEATER GIN & TONIC	GIN & TONIC	40%	SINGLE+MIXER
14	ABSOLUT VODKA & LEMONADE	VODKA & LEMONADE	40%	SINGLE+MIXER
15	CAPTAIN MORGAN SPICED RUM & COKE	RUM & COKE	35%	SINGLE+MIXER
16	SEEDLIP 'GIN' & TONIC	GIN & TONIC	0.0%	SINGLE+MIXER

Appendix 3. *Questions specific to the gamified task*

1. It was an ordinary Wednesday and nothing remarkable could distinguish it from any other Wednesday. The sun was gradually tilting towards the horizon, painting the sky in reddish tones. All work for the day was finally finished and you breathed a sigh of relief. The evening was completely at your disposal and you were sure that nothing unexpected would come up. You decided to end this day by having a drink in a local bar you go to from time to time. While getting ready to leave, you were thinking about whether to invite someone to join you or to go alone. What have you decided? (with the options: 'Go alone', 'Go with a partner', 'Go with a friend', or 'Go with a couple of friends')
2.
    a) Since you didn't need to wait for anyone, you quickly finished getting ready and left your place, heading towards the bar. When you arrived, you went straight inside the bar to get a drink and find a spot.
    b) You asked your partner if they want to join you and they agreed to meet you in the bar in an hour. Since you had plenty of time before you meet, you slowly finished getting ready and left your place, heading towards the bar. When you arrived, no one else was there yet. Did you wait for them outside or go inside to get a drink and find a spot? (with the options: 'Inside', or 'Outside')
    c) You texted [*your friend/some of your friends*] and they agreed to meet you in the bar in an hour. Since you had plenty of time before you meet, you slowly finished getting ready and left your place, heading towards the bar. When you arrived, no one else was there yet. Did you wait for them outside or go inside to get a drink and find a spot? (with the options: 'Inside', or 'Outside')
3.
    a) The lighting was pretty dull inside the bar but you could see the interior more or less clearly. It was a typical bar with several seating spaces with and without tables, as well as some standing spaces. There weren't that many customers inside, so you could pick your spot quite freely. What place did you end up choosing? (with options: 'Sitting with a table', 'Sitting without a table', 'Standing with a table', or 'Standing without a table')
    b) You waited for your [*partner/friend/friends*] to arrive and went in together. The lighting was pretty dull inside the bar but you could see the interior more or less

clearly. It was a typical bar with several seating spaces with and without tables, as well as some standing spaces. There weren't that many customers inside, so you could pick your spot quite freely. What place did you end up choosing? (with options: ‘Sitting with a table’, ‘Sitting without a table’, ‘Standing with a table’, or ‘Standing without a table’)

4.

a) As the place was chosen, now it was time to get a drink. You went to the bar counter wondering what you are going to drink. A bartender greeted you with a smile and looked at you patiently waiting for an order. You still haven't made up your mind about what to have and once the bartender noticed that, he handed you their drinks menu.

b) As the place was chosen, now it was time to get a drink. [*You and your partner/You and your friend/Everyone*] agreed that you'll go to the bar counter first, and so you did, wondering what you are going to drink yourself. A bartender greeted you with a smile and looked at you patiently waiting for an order. You still haven't made up your mind about what to have and once the bartender noticed that, he handed you their drinks menu.

5. Once you made up your mind, you told the bartender what you want to have and he started making the drink. He didn't have any other customers waiting and you could tell that he was bored as he was taking longer than usual to serve the drink. As this thought crossed your mind, the bartender said: 'Nice choice by the way, I have it quite often myself. I'm surprised you picked this drink from our long list. What made you choose it?'. He was clearly waiting for your reply and you didn't want to come across as impolite, so you took a moment to think about your choice. What did you say?

6.

a) Satisfied by your answer, the bartender finished making the drink and put it on the bar counter with a smile. You paid for the drink and headed back to the spot you picked before, taking sips from the drink on your way there. You [*sat in a chair and put the drink on the table/sat in a chair/put the drink on the table/held the drink in your hand*], thinking what a great spot you chose [*as you could freely move around the bar if you wanted to*]. You were slowly drinking, observing everything around you and enjoying a pleasant evening. You were happy to finally have some time to yourself without the need to rush anywhere or to talk to other people.

b) Satisfied by your answer, the bartender finished making the drink and put it on the bar counter with a smile. You paid for the drink and headed back to the spot you picked before, taking sips from the drink on your way there. You [*sat in a chair and put the drink on the table/sat in a chair/put the drink on the table/held the drink in your hand*], thinking what a great spot you chose [*as you could freely move around the bar if you wanted to*]. You were slowly drinking, enjoying a conversation with your [*partner/friend/friends*] and a pleasant evening overall. You were happy to finally have some time with your [*partner/friend/friends*] without the need to rush anywhere.

7.

a) Time went by quickly and at some point you realised you finished your drink. The idea of staying for one more crossed your mind but you quickly dismissed it as you knew you had a busy day ahead tomorrow and needed some rest. When you came home, you got ready for bed as quickly as you could. As you were falling asleep, different moments from today's evening were flashing before your eyes, bringing a smile on your face. It lasted awhile, until your tiredness finally got an upper hand and you fell asleep sometime later.

b) Time went by quickly and at some point you realised you finished your drink. The idea of staying for one more crossed your mind but you quickly dismissed it as you knew you had a busy day ahead tomorrow and needed some rest. You said goodbye to your [*partner/friend/friends*] and left as it was already pretty late. When you came home, you got ready for bed as quickly as you could. As you were falling asleep, different moments from today's evening were flashing before your eyes, bringing a smile on your face. It lasted awhile, until your tiredness finally got an upper hand and you fell asleep sometime later.