The impact of binge drinking on emotion recognition

The impact of binge drinking on emotion recognition

Carmel Corcoran

A thesis submitted in partial fulfilment of the requirements of the University of West London for the degree of Doctor of Philosophy

January 2022

Abstract

Binge drinking or heavy episodic drinking is variously defined but according to the World Health Organisation (WHO) it is the consumption of at least 60 grams or more of pure alcohol, 5 or more standard alcoholic drinks, at least once in the last 30 days. Alcohol costs society between 1.3% to 2.7% of GDP, approximately £46 billion pounds whilst direct costs to the NHS are in the region of £3.5 billion pounds. Much research has been conducted on alcohol dependence (AD) and the impact on the individual and cognition. However, much less research has been conducted on binge drinking, and where it has, research has tended to focus on executive function whilst social cognitions have largely been neglected. Social cognition has been defined as any psychological process that facilitates an individual's ability to interact in a social group and is essential for human wellbeing and the ability to thrive in society. Being able to read and respond appropriately to facial expressions is a key factor underpinning social interaction.

This thesis aimed to address some of the gap in knowledge with respect to binge drinking and emotion recognition. The research had the following aims:

1) to clarify previous findings of emotion recognition impairment and to identify whether binge drinking impacted the bottom-up ability to recognise facial expressions at a behavioural level in a similar way to top-down emotion recognition

2) to identify whether there were differences in how binge drinkers gathered information from faces for processing.

To address these aims a quantitative method was used. Study 1-Part 1 (N=50, HBD = 25, 14 females, LBD = 25, 19 females) examined early/bottom-up emotion

recognition for static faces, Study 1-Part 2 (N=39, HBD=20, 10 females, LBD = 19, 16 females) identified the visual scan path gathering information for processing from emotional faces and emotional images, whilst Study 2 (N=46, HBD= 23, 11 females, LBD=23, 19 females) examined early/bottom-up emotion recognition, late/top-down emotion recognition of both static and dynamic faces and the visual scan path over both static and dynamic faces. The participants were recruited from the student population, a group particularly prone to binge drinking.

The research generated some interesting findings some of which supported other research and others which furthered the insight into the impact of binge drinking on social cognitions beyond the behavioural level. This research suggests there is no behavioural difference in bottom-up emotion recognition however there is a positive bias at lower levels of BD and a negative bias at higher levels of BD. There was an overall deficit in emotion recognition at higher levels of binge drinking and with an increased cognitive load. This study has also identified differences in how high and low binge drinkers scan static and dynamic images as well as viewing strategies used for emotion recognition. Taken together these findings suggest a less efficient viewing strategy by high binge drinkers which becomes more pronounced at higher levels of binge drinking and with increased task complexity resulting in impaired recognition. The mechanism implicated in this is the amygdala which is instrumental in directing gaze to the eyes and is also impacted by alcohol.

Impaired recognition of facial emotion expressions can have serious consequences impacting the wellbeing of the individual and their social circle. Uncomfortable social interactions due to incorrect or negative interpretation of

expressions can have a serious detrimental effect on the individual and lead to a defensive attitude, avoidance of similar situations or to drink more to cope in these social settings. In addition, the inability to recognise negative emotions such as Fear or Anger at lower levels could exacerbate situations where there is a risk of domestic violence or date rape. Suggestions for interventions and further research are discussed.

Acknowledgements

Firstly, I would like to thank my supervisors, Associate Professor Raffaella Milani, Dr. Frances Hunt and Dr. Julia Townshend for their all of their support on what has been an epic journey in every sense. It is thanks to Julia that I began this journey and although she has been unable to see it through to the end, I owe her a debt of gratitude for her advice and support. A special mention also for Raffaella who stepped up and it is her encouragement and belief that has spurred me on to complete this journey.

I would like to extend my thanks to my colleagues and friends in the Psychology department at UWL who have provided some much-needed support and congeniality throughout. A special mention in this context must be extended to Professor Caroline Lafarge who has always been willing to lend a sympathetic ear and encouragement when times were tough. It would be remiss not to thank my wonderful participants who gave up their time and expressed very positive interest in my research.

I must also thank my close friends and family (a special mention for my sister Christine), who have learned not to keep asking "when are you finishing?". For providing much needed distractions and for your support and interest in my research I am forever grateful.

Finally, to my daughters, Tara and Zoe, who put up with my unavailability but were always understanding, supportive and proud of my achievements. And to my parents, Denis and Noreen, who put a value on education and learning in all its formats and inspired me to be curious about the world around me.

Contents

Table of Figures

Table of Tables

Abbreviations

AD	Alcohol Dependence
ACC	Anterior cingulate cortex
AOI	Area of Interest
AUD	Alcohol Use Disorder
BD	Binge Drinking
BS	Binge Score
CG	Control group
CNS	Central nervous system
CT	Computer Tomography
EEG	Electroencephalogram
ERP	Event related potentials
ERT	Emotion Recognition Task
fMRI	Functional Magnetic Resonance Imaging
GABA	Gamma-aminobutyric acid
HBD	High Binge Drinker
LBD	Low Binge Drinker
MDM	Mood dependent memory
MPFC	Medial prefrontal cortex
PFC	Prefrontal Cortex
SOA	Stimulus onset asynchrony
STS	Superior temporal sulcus
TMS	Transcranial magnetic stimulation
VSP	Visual Scan Path

Chapter 1 Introduction

1.1 Overview

This thesis explored the impact of binge pattern alcohol consumption on social cognition. This section explains the key considerations of alcohol consumption in a binge drinking pattern and social cognition from the perspective of emotion recognition. It provides background information on the influence of both to society at large and also the individual.

Binge drinking or heavy episodic drinking is variously defined but according to the World Health Organisation (WHO, 2018) it is the consumption of at least 60 grams or more of pure alcohol, or 5 or more standard alcoholic drinks, at least once in the last 30 days. According to the Institute of Alcohol Studies (IAS) (n.d.) alcohol consumption in the UK is now reducing overall, with the most recent published figures placing annual consumption in the UK at 9.8 liters per head in 2018 a reduction from a peak of 11.6 liters per head in 2004. Notwithstanding the overall reduction indicated in alcohol consumption, hospital treatment for alcohol related illness has risen every year since 2008 with the most recent figures showing alcohol attributable admissions at 336,310 in 2018/2019 (Statistics on Alcohol England, 2020). The total annual cost to society of alcohol related harm is estimated to be in the region of 1.3% to 2.7% of GDP, an estimated £46 billion at the higher level of 2.7% (Burton & Marsden, 2016), whilst direct costs to the NHS are estimated to be in the region of £3.5billion per year (NHS, n.d.). The levels of risk and harm to society in general, through lost productivity and NHS costs are problematic and the COVID pandemic has led to between 20% and 30% of people indicating they drank more during lockdown, exacerbating these problems (IAS, 2020).

The broader costs of alcohol to society are beginning to be explored in a more comprehensive manner and reported through the Office for National Statistics, Public Health England and NHS Digital. These broad costs are made up from individual losses through ill health and the negative impact on employment, quality of life and personal relationships (Black, 2016; Burton & Marsden, 2016; Holmes, 2021). These individual losses are built up over time and begin with levels and patterns of alcohol consumption that are perceived as only being problematic at the time of consumption and in the immediate aftermath due to intoxication, such as binge drinking, but less is known about the subtler long-term impacts of this type of consumption on individuals. Whilst there has been a significant amount of research on the long-term impact of severe alcohol use disorders (Aloi et al., 2018; Bernardin et al., 2014; Bushman & Cooper, 1990; Cortes et al., 2018; Loeber et al., 2009; O'Daly et al., 2012; Rose & Duka, 2007; Thomson et al., 2012) and the short term impact of alcohol on the brain (Attwood, Ohlson, Benton, Penton-Voak, & Munafo, 2009; Capito, Lautenbacher, & Horn-Hofmann, 2017; Khouja, Attwood, Penton-Voak, & Munafò, 2019; Weafer, Gallo, & de Wit, 2016) much less research has focused on binge drinking.

At an individual level, it has been established that for those who misuse alcohol to the extent that they are diagnosed with alcohol dependence or severe alcohol use disorder, the ability to function effectively in society is negatively impacted and this has been related to social cognition deficits influenced by alcohol (Attwood & Munafo, 2014; Rupp, Derntl, Osthaus, Kemmler, & Fleischhacker, 2017). Where binge drinking has been the focus of research, these studies primarily examine the impact on executive functioning (Lannoy, Billieux, & Maurage, 2014). However, the impact of binge drinking on social cognition, specifically emotion recognition, has been largely overlooked and this study aims to fill in some of the gaps in knowledge in this respect.

Social interactions are essential for human wellbeing and the ability to thrive in society (Baumeister & Leary, 1995; Tracy & Robins, 2008). At all stages of the life-cycle we rely on others for our development and survival. In order to effectively manage social interactions, an individual needs to be able to communicate physical and emotional needs to others and in turn, be able to understand the needs of others on multiple levels in a reciprocal way (Frith, 2008; Van Kleef, 2010). There is evidence that social relationships can influence health and health outcomes, for example, a relationship was established between sociability and resistance to developing a cold when 334 volunteers were assessed for sociability and exposed to a common cold virus (Cohen et al., 2003). The higher the sociability score the greater the resistance to cold symptoms, measured both subjectively and objectively. In another study (Oishi et al., 2013) it was found that feeling connected to others increased the ability to withstand pain and furthermore reduced perceptions of steepness of an incline and of distance to walk to a specified location so that they appeared easier to accomplish. A meta-analytic review (Holt-Lunstad et al., 2015) was conducted to clarify the relationship between social isolation and pre-mature mortality. Holt-Lunstad et al. (2015) analysed the effect size in 70 studies with cumulative data collected over 7 years amounting to 3,407,124 responses and an average age of 66 years, and found that loneliness, social isolation and living alone increased the odds of premature death by 26%, 29% and 32% respectively (Holt-Lunstad et al., 2015). Social interaction is important therefore, not just for work and personal well-being but also health and life expectancy. Anything that negatively impacts the efficient functioning of successful social interactions, such as a deficit in social cognition, as identified amongst those with an AUD (Domínguez-Salas et al., 2016; Le Berre, 2019; Rupp et al., 2017), is important to be explored and understood.

The factors that impact social cognition and the key mechanisms that underpin social interactions need to be examined therefore in order to understand where the difficulties may be occurring. Emotion recognition is one such mechanism and has been a widely used paradigm to explore the extent of the impact of various physical and mental health conditions on social cognition. People who have conditions such as schizophrenia, depression or brain damage as a result of traumatic injury, or diseases for example Huntington’s disease or alcoholism, often have difficulty with social interactions and these are often explored through emotion recognition (Kohler et al., 2010; Larsen et al., 2016; Levola et al., 2014; Surguladze et al., 2004; Visser-Keizer et al., 2016). Emotion recognition therefore is the paradigm that is used to explore social cognition in the current research.

The remainder of this Chapter sets out the principal theories underpinning what emotions are and how individuals perceive them. It includes accounts for face recognition including emotion recognition and the mechanisms involved in capturing and processing this information. Finally, the impact of alcohol on the brain both in terms of general cognition and emotion recognition are outlined.

Chapter 2 sets out the evidence to date that directly explores facial emotion recognition and binge drinking. Although evidence is limited and inconsistent it does provide a supportive argument for a relationship between binge drinking and emotion recognition. Comments on the studies to date and how they have influenced the current research are highlighted.

Chapter 3 outlines the methodology employed in the current research which is a quantitative method using a quasi-experimental design. The reasons for including questionnaires to measure additional factors such as mood and alexithymia are discussed. The rationale for the choice of specific measures is also included. The behavioural tasks of Emotion Recognition and the Eye-tracking tool are also explained in detail.

Chapter 4 details Study 1-Part 1 which tested the bottom-up (sensory input only) early emotion recognition of high binge drinkers (HBD) and low binge drinkers (LBD) for the six emotions of Anger, Disgust, Fear, Happy, Sad and Surprise with each stimuli being presented for 200 milliseconds. These were complex emotions with 15 different levels of the emotion being presented. This study also tested how HBD and LBD rated the valence and arousal of emotionally valenced images.

Chapter 5 details Study 1-Part 2 which examined the length of the visual scan path and fixation patterns of the HBD and LBD to the emotions of Anger, Fear, Happy and Surprise. The length of the scan paths for the emotionally valenced images grouped by positive, negative and neutral are also examined for differences between the HBD and LBD.

Chapter 6 builds on the findings of Chapter 4 and 5 and tested the behavioural element with HBD and LBD being tested on bottom-up (sensory input only) rapid emotion recognition of complex facial expressions presented for 200 ms. Instead of passive viewing of the facial emotion expressions as in Study 1-Part 2, two cognitive tasks requiring the recognition of the emotions presented and rating the intensity of the emotions were added to Study 2. The stimuli were presented for 3 seconds and included three additional emotions giving a total of seven, Anger, Disgust, Fear, Happy, Neutral, Sad and Surprise. This tested top-down recognition (drawing on previous experience and knowledge) of simple images (one clear emotion). As static images have been criticized for not being ecologically valid, an equal number of dynamic images were also tested for the same expressions, also presented for three seconds.

Chapter 7 provides an overview and discussion of the whole research findings and conclusions. The strengths and limitations of the current research are considered. This chapter also sets out the contribution to knowledge on understanding how binge drinking impacts emotion recognition and identifies the mechanism though which these deficits may occur. Interventions to address this impact and future research directions are discussed. As a novel approach was employed by using eye-tracking in this context, further research needs to be conducted to corroborate the findings of the current research.

1.2 Theories of Emotion

As emotions are central to social interactions and social cognition, it is pertinent to identify what is understood by emotions and to outline the theories aiming to explain what emotions are before moving on to explore how they are recognised. Emotions are broad concepts and there is no consensual definition although a partial working definition was proposed by Mulligan and Scherer (2012)

> x is an emotion only if
>
> x is an affective episode
>
> x has the property of intentionality (i.e., of being directed)
>
> x contains bodily changes (arousal, expression, etc.) that are felt
>
> x contains a perceptual or intellectual episode, y, which has the property of intentionality
>
> the intentionality of x is inherited from the intentionality of y
>
> x is triggered by at least one appraisal
>
> x is guided by at least one appraisal. (p.346)

Emotions are communicated through voice, tone, words, gestures posture as well as facial emotion expressions (Mehrabian & Russell, 1978). There are various theories of emotions and how they are experienced, and these broadly take three approaches: physiological, neurological/cognitive and evolutionary.

The physiological perspective is based on the premise that emotions happen as a result of physiological reactions to events. This was proposed initially by William James (1884) and Carl Lange (1887) and became known as the James-Lange theory (Dębiec, 2014). According to the theory, a stimulus is seen, and a physiological reaction follows. The emotional experience is how that physiological reaction is interpreted. For example, when a stimulus is seen and the body trembles, the heart starts to race and then that is interpreted as Fear as opposed to Fear being experienced and therefore the physiological reactions follow. This theory was later refuted (Cannon, 1927). The alternative Cannon-Bard theory of emotions (Cannon, 1927) pointed out that the same physiological response could be attributed to more than one emotional state, for example, heart racing on a romantic date would indicate a specific emotion whereas heart racing after running, the same physiological response, would not indicate any specific emotion. The Cannon-Bard theory therefore proposed that individuals feel emotions and experience physiological responses simultaneously on presentation of the stimulus.

The neurological/cognitive perspective contends that emotions arise from the appraisal of the environment as positive, negative or neutral. The individual then has a secondary appraisal assessing how to cope with the stimulus. This is seen in Lazarus's Cognitive-motivational-relational model (1991) where he proposes that a primary appraisal takes place evaluating the relevance, congruence and consequences of the action for self-esteem and the environment. A secondary appraisal would then take place to assess the environment in terms of how the individual might cope with it and how much coping might affect future relations. Therefore, cognitive theories hold that emotion experience includes various cognitive components including activating appraisals, subsequent desires, and intentions. It is contended that emotion and cognition are inseparable as the feeling of emotions implies an attempt to interpret them which is itself a cognitive act (Carofiglio & De Rosis, 2005).

In contrast, the evolutionary perspective per se does not indicate a specific role for cognition in the experience of emotion and proposes that emotion experience is more immediate and automatic (Al-Shawaf et al., 2014). The evolutionary theories propose that emotions have an adaptive role for survival in the environment and this adaptive interpretation was initially put forward by Darwin (1872) (as cited in Ekman, 1982, p. 239). Darwin proposed that animals and humans are both born with the ability to decode the emotional meaning of some facial expressions. This was confirmed by questioning people from isolated tribes and identifying similar facial expressions to communicate specific emotions independent of language and culture (Ekman, 1992). This forms the basis of the Basic Emotion Theory (BET) which proposes that emotions are brief states that involve physiological, subjective and expressive components that facilitate an adaptive response to primary survival issues from the evolutionary perspective of avoiding danger, family protection and hierarchy (Keltner et al., 2019). Although the universality of this has been questioned (Crivelli et al., 2016), it is a widely accepted theory which suggests a biological basis for emotions.

The notion that there are basic emotions was taken forward by Tomkins (1962) who proposed a theory based on a series of innate primary emotions, the features that identified them, their development and their significant role in the life of individuals. According to this view, it is only when someone becomes aware of their facial expression, that they become aware of their emotions (Tomkins & McCarter, 1964).

The emphasis on facial expressions was further investigated in studies on facial expression of emotions and emotion recognition in faces, by Carroll Izard. Izard (1977; 1989) proposed the 'Differential Emotions Theory' (DET), which views emotion experience as a feeling state, a direct result of the neural processes associated with that emotion. It is deemed to be experienced immediately before any cognitive processing can take place. Accordingly "In an evolutionary-biopsychological perspective, emotions are called basic because of their hypothesized role in evolution (e.g., Plutchik, 1980), their biological and social functions (Izard, 1989), and their primacy in ontogenetic development (Izard & Malatesta, 1987)" (Izard, 1992, p. 562). An inherent implication of the evolutionary model is that emotion as an entity should be universal. The fact that brain stimulation could elicit emotion is sufficient to draw into question the role of cognition as essential for emotional experience (Izard, 1993). Izard suggested that emotions could be activated by four mechanisms: neural (non-cognitive evaluative processes), sensorimotor, motivational and cognitive. These are proposed as separate but highly interactive hierarchical systems.

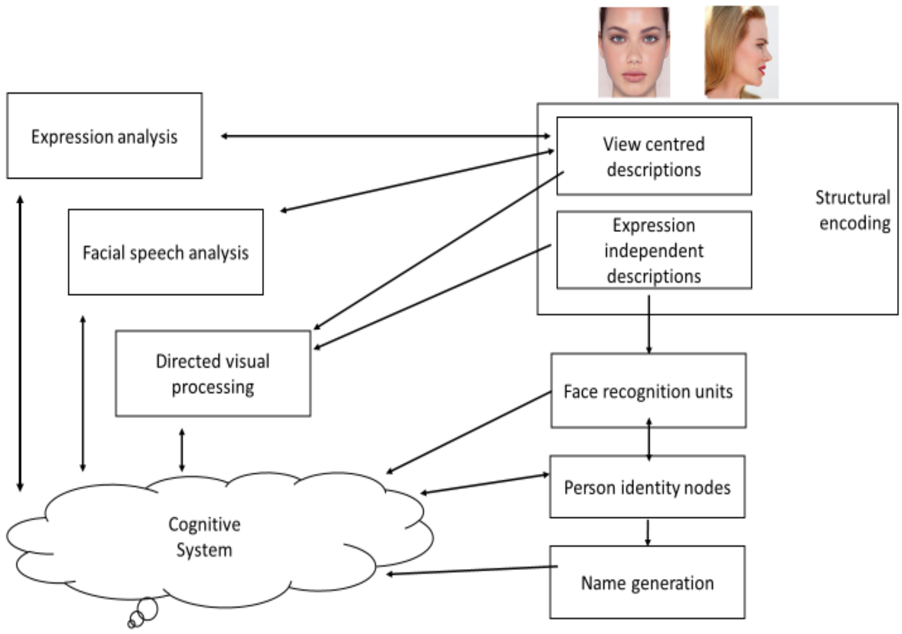
It is not universally accepted that emotions are discrete entities, and it has been proposed instead that they are variable and context driven and therefore part of a cognitive evaluative system (Barrett & Wager, 2006). For Barrett (2006) the emotion paradox, as she terms it, can be resolved by the categorisation account. This assumes individuals have a core affect that is a basic biological substrate available to be categorised. This is constantly changing based on valuations of the environment and motivations. Humans draw on conceptualisations of emotions, such as Anger, previous experiences and contexts from memory to tailor these to the current situation and categorise it as 'Anger'. As such, conceptualisations of Anger are different for everyone and the context will determine which conceptualisation will be constructed at any point in time (Barrett & Wager, 2006). Barrett disagrees with the evolutionary hierarchical model proposed by Izard (1993) on the fundamental belief that emotions, as we understand them, do not exist without cognition and memories to conceptualise them, and rely on personal interactions and experience to categorise them in a social context. For Barrett therefore, emotions are experienced differently by everyone depending on their social environment and it is language that helps us to categorise them. This suggests that limited verbal skills would impact the ability to recognize and categorise emotions and there is some evidence supporting this (Montebarocci et al., 2011) Furthermore, the social context impacts how faces are processed (Bublatzky et al., 2014) which strongly supports a cognitive role in emotion processing.

Whilst there is no clear consensus on a comprehensive theory of emotion, there are different stages in the processing of emotion that satisfy each model which are not mutually exclusive. There is a common acceptance, whichever theory is advanced, of the role of emotion in expression and recognition to achieve good social integration (Van Kleef, 2010). The existence of basic innate emotions remains the dominant perspective for emotion research (Fusar-Poli et al., 2009). Cross-cultural research conducted by Ekman in the 1960's, consisted of presenting participants with pictures of actors making emotional expressions and asking them to judge the expressions. The general ability to recognise six basic emotions (Happy, Sad, Fear, Anger, Surprise and Disgust) was evident even in isolated and tribal cultures (Ekman & Friesen, 1971). This was interpreted as confirmation of the innate nature, neurophysiology and neuroanatomy of emotional facial recognition and led to the development of a database of Pictures of Facial Affect (Ekman & Friesen, 1976). This paradigm has been widely used in research on emotions and emotion recognition (Fusar-Poli et al., 2009). Whilst the notion of basic emotion is not universally accepted (see Ortony & Turner, 1990 for a review; Barrett & Wager, 2006; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012), it is widely supported and has formed the basis for much research on emotion recognition (Ekman, 1992; Fusar-Poli et al., 2009; Izard, 1992). Facial emotion recognition is a key process underpinning the communication of emotions and social interaction, it is therefore the approach adopted for the research in this thesis due to its wide use and ease of implementation.

1.3 Face recognition

As an outward sign of both emotional experience and communication of intent, facial emotion expressions and the ability to read them effectively underpin social cognition and our interactions with others (Morrison & Bellack, 1981). There are several theories about how and where this occurs in the brain. Research into understanding the brain mechanisms and connections activated in face processing has been facilitated through animal studies (Ghashghaei & Barbas, 2002; Murray, 2007), brain injury patients (Babbage et al., 2011) and with developing technology, functional Magnetic Resonance Imaging (fMRI) (Brooks et al., 2012), Positron emission tomography (PET) (Phan et al., 2002), electroencephalogram (EEG) (Rousselet et al., 2007) and transcranial magnetic stimulation (TMS) studies (Bush et al., 2000).

A face needs to be identified as a face before any specific facial emotions are recognised. Interest in cognitive theory and advancements in technology such as imaging techniques facilitated a growing interest in understanding face recognition in the 1980’s (Gross & Sergent, 1992). Bruce and Young (1986) put forward a model for face recognition which indicated processing pathways and modules for the recognition of faces. They proposed a distinction between the processing of familiar faces, which should be automatic and rapid, and unfamiliar faces, which should require more time and effort. According to this model seven types of information can be gleaned from faces: pictorial, structural, visually derived semantics such as age and sex, identity specific semantics such as shape of nose or mole, name, expression and facial speech code in the form of lip movements. The Bruce and Young model assumes that facial emotional expressions are not important for face recognition per se. Therefore, the emotional content of faces i.e. expressions, are analysed separately from identity. The model (see Figure 1 below) predicts that judgments about facial emotional expressions should not be influenced by the familiarity of the face and therefore there is functional independence between identity (familiar and unfamiliar) and emotional expression processing.



Source: Adapted from Bruce & Young (1986)

Figure 1. Face Recognition Model

Several studies by Bruce and colleagues contributed to the formulation of this model. Bruce, (1982), presented healthy participants with pictures of both familiar and unfamiliar faces. The faces were learned and unlearned, changed viewing angle (frontal and three-quarter angle) and changed expression (smiling to unsmiling) or changed in both angle and expression. In agreement with previous research (Walker-Smith, 1980), Bruce found that unchanged faces were recognised more quickly and accurately than those with a change in angle or expression, which in turn were recognised more accurately than faces with changes in both. In the same study (Bruce, 1982) a second trial was conducted using familiar and unfamiliar faces with similar results to the first trial with the addition that unfamiliar faces were recognised more slowly and less accurately when a change had occurred, whereas familiar faces were recognised with the same accuracy as previously but at a slower rate. See Posamentier and Abdi, (2003) for a review of processing of faces and expressions. The Bruce model was also tested using an identity matching task, and an emotion matching task (Young et al., 1986). Participants viewed pairs of faces, some familiar and some unfamiliar, and needed to decide if they were the same or different in terms of identity or expression. Participants were quicker in responding to familiar faces for identity but there was no difference between familiar and unfamiliar responding when asked about expression. This finding is consistent with the predictions that speed of expression recognition would not differ between familiar and unfamiliar faces, but identity recognition would be quicker for familiar faces than unfamiliar. It is also in line with the model proposed by Bruce and Young (1986) and supports the theory in proposing that emotion recognition is a separate process and independent of identity recognition.

Further support for the dissociation between the recognition of faces and emotions was based on case studies of patients suffering from prosopagnosia, which is a condition whereby people lose the ability to visually recognise the identity of individual faces previously known to them but can still recognise emotional expressions and voices (Humphreys et al., 1993; McNeil & Warrington, 1993). These studies showed a double dissociation between the ability to recognise faces but not emotions and vice versa. However, it is difficult to draw exact conclusions about specific brain areas from such studies due to the plasticity of the brain which re-organises itself to compensate for damage, recruiting resources from other brain areas to complete tasks as evidenced by stroke victims (Johansson, 2011). There was also the proposal that those suffering from prosopagnosia were not deficient in the recognition of faces per se, but it was the similarity and complexity of the category which caused the difficulty. Therefore, similarly complex objects would also be problematic for those suffering from prosopagnosia but Farah (1995) in her studies discounted this.

However, the Bruce and Young model (1986) has been challenged in research conducted by Endo, Endo, Kirita, and Maruyama (1992) who conducted two studies, one used familiar and unfamiliar faces but with three different emotions (Happy, Angry, Neutral) rather than single or two emotions as used by Young et al. (1986). Endo et al. (1992) found that familiar faces were recognised quicker when they had a Neutral emotion rather than Happy or Angry. In their second study, Endo et al. (1992) tested whether familiar faces were recognised quicker with a Neutral or Happy emotion, and they used famous faces as the familiar, with both Happy and Neutral emotions. The familiar faces were recognised quicker with the Happy emotion than the Neutral emotion. Both studies indicate an impact of emotion on speed of recognition of the familiar faces, indicating there is an effect of facial emotion expression on recognition which contradicts the Young and Bruce model. However, it should be noted that the impact should be the same for personally familiar and famous familiar faces which was not the case in the studies by Endo et al. (1992). These conflicting results were explained in terms of an instance based model (Johnston & Barry, 2001) where famous faces are viewed repeatedly and seen in the media with Happy emotions which may be the prototype encoded for that face, whereas personally familiar faces would be encoded with a more Neutral emotion, thus both resulting in quicker recognition but for different emotions. In another study (Sansone & Tiberghien (1994) cited in Posamentier & Abdi, 2003, p. 116), images were presented for learning with the same expression 5 times, the unique condition, or 4 times with the same expression and one time with a different expression, the mixed condition. Participants were shown an image of the face with a new facial expression to those shown previously. Faces were recognised quicker by those in the mixed condition than the unique condition. This shows that encoding the face with more than one expression, facilitated recognition of the same face with a novel expression over single expression encoding.

In a review of evidence on face processing and facial expressions (Posamentier & Abdi, 2003) covering neuropsychological studies, psychology studies, neuroimaging and event-related potential (ERP) studies, overall evidence points to the existence of dissociable systems involved in the processing of facial expressions. A review of the evidence from neuroimaging studies was examined (Haxby et al., 2002) and based on the evidence, Haxby et al. (2002) developed a hierarchical model of a 'Distributed Neural System for Face Perception'. They propose this model which breaks down the steps for face and emotion recognition and attempts to clarify the process of where in the brain they occur. See Figure 2.

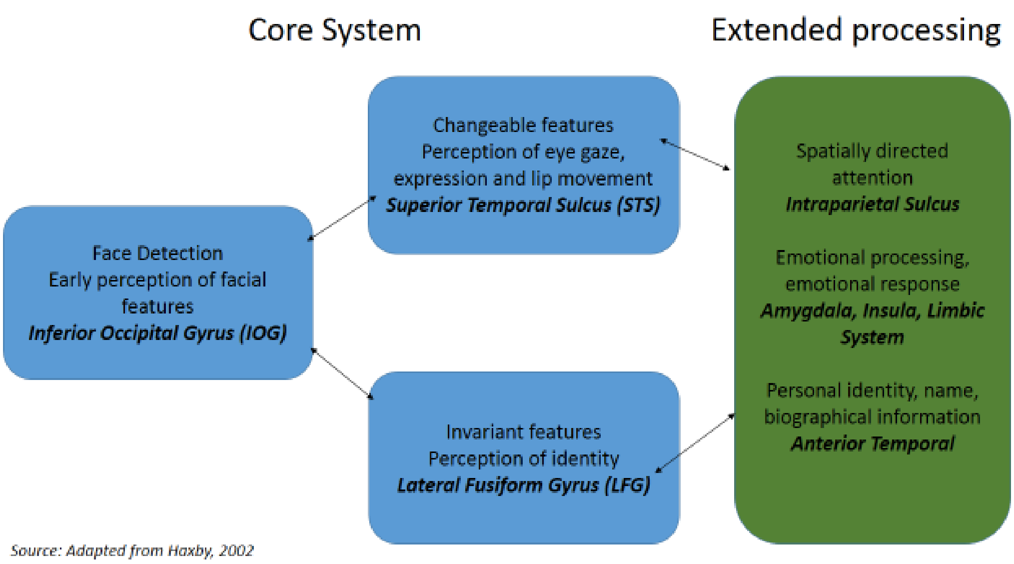


Figure 2. Core system for face recognition

The model by Haxby et al. (2002) distinguishes between the processing of invariant features of faces, e.g. the distance between the eyes, which are key to recognition of unique identity and the processing of changeable aspects of faces which are key to perception of information that facilitates social interaction. These form part of what he called the core system for the visual analysis of faces. Haxby et al. (2002) also introduced the extended system that processes the meaning of information gleaned from faces. The author proposes a coordinated participation of multiple regions of the brain to accomplish face perception functions. For example, processing the spatial information conveyed by gaze and head position involves the recruitment of the face-responsive region in the superior temporal sulcus and the spatial attention system in the intraparietal sulcus, whereas processing of emotional expression involves the recruitment of regions for the visual analysis of expression and regions for the representation and producing emotions which include parts of the amygdala and insula.

The implication of this model is that a cognitively defined function such as emotion recognition, does not have a brain area specialised in just that task, but specific brain areas work together to contribute to achieve the function (Haxby et al., 2002). Fairhall and Ishai (2007), conducted fMRI scans and Dynamic Causal Modeling to investigate the effective connections between the core and extended systems as identified by Haxby et al. (2002). Their findings confirmed a hierarchical structure of the core system, and that the fusiform gyrus plays a dominant role on the extended system, which includes emotion processing. Fairhall and Ishai (2007) found a difference between connectivity of emotional and famous faces, with emotional faces displaying more connectivity between the fusiform gyrus and the amygdala, whilst for famous faces there was more connectivity between the fusiform gyrus and the orbitofrontal cortex. They concluded that the connectivity of the visual-limbic and visual-prefrontal face responsive pathways differed depending on the face content. In addition from a functional perspective, Adolphs (2001) identified that social cognition draws on numerous abilities and brain structures in the evaluation of emotion and social environment. In effect, Adolphs proposes that a typically complex, emotionally relevant scenario requires the amygdala, ventromedial frontal cortex and right somato-sensory related cortex to work together in parallel. The amygdala provides a quick and automatic attention bias with respect to those aspects of the response relating to the evaluation of the potentially threatening environment or with respect to allocating processing resources to those stimuli that are potentially important but ambiguous. The ventromedial frontal cortex associates elements of the situation with elements of previous experiences and sets off a replay of the corresponding emotional state. By contrast, the right somatosensory-related cortices are called upon to the extent that a detailed, comprehensive representation of the body state associated with emotional or social behaviour needs to be made available. All of these components would be important to guide social behaviour in a typical situation in real life, and all of them emphasize the close link between emotion and social cognition (Adolphs & Anderson, 2013).

The social environment also has a role in shaping how social cognitions function. A review by Hari and Kujala, (2009) makes the link with how the social world influences the mind. This is a departure from looking at where in the brain certain social cognitions occur. Hari and Kujala (2009) contend that environment and culture help to shape activity in specific brain areas. While many common brain areas are activated whilst conducting the same task, not all brain areas will be activated in the same way across all subjects indicating the individuality of brain areas. This is demonstrated in a study of Chinese and Western participants looking at how they respond to judgements of personal trait adjectives of self, mother or a famous person (Zhu, Zhang, Fan, & Han, 2007). The medial prefrontal cortex (MPFC) and anterior cingulate cortex (ACC) were similarly activated for self and famous person judgements for both Chinese and Western participants, whilst the MPFC was activated for mother judgements in Chinese but not Western participants. There is a complex inter-relationship, therefore, between our social environment, social cognitions and emotions.

The models discussed are important in showing the progression in understanding of emotions and how and where they are processed in the brain. The distributed model such as the one proposed by Haxby et al. (2002) is perhaps the most convincing as it demonstrates the complexity of the processes. It also explains how some aspects of emotion processing may be impaired whilst others continue to function normally.

Any process that occurs in the brain, such as emotion recognition, is potentially susceptible to change due to alcohol. Alcohol has been shown to cause neuroanatomical changes leading to cognitive impairments in patients with an alcohol use disorder (AUD) (Bernardin et al., 2014). Whilst the whole brain is vulnerable to alcohol, the most severely impacted areas are the frontal lobes, specifically the prefrontal cortex (PFC), an area also key for normal cognitive, emotional and interpersonal functioning (see Oscar-Berman & Marinkovic, 2003 for a review). Therefore, it is likely that there are consequences for emotional impairments on social interactions. For example, Carton, Kessler, and Pape (1999) identified a relationship between emotion recognition and social well-being, where non-verbal decoding skills were significantly related to relationship well-being.

Specifically, problems in correctly identifying facial emotion expressions and tones of voice were associated with less relationship well-being (Carton, Kessler, & Pape, 1999) and these have also been found to be associated with alcohol use (Maurage, Campanella, et al., 2009).

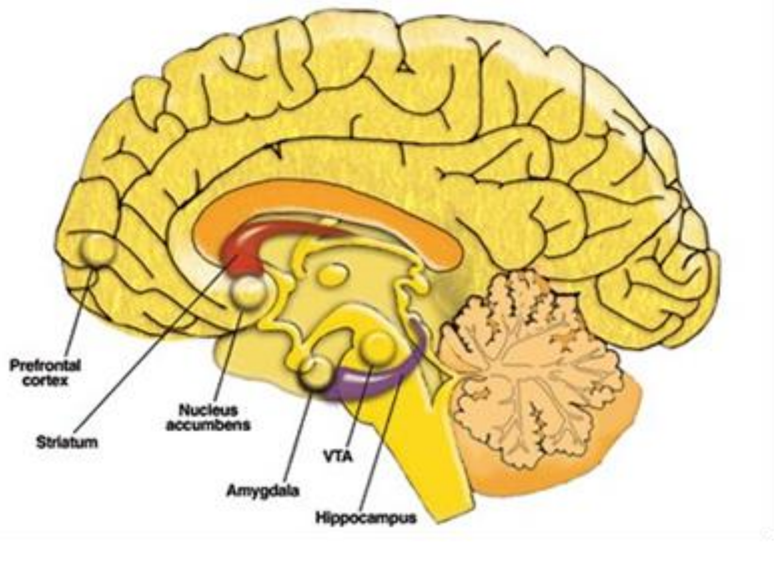
The next section provides an overview of the impact of alcohol on the brain and then specifically emotion recognition as identified though indirect tasks and neuroimaging studies.

1.4 Alcohol and the Brain

Chemically alcohol is ethanol or ethyl alcohol, but it is commonly known as alcohol. Once consumed alcohol is broken down in the liver to form acetaldehyde and alcohol which are molecularly small and can cross the blood-brain-barrier (Nutt, 2020). The pharmacology of alcohol is complex, and it impacts most parts of the body but particularly the central nervous system (CNS), the cardiovascular system, and the liver and gastrointestinal system, as well as having adverse effects on metabolic pathways (Drummer, 2014). In the CNS alcohol has a pervasive reach given its structure, impacting neurotransmitters, neuromodulators and proteins. The main neurotransmitters impacted are the gamma-aminobutyric acid (GABA), the predominant inhibitory neurotransmitter and glutamate the main excitatory neurotransmitter, which are effectively the on-off switches for the brain. When glutamate is released then GABA is also released to balance it as too much glutamate in the system leads to anxiety and potentially brain damage. Along with these neurotransmitters there are neuromodulators which alter the response of the brain rather than directly affecting it. For example, noradrenaline which adds emotional information to memories but is not the main component in memory creation. Along with noradrenaline, serotonin (a monoamine neurotransmitter) and dopamine, which is key to the mesolimbic reward pathways are also widely impacted by alcohol (McIntosh & Chick, 2004). Alcohol works at a chemical level in the synapse impacting the transmission and receptors between neurons. When alcohol enters the CNS the first reaction is to turn on the GABA system so that one starts to feel relaxed. However, when there is too much GABA then other parts of the brain switch off such as judgement, controlled by the frontal cortex which is particularly sensitive to alcohol. As more alcohol is consumed and blood alcohol levels increase to 80 milligrams per 100 millilitres of blood (80mg%) the glutamate receptors become blocked and when 150mg% is reached the ability to lay down new memories is lost resulting in an alcohol induced blackout. Rising blood alcohol levels also increase the effect of serotonin which is a mood enhancer making people feel more empathetic. Alcohol also releases dopamine which is involved in drive, motivation and energy. It makes the individual feel more active, enthusiastic and louder. Dopamine is also involved in laying down patterns of behaviour and is therefore key in addiction. In addition, endorphins are released with the consumption of alcohol, which contribute to the feelings of pleasure and are also associated with addiction. Whilst broadly alcohol has a certain impact on the functioning of the brain the outcome can vary depending on the individual, the context and the intensity of chemicals within the brain.

Those with an alcohol use disorder (AUD) have been identified as one group with impaired social cognition and emotion recognition (see Bora & Zorlu, 2017 for a review). There has been significant research examining which areas of the brain are impacted by alcohol and this has evolved from the deterioration of normal functioning evident in those with an alcohol use disorder (AUD). The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) identifies AUD as a problematic pattern of alcohol use leading to clinically significant impairment or distress. The severity of the AUD is categorised by experiencing several specific criteria over the previous 12 months (See Appendix 1). Excessive alcohol use and alcohol dependence (AD) exist along a continuum of AUD (Helzer et al., 2006) with the most severe being alcohol dependence (AD). Alcohol dependence is characterised by: "*a strong desire to take the drug, difficulties in controlling its use, persisting in its use despite harmful consequences, a higher priority given to drug use than to other activities and obligations, increased tolerance, and sometimes a physical withdrawal state"* (ICD – 10, 2019). In conducting research amongst those with a severe AUD it is difficult to identify whether the impairments viewed are the result of the alcohol itself, or other related factors such as thiamin deficiency. A review by Harper, (2009) identified studies using fMRI and an uncomplicated AD (i.e., with no other related conditions) and established that ethanol impacts the brain causing brain shrinkage, mainly of the white matter, and neuronal loss in parts of the cerebral cortex (superior frontal cortex), hypothalamus (supraoptic and paraventricular nuclei), and cerebellum. The author found many areas of the brain that were normal in uncomplicated AUD were damaged in those with Wernike-Korsakoff syndrome. Harper (2009) suggested that the identified changes in dendrites and synapses, together with alterations in the receptors and transmitters, could explain the functional changes and cognitive deficits which are perceived in uncomplicated AUD before structural neuronal changes which occur with more severe alcohol intake.

The main areas of the brain that are impacted by alcohol are the frontal lobes, limbic system - including the amygdala, and cerebellum (Oscar-Berman & Marinković, 2007). The amygdala has been linked to emotion recognition in so far as it directs attention to the eye region of emotional faces for information gathering (Adolphs, 2002; Adolphs et al., 2005; Gosselin, Spezio, Tranel, & Adolphs, 2011; Kennedy & Adolphs, 2010). The influence of alcohol therefore could impact the normal functioning of attention to the eye region.



Source: *Clapp, Bhave & Hoffman. 2008.*

Figure 3. Some of the areas of the brain that are affected by alcohol, including the mesolimbic dopamine system (which includes the ventral tegmental area, nucleus accumbens, and prefrontal cortex), amygdala, striatum, and hippocampus.

Cognitive impairments in those with an AD mainly affect executive functions, episodic memory and visuospatial abilities (see Bernardin et al., 2014 for a review). There are three main theories of how cognitive impairment occurs in those who abuse alcohol: the frontal lobe hypothesis, the lateralisation hypothesis and the diffuse brain hypothesis (Smeraldi et al., 2015).

The frontal lobe hypothesis works on the understanding that it is the frontal lobes that are most vulnerable to the effects of alcohol. A review on frontal lobe changes in alcohol dependence found supporting evidence for the frontal lobe theory from different types of studies, including animal studies, post mortem studies, computer tomography (CT) and fMRI studies of structural abnormalities in the frontal lobe system in AUD (Moselhy, Georgiou & Kahn, 2001). Deficits in planning, problem solving, manipulating abstract concepts and visuospatial abilities were also identified in the review supporting the frontal lobe hypothesis. However, these findings are not consistent and do not appear in all studies (Fama et al., 2004) which suggests that the frontal lobe hypothesis only partly explains the deficits and there are other factors involved. The lateralisation hypothesis states the right hemisphere functions are more vulnerable to the effects of alcohol. This has a role in selective attentional processing and is also supported by results of tests for impairments amongst those with an alcohol dependence (Evert & Oscar-Berman, 2001). Finally, the diffuse brain dysfunction hypothesis posits that alcohol affects all areas of the brain and is supported by research identifying verbal, visuospatial and abstracting deficits (see

Parsons, 1998 for a review). Research was conducted amongst a clinical sample of 55 people with a diagnosed alcohol dependance to compare all three hypotheses (Smeraldi et al., 2015). The following tests were included to cover all aspects of cognition relating to each hypothesis: verbal memory (word recall); working memory (digit sequencing); token motor task (psychomotor speed and coordination); selective attention (symbol coding); semantic fluency; letter fluency; Tower of London; MODA, which is a short neuropsychological paper and pencil test used to assess dementia. It was concluded that frontal functions are quite resilient to alcohol damage and therefore did not confirm the frontal lobe hypothesis. However, neither were the results for either of the other two hypotheses conclusive. A notable limitation of the study is the small sample size and complex drug use of the sample making it difficult to attribute the results exclusively to alcohol consumption and not a combination of other clinical features or other drug abuse. This study was therefore not sufficiently robust to be able to confirm a single theory of the how alcohol impacts the brain and cognition. Nonetheless, there is evidence from this and other studies (e.g. Field, Schoenmakers & Wiers, 2008; Irwin, Leveritt, Shum & Desbrow, 2013; Rose & Duka, 2007) to acknowledge the impact of alcohol on cognitive functioning, particularly executive functioning, in those with a severe AUD or AD although a comprehensive theory is yet to be put forward. In addition to this, there is evidence to suggest an impact of alcohol consumption on social cognition and this is outlined below.

1.4.1 Alcohol and Emotion Recognition

The exact hypothesis regarding how the main structures of the brain affected by alcohol interact continues to be explored, it is nonetheless evident that excessive alcohol consumption does affect the neuronal transmissions and brain structure which in turn impacts perception and behaviour (Harper, 2009; O'Daly et al., 2012). One aspect of this, not yet highlighted, is the neuropsychology of emotional alterations associated with alcohol. The role of the amygdala with respect to emotions has been demonstrated (Kennedy & Adolphs, 2010) and also how it responds to alcohol consumption (Glahn et al., 2007; Wrase et al., 2008).

The impact of the acute consumption of alcohol on the amygdala and emotion recognition has also been examined. Hur et al. (2018) conducted a single blind study using fMRI to measure the reactivity of the central extended area of the amygdala when participants were looking at emotional expressions (fearful or neutral) or buildings (suburban residential homes or urban skyscrapers) following the administration of alcohol or a placebo. The researchers confirmed the findings from animal studies of reduced reactivity in two areas of the amygdala to emotional faces but not buildings following the administration of alcohol versus the placebo. In addition to the acute impact of alcohol on the amygdala, emotion recognition amongst social drinkers was examined following the acute administration of alcohol or a placebo (Khouja et al., 2019b). Participants completed a forced choice recognition task of 6 emotions (Anger, Disgust, Fear, Happy, Sad, Surprise). Whilst the study did not identify any clear impairment in emotion recognition following the consumption of alcohol there was weak evidence of a bias towards anger perception which could contribute towards alcohol related aggression. These studies focused on social drinkers and the acute administration of low doses of alcohol. Behaviourally, there was little difference in emotion recognition although there was a bias towards anger and there was a dampened response in the amygdala. However, the current study is more concerned with the longer-term impact of withdrawing from binge drinking episodes on emotion recognition rather than any acute impact.

Carton et al., (1999) identified a relationship between emotion recognition and social wellbeing. In support of this and extending the finding to those with an alcohol dependence (AD), Kornreich et al. (2002), identified through the literature that those with an AD also had difficulties in maintaining healthy interpersonal relationships even when they were not under the influence of alcohol. This suggests that the impact goes beyond the acute consumption of alcohol to something more enduring.

A systematic literature review (Donadon & de Lima Osorio, 2014) of the recognition of basic facial expressions by those with an alcohol dependence in terms of accuracy, intensity and latency was conducted. The results were not conclusive as the authors found that in some studies those with AD display greater impairments in facial emotion recognition tasks, while others found no difference between the clinical group and controls. However, Donadon and de Lima Osorio (2014) did conclude that there was a trend towards greater deficits in those with an AD. Individuals with an AUD were more likely to commit more errors in the recognition of Sad and Disgust and required greater emotional intensity to recognise facial expressions of Fear and Anger. This is supported by fMRI studies which have shown that those with an AUD have lowered brain activation in regions that mediate visual, auditory and visual-motor processes and deficits in processing Anger (Hermann et al., 2007).

With regard to the accuracy of emotion recognition some studies found those with a severe AUD showed greater impairment in some emotions than others (Carmona-Perera et al., 2014; Kornreich et al., 2001). By contrast, others found no difference between groups in accuracy (Foisy et al., 2007) indicating there was no impairment in ability to recognise emotions. The results, therefore, were inconsistent with regards to accuracy. Studies examining emotional intensity found greater intensity was needed for alcohol dependent participants to identify emotions (Frigerio et al., 2002). However, for the emotion of Happy there were no between-group differences. This absence of differentiation between groups for the recognition Happy has been interpreted as a preservation of positive emotions. It has been suggested that it may be a case of novelty; Happy is often the only positive emotion presented and therefore tends to stand out amongst the negative emotions facilitating identification. Where a group of positive emotions are displayed there is a more generalised impairment to these emotions also (D'Hondt, Lepore, et al., 2014). With regards to latency, those with an AUD did require more time for emotion recognition (Donadon, & de Lima Osorio, 2014).

Donadon and de Lima Osorio (2014) did note the lack of commonality between stimuli and procedures in the studies identified for their review but concluded that this did not appear to have influenced outcomes. The authors acknowledged there may have been other confounding variables which had an impact on the inconsistency of results, particularly regarding the clinical samples: lack of an intelligence test in the clinical sample, or control and identification of comorbid personality disorders along with duration and severity of dependence. Nevertheless, it does seem that simple studies, such as a yes / no response to identifying an emotion, are less sensitive to impairments whereas the more complex tasks needing more input and processing by participants, such as identification of a morphed emotion and selection from a list of four or more options, are able to demonstrate differences, which may offer an alternative explanation. It has been noted elsewhere (D'Hondt, Lepore, et al., 2014) that the research amongst individuals with an alcohol dependence tends to be predominantly conducted by relatively few researchers and predominantly in Europe and the lack of standardised methods and stimuli makes direct comparisons difficult.

The deficits identified are important however, as they may have an impact on the social interactions of the individual who is dependent on alcohol. This is more relevant as the impairments related to social cognition are not restricted to the variables mentioned above and also of note is that those with an alcohol dependence have a tendency to overestimate emotions and show response biases towards negative emotions (Townshend & Duka, 2003). One implication of this is that those with a severe AUD are more susceptible to displaying inappropriate reactions in social settings. Thus, those with a severe AUD may experience difficulties in interpersonal relationships and social isolation and even become involved in fights and/or aggression which can reduce quality of life and reinforce alcohol use as a coping mechanism. The impact of different patterns of alcohol consumption, such as binge drinking, on cognitive processing is addressed in the next section.

1.4.2 Binge drinking and cognitive processing

Binge drinking is the consumption of at least 60 grams or more of pure alcohol, 5 or more standard alcoholic drinks, at least once in the last 30 days (WHO, 2018). As different researchers consider various additional factors such as the speed of drinking or the number of occasions of bingeing per month, it makes research into this topic difficult to advance as not everyone is measuring the same concept of binge drinking. This issue can be demonstrated by just looking at three studies, one conducted in 2007 (Brumback et al., 2007) and two in 2009 (Crego et al., 2009; Maurage, Pesenti, et al., 2009) where the criteria for binge drinking varied widely. The 2007 study (Brumback et al., 2007) looked at a population consuming 10 or more drinks per week with regular (1-5) occasions of 'binge' consuming >5 drinks on one occasion for males and > 4 for females. The control group consumed fewer than six drinks per week with no 'binge' episodes. By contrast in the Crego et al. (2009) study, binge drinkers consumed 6 or more standard drinks on one occasion at least once a month and drank at a speed of at least 3 drinks per hour, whilst in a longitudinal study (Maurage, Pesenti, et al., 2009), binge drinkers were categorised as consuming 20 units per week and the control group consumed less than 3 units per week. The definition of binge drinking is evolving and, as can be seen in the examples above, the lack of precision and consistency, not just for binge drinking but also the control groups, makes cross-study comparisons and generalisations difficult. This is a considerable stumbling block in the advancement of generalisable knowledge in this area of alcohol consumption (Courtney & Polich, 2009). Attempts to standardise the definition have previously been made using single occasion drinking > 5 drinks for males and > 4 for females which was used in large scales studies in the US (Weschler et al., 1994). However, single occasion use was not seen as a comprehensive approach to binge drinking and Townshend and Duka, (2002) addressed this using an adaptation of the Alcohol Use Questionnaire (Mehrabian & Russell, 1978) which did not just consider the volume of alcohol consumed but also the pattern of consumption in terms of frequency of getting drunk and speed of drinking. Notwithstanding the introduction of this measure to operationalise binge drinking in 2002, as can be seen from the studies above, there is still an issue with consistency of approach. In more recent years a more consistent approach based on that by Townshend and Duka (2002) has been applied in studies on binge drinking conducted in Europe (Lannoy et al., 2019, 2017; Lannoy, Dormal, Billieux, & Maurage, 2018) which is useful for comparison purposes. However, as these are all from the same group of researchers it is important for consistency across studies and accuracy in terms of the concept of binge drinking that other researchers also adopt this operationalisation of binge drinking. In order to facilitate this, the current study will use the Townshend and Duka (2002) adaptation of the AUQ to categorise binge drinkers.

Alcohol does not just have an impact on those with an alcohol use disorder but also has an impact on those who drink to excess even occasionally, in terms of feeling hung over, with negative impacts on work performance. Some researchers propose there is a connection between binge drinking and alcohol use disorders suggesting they operate along a continuum (Enoch, 2008; O. A. Parsons, 1998). This continuum hypothesis is supported by neuropsychological studies (see Hermens et al., 2013 for a review) and electrophysiological studies (Maurage, Petit, et al., 2013). The continuum hypothesis suggests that as the same areas of the brain (frontal and temporal regions) appear to be affected by both a binge pattern of drinking and AD that they may be different stages of the same phenomenon. This is not to say that all binge drinkers would eventually have an alcohol use disorder but that the deficits that appear as a result of binge drinking (BD) differ from those of an AD only in terms of severity rather than being qualitatively different, that is, affecting different cognitive functions.

Binge drinking has been shown to impair the ability to withhold a prepotent response, (i.e., an immediate response for which reinforcement is available) a measure of impulsivity (Townshend & Duka, 2005). This stems from a lack of inhibitory control from the frontal lobes and early exposure to BD is associated with frontal lobe damage (Maurage et al., 2012). These researchers found that the younger adolescents were when they started drinking, particularly if they had a binge pattern of drinking, the greater the impact on perception, attention and high-level decision making (Maurage et al., 2012). However, not all changes are found to be negative. In a CANTAB visual search task, BD were in fact quicker at matching the abstract shapes as they showed quicker movement time rather than thinking time implicating motor impulsivity as being impacted by BD (Townshend & Duka, 2005).

It can be difficult to determine if the prefrontal dysfunction existed prior to drinking and could in fact be a predisposing factor in BD behaviour. However, animal studies, specifically rats, found that administering alcohol in a binge pattern followed by periods of withdrawal can also induce cortical damage and lead to related cognitive deficits (Crabbe et al., 2011; Koob, 2003). Further support for this comes from a study by Maurage, Pesenti, et al. (2009) who conducted a longitudinal study on first year university students who had no history of alcohol consumption. Following personality traits and psychological testing, the students were allocated to two groups based on their expected alcohol consumption; a low consumption and binge drinking group. The researchers recorded event related potentials (ERP) whilst participants completed various tasks at the start of the year and again at the end of the academic year, 9 months later. Whilst there were no between group differences at the start of the year, at the second measure the binge drinkers had significantly slower cerebral activity compared with controls. This indicated that even short-term binge drinking could indeed lead to marked cerebral dysfunction. In another longer term study, where the initial measure was taken in the first year at university with a 2 year follow up in year three, deficits were also found in BD in terms of working memory, episodic memory and executive abilities (Mota et al., 2013). In cross-sectional studies of binge drinkers, the impairment of executive function has also been identified in terms of working memory (Parada et al., 2012), perception, attention and decision making (Maurage et al., 2012).

The evidence above points to an impact of the pattern of alcohol consumption, specifically binge drinking, on cognitive functioning over and above the overall amount of alcohol consumed per se. This is an area that warrants further exploration.

The connections between social cognition, emotion recognition and alcohol use, have been outlined above. However, there are other factors such as alexithymia and current mood which impact emotion recognition and interpretation. Nicotine has also been identified as having an impact on some cognitions such as memory (Dawkins et al., 2012, 2013). However with regards to social cognitions, for smokers it appears to be the abstinence of nicotine that impacts emotion responses (Dawkins & Powell, 2011) although the evidence for this is equivocal (see Martin & Sayette, 2018, for a review) information on smoking was included in the data collection.

1.5 Other factors that impact emotion recognition

1.5.1 Alexithymia

Alexithymia is a multifaceted personality construct highlighted as a condition by Nemiah, Freiburger and Sifineos (1976), cited in Grynberg et al., 2012, p. 1. Alexithymia is characterized by difficulty in describing and identifying emotional states and having an externally oriented thinking style (Moriguchi & Komaki, 2013). It has also been associated with impaired emotion recognition and this association is suggestive of a broader emotion processing impairment (Lane et al., 1996). As such it is important to identify whether any of the participants in a study on emotion recognition are impacted by this condition. The term Alexithymia was used to describe clinical patients with psychosomatic problems who had difficulty expressing and describing their emotions. Alexithymia has been identified across different disorders, including autism spectrum disorder (Costa, Steffgen, & Samson, 2017), eating disorders (Cochrane et al., 1993; Kim et al., 2008) and depression (Luminet et al., 2001). In a systematic review, Grynberg et al. (2012) concluded that the emotion recognition identified in disorders such as Autism Spectrum and eating disorders may, in part, be attributed to the comorbidity of Alexithymia.

With regards to alcohol consumption, Rybakowski, Ziółkowski, Zasadzka, and Brzeziński (1988) found a high prevalence of Alexithymia (78%) in an in-patient group of men with alcohol dependence. Other studies indicate prevalence amongst those with an AD ranges between 42 – 79% (Evren et al., 2008) (See Thorberg, Young, Sullivan, and Lyvers, (2009) for a review). Rybakowski et al. (1988) did note the in-patients with alexithymia tended to be younger, with a shorter duration of alcohol dependence but not severity of illness and they also tended to have a higher rate of hypertension. The authors hypothesized that the psychological and biological factors of the inpatients may have made them more susceptible to alcohol and therefore more prone to development of an alcohol use disorder. However, facial emotion recognition was not reported in that study.

Alexithymia is not just found in clinical populations. It has been suggested that the prevalence of alexithymia amongst a student population in the UK could be as high as 17%, which is in line with findings in other countries (Mason et al., 2005). However, whilst the presence of alexithymia does not necessarily correlate with an impaired ability to accurately identify emotional facial expressions (Kessler et al., 2006), as it has been associated with impaired facial emotion recognition (Lane et al., 1996; Senior et al., 2018), and given the prevalence of alexithymia among the target population for the current study it would be prudent to include this as a measure in the current study.

1.5.2 Mood

Mood states are a factor identified as having an impact on information processing (Schmid, Mast, Bombari, Mast, & Lobmaier, 2011). The effects of mood states on memory have been intensively investigated because of their importance for understanding the relationship between emotional and cognitive processes. Bower (1981) developed an associative network theory of how emotions influence cognitions which attempts to explain this phenomenon. A theoretical framework was proposed whereby emotions are represented as units within a semantic network that encodes memories. This network theory of emotions (Bower et al., 1981) assumes that by spreading activation, a dominant emotion will increase emotion-congruent interpretations of stimuli and the environment.

This type of activation would result in phenomena such as mood-state dependent memory (MDM) and mood congruent learning. Those parts of the brain involved in memory are the limbic system, which includes the hippocampus, the amygdala, the cingulate gyrus, the thalamus, the hypothalamus, and are also implicated for emotion memory, recognition and behaviour (LeDoux, 1997). Understanding this phenomenon may highlight other aspects to consider for face and emotion recognition and whether they are also impacted by mood states and by alcohol consumption.

Mood-state-dependent memory is when memory is optimised when mood at recall is the same as mood at learning (Bower, 1981). This is also linked to emotional valence and interpretation of emotional stimuli. Studies attempting to confirm and clarify the processes involved in the phenomenon have been inconsistent (see Blaney,1986 for a review). One suggested explanation for the inconsistent results could be that the tasks that involve internal processing such as reasoning and thoughts, are more sensitive to mood manipulation whereas tasks that originate from external events are not particularly sensitive to modification of mood (Eich & Metcalfe, 1989). Ucros (1989) conducted a meta-analytic review and found that mood-state-dependent memory is more often observed when the mood is positive than when it is negative. She concluded that the variability in findings could be attributed to methodology in terms of the nature and complexity of the experimental environment and the motivation of the participants.

Mood congruity suggests that learning and recall are most effective when the learners' current mood is congruent with the affective content. Rinck, Glowalla, and Schneider (1992) studied mood congruity by putting participants into either happy or sad moods and asking them to rate the emotional valence of a list of words. The next day they were asked to recall the words. It was hypothesised that there would be mood-congruent learning of strongly toned words and mood incongruent learning of slightly toned words due to the elaboration required to rate the words. Both predictions were upheld in these two experiments. This demonstrated that mood congruent and mood incongruent learning could take place in the same experiment using the same stimuli. This was explained through the elaboration required in processing the slightly toned incongruent words in order to rate them. Rinck, Glowalla and Schneider (1992) emphasised the importance of the materials and stimuli when conducting research into mood and memory as these could impact the outcomes and offer some explanation for conflicting and inconsistent results. Eich (1995) elaborated on this and in his review highlighted four elements that were requisite to finding a positive result for mood dependent memory:

- Nature of the target events – it is more effective if the participants generate the target events through internal processes such as imagination, reasoning and thought
- Nature of the retrieval task – free-recall seems to be a more sensitive measure of mood dependent memory (MDM) than primed or recognition memory

- Efficacy of mood modification – this needs to be intense and effective for MDM to occur
- One-dimensional or two-dimensional modifications of affect – the MDM will be more apparent when both mood and arousal are modified rather than mood alone

Forgas and Locke, (2005) identified that mood state can also influence the social judgements of participants whereby participants in a happy or good mood were more forgiving and less judgmental about others whist those in a negative mood were more critical and harsher in their judgements. This was explained by the amount of processing required so that judgements that require extensive processing are often influenced by mood state, but those that can be made easily are less likely to be influenced by mood. Elsewhere, it was found that there is more evidence of mood-congruent retrieval with positive than with negative affect (Rusting & DeHart, 2000). This was understood to occur because many people in a negative mood are actively trying to change that mood and therefore do not produce a mood congruent effect.

Given the evidence provided thus far it would be reasonable to expect similar mood-congruity in the recognition of facial expressions such that in a positive mood, faces with positive expressions would be recognised more quickly and accurately while in a negative mood, negative expressions would be recognised more quickly and accurately. This effect is fairly clearly identifiable in a laboratory setting where for example Schmid and Schmid Mast (2010) were able to demonstrate a negative bias for emotion recognition in a negative mood and a positive bias in a happy mood. There is however, evidence that whilst this is the case in some situations, with patients, in a clinical setting, it can be difficult to disentangle whether it is mood or other cognitive impairments that negatively impact the patient's ability to recognise emotions. Asthana, Mandal, Khurana, and Haque-Nizamie (1998) found an emotion deficit in clinically depressed patients whereby they had difficulty differentiating between emotional and Neutral expressions and difficulty in discriminating between emotions. In the same study the authors found a visuo-spatial deficit indicating a more pervasive impairment than just emotion specific. It is suggested (Rottenberg et al., 2005) that rather than a specific emotion deficit amongst depressed patients there is a reduced response to all emotional cues instead of an emotion specific negative bias.

Mood is implicated more generally in facial emotion recognition. Bouhuys, Bloem and Groothuis (1995) took healthy subjects and induced depressed and elated moods using music. Participants had a previously rated set of 12 emotional faces split into six ambiguous facial expressions, an equal mix of positive and negative emotions and six with clear either positive or negative emotions. Eleven participants for whom the induced depression was strongest were analysed separately and results indicated they perceived more rejection and sadness in the ambiguous faces and less invitation and Happy in the clear faces. This subset, with the strongest depression, also identified more Fear in the clear faces that expressed less intensive emotion. This was interpreted as a depression-related negative bias in the perception of facial emotion expression. Furthermore, Schmid and Schmid Mast (2010) found a negative bias in healthy participants in sad moods and a positive bias for participants primed with happy moods in line with mood congruent theory. The recognition of mood congruent expressions was not impacted by moods, but incongruent moods hampered the recognition of Happy and Sad expressions. A limitation of this study was that only two emotions were tested.

It has been established that one of the motives for alcohol consumption is to regulate mood (Cooper et al., 1995), and evidence suggests that regulating mood through alcohol consumption will also impact emotion recognition. Indeed a systematic review (Lannoy et al., 2021) concluded that binge drinking is related to more heightened negative emotional states, including depression and anxiety, and that binge drinkers have difficulty with emotion recognition in others.

In a study Schmid et al. (2011) tested the processing styles of Happy, Fear, Anger and Sad using an eye-tracking methodology to identify whether people in happy and sad moods use different processing styles, either global or local processing, for the different emotions. They concluded that when in a happy mood participants processed information more globally than when in a sad mood. In addition, in the sad mood condition, global information processing improved emotion recognition, whereas in the happy mood condition, processing style did not impact emotion recognition accuracy. However, elsewhere it has been demonstrated that happy moods improve accuracy. Happy moods induce more global and automatic processing (deVries et al., 2018) and a sad mood more local and analytic processing (Gasper & Clore, 2002). It is not unreasonable therefore, to speculate that there may have been a methodological issue with the findings where happy mood did not improve recognition and the mood states induced were perhaps not as intense as necessary to impact processing.

Given the findings above, there is a link between mood state and emotion recognition independent of any association with alcohol. However, because binge drinking has an impact on mood it may hinder emotion recognition (Lannoy et al., 2021). It is necessary, therefore, to measure mood in the current study and account for it in the analysis if any differences in mood are identified between high and low binge drinkers. The measurement of mood chosen will be explained in the Method section of this report. See Section 3.5.3.

The evaluation of facial emotion processing styles has been assisted by advances in technology and computer processing power which meant that eye-tracking use has expanded beyond the original studies which largely focused on simple eye movements (Duchowski, 2002). As in the study above by Schmid et al. (2011), eye-tracking has been shown to be effective in evaluating the processing of perceived information and in linking behaviour and the underlying psychological processes involved in that behaviour (Luna et al., 2008). For this reason, it will be used in the current research and explored in more detail in Section 1.7.

1.6 Attention, visual perception, and scan paths of faces

Given the complexity of individuals' surrounding environment and competing calls on limited mental resources it is not possible to provide the same amount of attention to everything in the visual field. In order to function efficiently the environment is scanned and attention is directed to salient features and stimuli for more detailed processing. Attention therefore is central to the perception of the environment and the next section outlines how that functions.

1.6.1 Attention in visual perception

Attention functions using two main processes; selection and orienting (Yang et al., 2012). The capture of attention is thought to occur through competing features of the available stimuli in a bottom-up approach (interpreting new sensory information in real-time) but this is mediated with top-down evaluation (relies on previous experience and context to interpret sensory input) of the stimuli (Yiend, 2010). Orienting of attention conversely is the process of shifting attention to an object or spatial location. This has three steps; shifting, engagement, disengagement (Posner et al., 1984). Shifting relates to the movement of attention across space. Engagement is the selection of a given stimulus for greater processing and disengagement is the termination of that processing leading to the next shift of attention.

The areas of the brain affected by selection and shifting of attention include the posterior parietal cortex and the frontal eye field (Chambers & Heinen, 2010; Muggleton et al., 2010). The exact location of the frontal eye field has been difficult to identify with precision, even with fMRI studies, but is in the region of the pre-central sulcus and dorsal area of the superior temporal sulcus (Vernet et al., 2014). The frontal eye field is responsible for integrating other gaze control systems including the supplementary eye field located in the frontal lobe, the pre-supplementary eye field, the dorsolateral prefrontal cortex, the cingulate eye field located in the anterior cingulate cortex and the dorso-medial frontal cortex and in the parietal lobe, it includes the parietal eye field and areas of the posterior parietal cortex as well as some sub cortical areas such as the superior colliculus in the mid brain, all of which are considered necessary to trigger eye movements (Vernet et al., 2014).

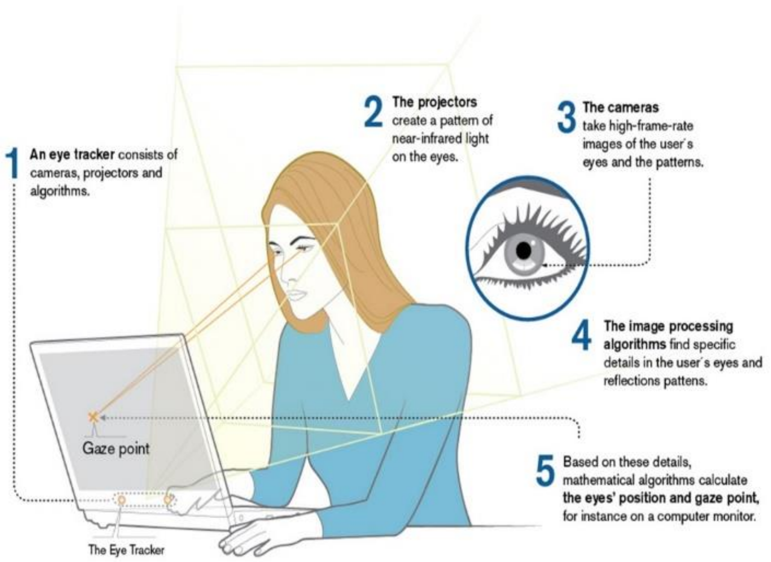
When considering the broad areas of the brain involved with attention, there is an overlap with areas affected by alcohol, emotion and face perception. These are the frontal lobes, anterior cingulate cortex and superior temporal sulcus, discussed in previous sections.

There are various paradigms used to identify attention to emotional stimuli. These include the Emotional Stroop, the visual search task and the cueing or odd-ball task. The Emotional Stroop requires participants to name the colour ink an emotional word versus a neutral word is written (Compton et al., 2003) and the expected outcome is that participants should be slower at naming the colour of the emotional word versus a neutral word as it captures attention and is processed for meaning and hence attention can be inferred. In the visual search task, an emotional face needs to be found amongst distractors, usually neutral faces or vice-versa where the distractors are emotional faces and the neutral face needs to be found (Schmidt-Daffy, 2011). The visual search task is interpreted as being appropriate for identifying the ability of a stimulus to engage attention. The cueing or odd-ball task is also used where two faces appear on the screen one neutral and one emotional followed by a target in place of one or the other (Cooper & Langton, 2006) and this is indicative of the selectivity of attention to emotional stimuli.

What these tasks have in common is that they all measure reaction times as an indicator of attention. For example, in those diagnosed with an affective disorder, such as anxiety or depression, there is an attentional bias to threat stimuli as measured using reaction times (Fox et al., 2002; Goodwin et al., 2017). These reaction times could be as a result of quicker orienting to threat stimuli or a difficulty in disengaging from threat once engaged but it is not possible to tell using these indirect methods and reaction time data alone (Shasteen et al., 2014). Identifying what is happening in real time is key to understanding this process. Advances in technology have made monitoring the eye gaze possible through eye tracking facilitating the monitoring of visual attention focus and fixations prior to stimulus response selection whilst also being able to differentiate search strategies (Williams et al., 1997). This is a more accurate and earlier indicator of attention which is not delayed or contaminated by a motor response compared with reaction time.

1.7 Eye-movement

A stimulus needs to be seen to be recognised and to have meaning attributed to it. Eye-tracking is the process of measuring either point of gaze (where one is looking) or the motion of the eye relative to the head. Eye-tracking data are collected using either a remote or head-mounted ‘eye tracker’ connected to a computer. While there are many different types of non-intrusive eye trackers, they generally include two common components: a light source and a camera. The light source (usually infrared) is directed toward the eye. The camera tracks the reflection of the light source along with visible eye features such as the pupil. These data are used to infer the movement of the eye and ultimately the direction of gaze. Additional information such as blinking and changes in pupil diameter are also detected by the eye tracker. The aggregated data is written to a file that is compatible with eye-tracking analysis software. Figure 4 below provides an illustration of the typical set-up for a remote eye-tracker.



Source: *Tobii Eve Tracker*

Figure 4. Setup for eye tracking study

Eye-tracking as a methodology tool is now in its fourth era (Duchowski, 2002) and is distinguished by the emergence of interactive applications. Duchowski (2002) broadly split the eye tracking applications into two groups either interactive or diagnostic. The interactive perspective uses the eye tracker as a powerful input device such that the system must respond to or interact with the user's eye movements. However, it is the diagnostic perspective that is of relevance in the current study. In this function, the eye-tracker provides objective and quantitative evidence of the users visual and attentional processes. Eye movements are generally recorded to identify the participant's attention pattern over a particular stimulus (Findlay, 1997). This type of application is typically unobtrusive, and the stimulus type being displayed does not need to change or react to the viewer's gaze.

There was no evident research which examined how binge drinkers or those with an alcohol use disorder scan faces to gather information for processing. However, examples and evidence to support the use of eye-tracking was drawn from the literature on those with schizophrenia or anxiety disorders, which has used eye-tracking in this capacity for some time. Research on anxiety disorders studies using reaction times have identified an attentional bias towards threat (Mathews & MacLeod, 2005; Mogg & Bradley, 1998). Whether this was an initial orienting of attention which rapidly disengages or whether it reflected sustained attention with difficulty in disengaging is unclear (Cisler et al., 2009). A review by Bar-Haim et al. (2007) called for a focus on the theoretical aspects of attentional bias to clarify the processes by which it occurs. The use of eye tracking was an effective tool in this endeavour to provide a continuous measure of attentional selection performed via eye movements of overt attention (Weierich et al., 2008). Whilst eye tracking does not take into consideration covert attention, Hayhoe and Ballard (2005) suggested that covert attention is mostly used to guide overt attention and is objective driven, therefore the lack of direct data on covert attention is not problematic to this type of study as it can be inferred from the overt data.

Eye tracking provides almost continuous information on where the overt visual attention is focused for gathering information for processing. This has distinct advantages over the indirect methods, outlined above (Section 1.6), which require numerous conditions to separate different components of attention. A single trial in eye-tracking acquires data across both spatial and temporal parameters, which in turn facilitates the identification of a time-course for eye-movement and any elements of attentional bias. The benefits of eye-tracking can thus overcome some of the weaknesses of the reaction time tasks which have only been able to capture a snapshot of attention at that moment in time without distinguishing between search patterns or vigilance avoidance or attention maintenance tendencies identified in theories of attention (Weierich et al., 2008). The longer a stimulus is presented on screen (500ms is long enough to permit several shifts in attention) the weaker the inference that can be made on the exact allocation of attention using indirect methods such as reaction times alone (Kellough et al., 2008). Eye-tracking can overcome this limitation and has proven a useful tool in research on attention in affective disorders. This is particularly effective for anxiety and depression to see whether there is avoidance of negative images in complex scenes for example (see Armstrong & Olatunji, 2012 for a review). Abnormal visual scanning of emotional faces has been identified using eye-tracking, for those with schizophrenia (Bestelmeyer et al., 2006; Loughland, Williams, & Gordon, 2003; Zhu et al., 2013) and this in turn has been linked with poor social interactions (Streit et al., 1997). This finding of abnormal scanning provides valuable input to the design of interventions to address issues with poor social interactions amongst these groups.

It has been suggested that the amygdala has a role in directing attention and fixations to the eye region of the face (Kennedy & Adolphs, 2010). It had been thought that the role of the amygdala related specifically to orientation of gaze to fearful faces. For example, a patient, with rare bilateral amygdala damage was found to have a particular deficit for the recognition of Fear (Adolphs, Tranel, Damasio, & Damasio, 1994). However, this has been revised and is now thought to be due to a more general lack of fixation to the eye area regardless of the emotion as identified through eye tracking (Adolphs et al., 2005). The deficit for the recognition of Fear is attributed to the importance of the eyes in communicating the expression of Fear over and above other emotions. Damage to the amygdala therefore can impede the instruction to fixate on the eye region and can impact the accuracy of emotion recognition, particularly Fear (Gamer & Büchel, 2009).

With respect to alcohol use, eye tracking has been a useful tool in identifying attentional bias for alcohol related stimuli (Manchery et al., 2017; Melaugh McAteer et al., 2015; Pennington et al., 2019). However, to our knowledge eye-tracking has not been used to date to compare the scan pattern and any attention bias to face areas of binge drinkers in comparison to non-binge drinkers. In examining this aspect of face perception, it is hoped to elucidate the direct impact this pattern of alcohol consumption has on face perception and emotion recognition from a behavioural perspective as reflected in eye-movement.

1.8 Summary

In summary, emotion recognition is automatic and adaptive. There are core emotions that are universally recognised and consistently agreed to be: Anger, Fear, Happy and Sad, but Surprise and Disgust are also frequently included in this list (Ekman, 1992). It has been suggested that there is a dissociation between processing of identity and emotion (Bruce & Young, 1986). There does not appear to be a single brain area that is specialised in facial emotion recognition but rather several areas (inferior occipital gyrus (IOG) superior temporal sulcus (STS) lateral fusiform gyrus (LFG), Amygdala, Insula and Limbic System) working together, each contributing incremental pieces of information for recognition to occur (Haxby et al., 2002). There are factors that can impact emotion recognition such as mood states and alexithymia and these need monitoring in any study on this topic.

The impact of alcohol on the brain has been studied amongst those with a severe alcohol use disorder (AUD) or AD. There are various theories about how this occurs but alcohol is known to affect the functioning of executive functions, episodic memory and visuospatial abilities (Bernardin et al., 2014). Emotion has been linked to social cognition, interpersonal relationships and wellbeing (Carton et al., 1999). Those with an AUD have been identified as having difficulties with interpersonal relationships even when no longer drinking (Kornreich et al., 2002). Research into specific alcohol-induced problems with emotion recognition has had mixed results which may in part be due to the different types of tests being conducted, with more complex tasks being more sensitive to differentiation between those with an AUD and controls (Donadon et al., 2014). Notwithstanding this, there does seem to be a deficit amongst those with alcohol dependence with accuracy for Sad and Disgust emotions and with the latency of response for Fear and Anger (Carmona-Perera et al., 2014; Kornreich et al., 2001).

Indirect behavioural outcomes such as reaction times are effective at providing between group differences but fall short of being able to explain with any certainty why reactions are faster or slower to particular stimuli. Tracking attention in terms of fixations and saccades in eye gaze has proved a useful tool in emotion research amongst those with an affective disorder (Armstrong & Olatunji, 2012) as well as those with more severe conditions such as schizophrenia (Loughland et al., 2003). Eye tracking uses real time eye movements and records scan paths which result in more detailed, enriched data than reaction times alone.

The next chapter sets out the research to date linking the pattern of binge drinking with emotion recognition.

Chapter 2 Literature Review

This chapter aims to focus on the evidence to date that directly explores facial emotion recognition (FER) and binge drinking (BD). Whilst comparatively little research has been conducted in this area, recently the level of published research has expanded. Research up to August 2021 is included in this review.

2.1 Method and Criteria

A systematic search strategy was implemented on the following databases: CINAHL complete; MEDLINE; PsychINFO. The search terms were emotion, or emotional or affect recognition AND binge drinking or heavy episodic drinking. The expanders were any related words. The limiters were, all peer reviewed journals in English language with a human, adult population. The initial search identified 272 articles and scanning the titles and reading the abstracts this was reduced to 4 articles. The inclusion criteria were as follows:

- Included a specific measure of binge drinking
- Included at least one element examining facial emotion recognition
- Included a behavioural element

Those excluded were for the following reasons: emotion regulation; the impact of binge drinking during pregnancy on the fetus; examined the acute administration of alcohol on emotion recognition; focused solely on auditory processing of emotions; did not have a behavioural element. A summary of the articles exploring the impact of binge drinking on facial emotion recognition is included in Table 1 below.

Table 1. Summary of the articles exploring emotion recognition in binge drinking

Authors	**Participants**	**Tasks**	**Results**
(Lannoy, Dormal, Brion, Billieux, & Maurage, 2017)	40 young adults, mean age 19.73, SD = 1.74, 22 female. 20 BD identified according to binge drinking score (Townshend & Duka, 2005)	Emotional detection from emotional facial and auditory stimuli (Happy, Anger) in unimodal and cross modal conditions and congruent and incongruent trials	No difference in BD and control group in processing emotional stimuli
(Lannoy, D'Hondt, et al., 2018)	53 young adults, mean age 20.14, SD = 2.36, 23 female, 17 BD (binge drinking score ≥16, number of doses per occasion ≥6, speed ≥2, drinking occasions per week between 2 and 4), 17 moderate drinkers (MDs; binge drinking score between 1 and 12, number of doses per occasion ≤3, speed between 0.33 and 2, number of drinking occasions per week ≤3) and 19 nondrinkers	Emotional detection from emotional facial and auditory stimuli (Happy, Anger) in unimodal and cross modal conditions and congruent and incongruent trials whilst EEG was recorded	No between group differences at the behavioural level. There was evidence of slower processing and higher activity at the perceptual, N100, and decisional level, P3b, in BD.
Lannoy et al., 2018)	46 young adults, 24 female, mean age 20.02, SD=1.95, 23 BD identified according to the BD score (Townshend & Duka, 2005) 16 or more. Control group BD score less than or equal to 12.	Facial emotion recognition task (FER). 6 basic emotions, Anger, Contempt, Disgust, Fear, Happy, Sad. 9 levels of intensity each.	BD had lower performance overall for all emotions and required a greater intensity of emotion for accuracy.
(Lannoy et al., (2019)	94 young adults, 39 female, mean age 21.07, SD=2.11, 52 BD= (18 female), 42 control group (21 female), BD categorised according to BD score (Townshend & Duka, 2005) higher than 15 and >6 doses on one occasion per month. Controls BD score < 13 and never 6 drinks on one occasion	FER 6 emotions: Anger, Contempt, Disgust, Fear, Happy and Sad. 9 levels of intensity each	BD had impaired performance for recognition of Fear and Sad.

The outcome of this search for relevant peer reviewed research highlighted the paucity of current research in this area which is dominated by a group of researchers in Belgium, France and Luxembourg (Lannoy et al., 2019, 2017;Lannoy, D'Hondt, et al., 2018; Lannoy, Dormal, et al., 2018). This highlights that research into this topic is in the early stages and much needs to be done, particularly in other countries to support and extend the findings of these researchers to other environments and cultures.

There are advantages to the studies being conducted amongst the same group of researchers. The researchers use much the same criteria for participant recruitment and the criteria used to define binge drinking is also consistent. This facilitates the direct comparison between studies, something that has proved difficult due to the variation in criteria used in the area of alcohol research previously. See Section 1.4.2 for more details. Across all four studies therefore there is a fairly homogenous group of participants, all students of francophone universities aged between 18 and 27. As much as possible a gender balance was achieved across the studies. Very strict and careful exclusion criteria are used across all studies. Potential participants with a history of psychiatric or neurological disorder such as depression, anxiety or phobias, along with any previous use of other drugs, apart from alcohol or tobacco, was excluded. Whilst this helps to eliminate what may be confounding factors it is likely to be less representative of binge drinkers in general (Kuntsche, Rehm, & Gmel, 2004) and therefore limit the ability to generalise the findings to a broader group. It would be of interest to use less strict recruitment criteria, to include people with no *current* psychiatric diagnosis and those who have previously used other drugs, to identify any impact on a more broadly defined sample of binge drinkers which may be more representative of binge drinkers in general. The drinking habits of participants captured not only the quantity of alcohol consumed but also the frequency and speed of drinking and the percentage of times participants drink that they become drunk. This detailed information enables the pattern of drinking to be distinguished from mere quantity and is particularly effective at distinguishing binge drinkers from other patterns of alcohol consumption (Townshend & Duka, 2002).

The continuum hypothesis of alcohol consumption (O. A. Parsons, 1998) posits that neurocognitive deficits due to alcohol consumption occurs along a continuum with low drinking at one end and severe alcohol use disorders (SAUD) at the other. If this hypothesis is correct, it suggests that the damage caused by alcohol in AUDs only differs by degree from the damage caused at lower levels of consumption. In an ideal world this would be tested by a series of longitudinal studies covering a large population with various patterns of alcohol consumption. This would be difficult and expensive to achieve and therefore cross-sectional studies with homogenous participants are a useful way to see if there are indications that the continuum hypothesis may hold true. There is some longitudinal evidence that binge drinking, even in the short term, impacts neural functioning (Maurage, Pesenti, et al., 2009). Therefore, further research albeit cross-sectional studies, are valuable and warranted on their own merits whether or not they establish a link with the continuum hypothesis.

There is ample evidence to indicate that binge drinking incurs deficits in executive functioning (Gil-Hernandez et al., 2017; Heffernan & O'Neill, 2012; Parada et al., 2012). Looking for evidence to support extension of the continuum hypothesis to social cognition a study by (Lannoy et al., 2017) aimed to establish whether there are emotional decoding deficits amongst binge drinkers. This deficit has been established amongst those with an alcohol dependence (AD) (Maurage, Campanella, Philippot, Pham, & Joassin, 2007) and should also extend to binge drinkers if the continuum hypothesis holds true. The authors chose an ecologically valid way of testing emotion decoding by simultaneously testing the visual and auditory emotions of Happy and Anger. Using two senses for emotional testing involves cross modal facilitation whereby identification of the stimulus through one mode is facilitated by the simultaneous presentation of a related stimulus via another sense (Chen & Spence, 2011). This facilitation effect has been shown to be disrupted in those with an AD (Maurage et al., 2007) and therefore an impairment should also be evident in binge drinkers although to a lesser extent. The participants and binge drinking criteria used in Lannoy et al. (2017) to test cross-modal facilitation of emotion recognition are summarised in Table 1. The task involved identifying emotions from facial and vocal stimuli in unimodal, or simultaneous cross modal conditions with the cross-modal conditions being either congruent or incongruent. The study did not find any difference between BD and the control group (CG) in the processing of emotional stimuli. They concluded that at least at the early stages of alcohol related disorders, emotional processing is preserved and therefore the continuum hypothesis did not extend to emotional processing. This finding is contrary to an earlier study (Maurage, Bestelmeyer, Rouger, Charest, & Belin, 2013) which used a more complex auditory task where Anger and Fear, both negative emotions, were morphed at 7 different levels (5/95, 20/80, 35/65, 50/50, 65/35, 80/20, 95/5) and participants needed to identify the dominant emotion. This study did find a behavioural difference between the BD group and the CG, where BD were less accurate in their responses than the CG. There were also differences in the fMRI data which showed that CG had higher activations than BD in bilateral superior gyri; and BD had higher activation than CG in the right middle frontal gyrus which was related to shorter reaction times. Lannoy, Dormal, Brion, Billieux and Maurage, (2017) suggest that these contradictory results may be due to the complexity of the task and that simpler tasks can be compensated for at the earlier stages of alcohol related disorders, despite brain alterations. This is supported by research amongst adolescents, aged 13 – 22, (Gil-Hernandez et al., 2017). The sample was split into 3 age groups, 13-15, 16-18 and 19-22. Following a battery of executive function tasks, the only difference was between the control group and binge drinkers in the 19 – 22 age group, where the BDs showed a poorer performance. This was attributed to a compensatory effect in the earlier stages of BD for the younger participants. As all the BD started drinking at 13 it was hypothesised that increased neuronal effort was required to obtain the same performance levels as the CG. However, the efficiency of this compensatory action decreased with longer periods of alcohol consumption. Whilst this hypothesis is supported by other research, such as (Campanella et al., 2013), it does need further clarification and the extent to which BD must occur to outweigh the possibility of compensatory recruitment of other brain areas has yet to be established. A limitation of the Lannoy et al., (2017) study is that only two emotions were used, a positive (Happy) and a negative (Anger) and therefore any nuances in behavioural outcomes for other emotions remain untested.

A follow-up study (Lannoy, D'Hondt, et al., 2018) aimed to go beyond the behavioural outcomes and explore the brain correlates of emotional cross modal processing in BD. The participants and drinking measures are outlined in Table 1. This was a replication of the task used in the previous study (Lannoy et al., 2017) with the main difference being along with the BD and a mid-drinking group (MD) the inclusion of a non-drinking group (ND) and electrophysiological measures were concurrently recorded. This event related potential (ERP) study explored the steps involved in examining a stimulus; early perceptual (p100 for visual, N100 for auditory), modality related (N170 for visual, N200 for auditory) to alter decisional (P3b) processes. It was hypothesized there would be no impairment at the behavioural level as in the 2017 study but did anticipate widespread cerebral modification among BD from early perceptive to late decisional processing stages in terms of increased amplitude in ERP components in BD.

Consistent with expectations no behavioural differences were found between groups. This is suggested to be the result of a compensation process where additional resources are recruited to complete the same task or process. Differences were found between BD and the ND at both the early and later stages of processing, namely the N100 and P3b, where BD had higher amplitudes indicating the need for extra resources to correctly perform the cognitive tasks. BD also had differential processing of visual stimuli for Happy and Anger at the decisional stage unlike non-drinkers (ND) who had no difference. This was attributed to possible impaired neural attentional and inhibitory processes. Whilst tentative this suggestion should be treated with caution. The N2, which is normally associated with allocation of attentional resources (Crego et al., 2009), was not reported as differing between groups in the current study. The differences between BD and ND are interpreted as suggesting a loss of the facilitation effect in early cross modal processing in BD and that more resources are required at the P3b decisional process for cross modal integration. One finding of the study remains unexplained; for latency BD were faster than MD on the last component of the occipital site although no difference was found with ND. Although this aspect remains an anomaly in the current interpretation the findings do point to a disturbance in BD in the processing of incongruent trial and Anger stimuli and the interpretation of a lack of facilitation effect at early processing. The ability to compensate for these neural modifications identified, means that the impact is not yet recorded at the behavioural level. The study does confirm that there is some impact of BD on emotional processing with regards to cross modal integration and clarifies the need for complex tasks and some other objective measure in future research in the absence of a behavioural impact.

Whilst there does appear to be some difference in processing emotion between binge drinkers and non-binge drinkers, albeit not at a behavioural level, the question about whether the ability to specifically decode a range of facial expressions is impacted was addressed in a study by Lannoy, D'Hondt, et al. (2018). Using a complex task and a range of emotions (Anger, Contempt, Disgust, Fear, Happy and Sad) binge drinkers were compared with a control group who consumed alcohol but not in a binge pattern (Lannoy, D'Hondt, et al., 2018). The participants and BD criteria are included in Table 1. The recognition of facial emotion expressions was explored in a complex task (Gaudelus et al., 2015) moving away from the binary, positive vs negative, paradigms of previous studies (Connell, Patton, & McKillop, 2015; Lannoy et al., 2017;Maurage, Bestelmeyer, et al., 2013). The main finding of the study was a global impairment in emotion recognition, which was not driven by any specific emotion. This was consistent with some evidence suggesting that, amongst those with an AD, the impact of alcohol consumption resulted in a global impairment and was not just restricted to negative valence (Maurage et al., 2011). As the detection of Fear and Happy was quite similar between groups it was suggested that the overall between group differences could be driven by the processing of specific emotions (i.e., Anger, Contempt, Disgust, and Sad). However, the authors acknowledged that the evidence to support such a claim was not statistically robust and further research in this area was required.

The final study identified (Lannoy et al., 2019) addressed this issue of robust statistical findings using a larger sample of university students (see Table 1 for details) and the complex task of emotion recognition (Gaudelus et al., 2015) used in the previous study (Lannoy et al., 2018). The authors maintained strict inclusion criteria similar to the previous studies and introduced a minimum dose per sitting (6+) once a month required for the BD sample to reflect more intensive use. The authors identified an impaired ability amongst BD in the recognition of Fear and Sad. This finding that was not apparent in the previous study was attributed to the increased sample size providing more power to differentiate between emotions. The finding was supported by previous findings in other studies (Donadon et al., 2014; O'Daly et al., 2012) suggesting amygdala damage as a result of binge drinking. Donadon et al. (2014) made the link between disrupted Fear recognition and interpersonal problems which in turn can lead to increased alcohol consumption. The finding of disruption of Sad recognition in BD was novel. Sad recognition is linked with reduced activity in the anterior cingulate cortex, and disrupted activity in this brain area has been reported in binge and heavy drinkers (Cservenka & Brumback, 2017). Lannoy et al. (2019) found a negative correlation between Sad recognition and binge drinking score. In addition, this study (Lannoy et al., 2019) found, through comparisons with normative data on the emotion recognition task and individual analysis, that only a subset of the participants displayed a clinical deficit. This highlights the heterogeneity of the binge drinking population but also enabled the authors to make the assertion that BD, or a subset thereof, presented a qualitatively similar deficit in emotion recognition as those with a serious alcohol use disorder (SAUD). The authors highlight the need for further research in diverse populations and countries whilst also acknowledging that by having stringent exclusion criteria, particularly around anxiety, depression the sample may not be representative of BD in general.

It is of note that Lannoy et al. (2017) found that not all the impacts of BD were necessarily negative as BD were quicker than the CG at emotion recognition in the unimodal condition. The authors proposed that this may be due to the social context and drinking motives for enhancement which facilitates more efficient recognition of the emotions of others. The suggestion is BD are more attuned to their social environment compared with the control group who are likely to socialize less. The authors justify this claim through research which highlights that social factors can improve emotion recognition (Bublatzky et al., 2014, 2017) and that binge drinkers had greater social acceptance and social integration than those who do not consume alcohol. Although this is not supported amongst older adults (Canham et al., 2016), it is supported by an 18 year longitudinal study on binge drinking in adolescents (Pedersen & Von soest, 2015). This may seem a bit tenuous but would go some way to explaining the phenomenon. Further investigation is however warranted to replicate these results and make more direct associations. An earlier study (Townshend & Duka, 2005), exploring cognitive performance in binge drinkers compared with social drinkers also found an advantage as a result of altered functioning due to BD. In a visual search matching task, which separates thinking time and movement BD had a quicker movement response (motor impulsivity) than the control group. Motor impulsivity is linked with altered functioning in the orbito-frontal cortex (Spinella, 2004).

The research therefore on emotion recognition and binge drinking has explored the visual and auditory recognition of emotions using a simple two emotion task which has been conducted twice with similar results at the behavioural level indicating no impact of BD on performance. However, when brain wave activity was recorded there were differences in activation which indicated more resources were required by BD to achieve the same results as the control group. When a more complex task was used (Lannoy et al., 2018; Lannoy et al., 2019) a global deficit in emotion recognition was identified and this was driven by Fear and Sad recognition. It is important therefore in future research to understand whether that result can be replicated by complex tasks in research conducted in other countries. Certainly, amongst those with alcohol dependence there is mixed evidence on whether the deficit in emotion recognition relates to all emotions (Kornreich et al., 2013) or is emotion specific (see Donadon & Osorio, 2014 for a review). Further research is required to elucidate this.

One factor which does not appear to have been considered in the analysis of the studies in this review is probability and any bias that participants may hold in choosing emotions when there is some ambiguity involved. This can mask underlying bias over and above recognition or accuracy. If a person chooses the Happy response to every stimulus, they will be correct for every instance Happy is presented but this does not reflect a genuine recognition of the Happy expression. This is an extreme and most participants will make a genuine effort to identify the emotion. The hit rate for accuracy is the reality in the social world and therefore whether some are correct by chance or a bias towards a specific emotion in ambiguous circumstances is of little consequence. In the context of identifying whether binge drinking impacts emotion recognition however the distinction would seem important particularly as the results are nuanced around specific emotions. Future studies therefore should take bias and probability into account in the analysis of the hit rate on emotions.

Efforts have been made to control for potential confounding factors in terms of checking for levels of anxiety via the State Trait Anxiety Inventory (STAI) (Spielberger & Gorsuch, 1983) and depression via the Beck Depression Inventory (BDI) (Beck, Steer, & Brown, 1996). However, these are not the only subclinical factors that could impact emotion recognition amongst young people. Alexithymia (see Section 1.5.1) is a subclinical condition where individuals have difficulty in identifying their own emotions, describing emotions and with the recognition of emotions in others (Lane et al., 1996). It has been suggested that the prevalence of alexithymia amongst a student population in the UK could be as high as 17% which is in line with findings in other countries (Mason et al., 2005). The evidence does suggest a link between alexithymia and emotion recognition in both clinical and healthy populations (Montebarocci et al., 2011) although this is not consistent across all studies (see Grynberg et al., 2012 for a review). The evidence is sufficient to warrant inclusion in an emotion recognition task given the prevalence of alexithymia in a student population (Mason et al., 2005). Alexithymia is also linked with AD, numbers vary but between 42% to 79% of those with an AD are thought to also have alexithymia (Evren et al., 2008) and some evidence suggesting a prevalence of BD amongst those high in alexithymia (see Thorberg et al., 2009, for a review). Alexithymia measures have been included in other studies on alcohol and emotion recognition resulting in mixed results, some with no significant between group difference (Maurage, Campanella, et al., 2009; Walter et al., 2011) whilst some do have between group differences in alexithymia levels (D'Hondt et al., 2015). Given the link between alexithymia and both emotion recognition and binge drinking it would be prudent to control for any potential impact this might have on the results.

2.2 Summary

These studies suggest there may well be an impairment for emotion recognition amongst binge drinkers particularly in the processing speed and overall accuracy and this is driven by the emotions of Fear and Sad in particular. The inconsistent results and paradigms used indicate that further research is required to confirm these findings.

This review identifies some interesting recommendations for future research. Firstly, it highlights the need for future research to use complex tasks and not simple two emotion studies. With regards to the population studied, care should be taken that any exclusion criteria do not distort the sample too much from the representativeness of the general binge drinking population making generalisations problematic. It has also identified the need for more behavioural studies that include objective measures that would have the sensitivity to uncover subtle brain changes affecting attention or processing before there is any impact on behaviour. Other factors besides anxiety and depression need to be accounted for in the set-up of any new studies including the possible impact of alexithymia and response bias. All these factors will be taken into consideration in the design of the current study.

2.3 Study Rationale

The continuum hypothesis proposes that impairments experienced by binge drinking (BD) and those experienced by those with alcohol dependence are similar and only differ in terms of severity (Enoch, 2008). There is certainly evidence of impairment on cognitive processes amongst BD similar to those experienced by those with an AUD (Heffernan & O'Neill, 2012; Parada et al., 2012). Impairment in facial emotion recognition has also been established amongst those with alcohol dependence (D'Hondt, de Timary, Bruneau, & Maurage, 2015;Townshend & Duka, 2003). However, there is a gap in the literature with respect to facial emotion recognition and binge drinking. This is an important aspect of the impact of BD to investigate as it would contribute to the knowledge of the effect of BD on social cognition, interpersonal relationships and wellbeing. In addition, it would provide more evidence for the continuum hypothesis of alcohol consumption. The aim of the current research was to contribute knowledge and begin to fill this gap in the literature and understanding of binge drinking and social cognitive function, more specifically on emotion recognition. This should help inform interventions for BD, particularly for students at a time of major life changes when social interactions are crucial to overall wellbeing.

The current research is composed of two main studies. Study 1 consists of two parts. Study 1, Part 1 explores emotion recognition by binge drinkers of complex emotions presented for 200ms. Previous research has not been consistent in identifying an impairment in emotion recognition (Lannoy et al., 2017; Lannoy et al, 2018; Lannoy et al, 2019). The current study therefore seeks to replicate in part the emotion recognition task previously used by Lannoy and colleagues employing complex emotions. As it has previously been identified that more complex tasks are more effective in eliciting between group differences (Donadon et al., 2014; Lannoy, Dormal, Brion, et al., 2018) the current task uses 15 levels of emotion intensity whereas previously 9 levels of intensity were used. Study 1-Part 1 also seeks to identify whether at an earlier stage in processing (bottom-up processing) a behavioural difference becomes apparent as the previous studies tested later top-down processing.

Specifically Study 1-Part 1 aims to identify whether binge drinking leads HBDs to be less accurate in emotion recognition overall and whether there is a particular deficit in the recognition of Fear and Sad

Study 1-Part 2 explores how participants gather information from emotional faces for processing. The functioning of the amygdala is impacted by alcohol demonstrating a dampened effect following acute alcohol administration (Hur et al., 2018). In addition, the amygdala is implicated in emotion recognition and eye movement (Adolphs, 2002b; Gosselin et al., 2011). Study 1-Part 2 therefore uses eye-tracking to identify whether HBD look at and thereby gather information about emotional faces in a different way to LBD. It also seeks to identify whether HBDs experience emotions differently and therefore look at emotionally valanced images differently to LBD and rate the intensity of the emotions lower than LBD.

Study 2 sought to expand the findings of both Parts of Study 1. A criticism of the inclusion of static images for emotion recognition tasks is that it is not very ecologically valid (T. D. Parsons, 2015). Everyday emotion recognition is often fleeting and expressions are dynamic in usual interactions (Ochsner, 2004). There are also distinct processing pathways for static and dynamic images (Kilts et al., 2003). This supports the inclusion of both dynamic and static images in Study 2. Previous research on dynamic and static images suggests that recognition of facial emotion expressions occurs quicker in dynamic images (Chiller-Glaus et al., 2011). This, along with the different processing pathways, suggests that deficits in the recognition of Fear and Sad expressions as previously identified using static images (Lannoy et al., 2019) may not be present when dynamic images are used. Study 2 therefore aims to replicate Study 1-Part 1 examining bottom-up emotion recognition by HBDs. In addition, Study 2 aims to identify whether the results of previous research on top-down emotion recognition (Lannoy et al., 2019), which identified a deficit for Fear and Sad emotion recognition, are consistent across static and dynamic images. Finally, by asking participants to rate the intensity of both the static and dynamic images Study 2 aims to identify whether HBD experience the emotions displayed as less intense than the LBD.

Study 1-Part 1 and Part 2 are reported separately in Chapters 4 and 5 respectively. Study 2 is reported in full in Chapter 6. The overall aim is to fill in some of the gaps in knowledge on binge drinking and emotion recognition.

The next chapter provides details of the methodological framework and details and rationale for the materials used.

Chapter 3 Methodological Framework

This chapter presents the rationale for the methodological framework and the choice of study design. The measurements that are of interest are reviewed and the rationale for the choice of instruments provided.

3.1 Research Philosophy

The questions that this research aims to answer relate to the impact that certain drinking patterns have on human cognition. Specifically, whether a binge pattern of drinking has a detrimental impact on the ability to recognise emotions. This research requires an objective stance. Objective knowing occurs outside the mind and deals with outward things not thoughts and feelings (Hospers, 1997). It takes a top-down, deductive reasoning approach and aims to verify hypotheses and generalise theories to a wider group. Objective knowing can be conducted from postpositivist world view. This assumes a deterministic philosophy which states that causes, probably, determine certain outcomes (Crotty, 1998). It is a development beyond positivism, which dealt with absolute truths, as it was held to be unlikely that one could be 100% positive of an absolute truth when dealing with human behaviour (Phillips & Burbules, 2000). Postpositivism remains deterministic in nature and the problems examined by postpositivists are those requiring a need to identify and quantify the causes that influence outcomes (Creswell, 2014) as in this study. However, whilst there is an objective reality that can be measured, as in this study with respect to the accuracy of emotion recognition, it is the interpretation of this reality that determines the social world, and it is the perceptions and interpretations of the actor that determine their actions. Therefore, the outcomes of this approach reflect careful observation and measurement of the objective reality or theory that exists outside ourselves. Because it is testing an objective theory, by examining the relationship between variables, it takes a quantitative approach which is influenced by an empiricist paradigm, and it involves the exploration of cause and effect of social phenomena and uses data collection based on empirical observation and critical interpretation (Creswell, 2014). Previous research on this topic has also taken an objective post positivist approach as outlined in the previous chapter. By taking a consistent approach it may be possible to relate the results to other research in a meaningful way. It should also make the results more accessible and widely accepted by the relevant research community.

3.2 Design

This study employed a quasi-experimental, cross-sectional design. Because it sought to identify cause and effect relationships, this is the appropriate design rather than descriptive research which focuses on describing a phenomenon, event or situation (Yilmaz, 2013). Based on the research question previously outlined, the current research collected numerate rather than descriptive data and was therefore quantitative in nature. One of the requirements of a true experiment is that participants can be randomly allocated to groups. As the current research explored specific drinking patterns this was not possible in this study and therefore a quasi-experimental design was implemented with participants naturally falling into either the high or low binge drinking groups using the median group score in accordance with Townshend, Kambouropoulos, Griffin, Hunt, and Milani (2014). For the current study the primary IVs were the drinking patterns and the emotions presented whilst the primary DV variables were the number of emotions correctly identified, the latency of responses and visual scans for face emotion recognition as measured by eye tracking. It was however recognised as identified in the previous chapter that there are factors other than drinking patterns that impact on emotion recognition such as Alexithymia and Mood. In order to control for these confounding or extraneous variables, these were also included in the study. All studies were piloted with a group of volunteers to ensure they worked correctly and were clear and easy to understand prior to being advertised for recruitment.

3.3 Participants

In any study the participants are the cornerstone to obtain an accurate result. That is, the right people need to be asked the right questions in order to arrive at the right conclusions. For this study, a population that had a propensity to drink alcohol at differing levels, in particular to binge drink, was required. For this reason, it would not have been practical to recruit a random sample of the population. The population needed to be relatively easy to recruit and local as they were required to attend the University research labs to complete the tasks on specialized equipment. A large-scale study in the United States by

Slutske, (2005) compared the drinking habits and outcomes of both students and peer non-student young adults aged 19 – 21. A nationally representative sample of 6352 young adults was surveyed and they concluded that whilst the students were more likely to binge drink and be treated for alcohol abuse, they were no more likely than their non-student peers to be treated for alcohol use disorders. For the current study this is important as a population that is biased towards an AUD would not be appropriate. A student population therefore is an appropriate target group. The age group of 18-35 was chosen as this is defined in other alcohol studies as the appropriate 'young adult' group (Foxcroft et al., 2015) and is in line with other studies being conducted in the University of West London in this topic area.

The aim in the current research was to recruit a convenient sample of approximately 20 participants for each group. A priori tests using G*Power (Erdfelder et al., 1996), a stand-alone programme for sample size calculation, indicated that this is sufficient to conduct an ANOVA repeated measures, within-between interaction with a Cohen's d large effect size α =0.8, error probability of .05 where a minimum total sample of 30 is required. The effect size is a standardised way to measure the size of the impact of the manipulation and Cohen's d is one of the most widely used effect measurements (Field, 2013) and is calculated by obtaining the mean difference and dividing by the standard deviation. This calculation makes it easy to compare across studies where different measures may be used. The a priori calculation also takes into consideration the Power required for future analysis. This refers to the probability of correctly rejecting the null hypothesis and avoiding a Type II error, concluding there is no difference when a difference really exists and the power in this calculation is 96%. It is important therefore to achieve a balance between the Power, the effect and the sample size all of which will vary depending on the study requirements (Faul et al., 2007).

There are two main methods of recruiting the sample, that is, a) probability and b) non-probability sampling. Probability sampling means that everyone has an equal chance of being chosen for the study which is the ideal for a truly random sample and more likely to be representative of the whole population. For the current study a non-probability sample was the best option as participants were required to have certain characteristics, which were to be social drinkers. This sampling method also had the benefit of being quicker and cheaper to achieve.

Inclusion criteria were that participants had to drink alcohol at least occasionally, be between the ages of 18-35 inclusive and have normal or corrected-to-normal vision. Those previously diagnosed with an alcohol use disorder, or a current mental health diagnosis were excluded.

Participants were recruited via SONA, a centralised participant management system used by universities to advise students about research studies, aims and participant requirements, manage timeslots for laboratories where required and keep track of research credits where awarded. Advertisements were placed in the library and on notice boards around the university. For non-psychology students a £10 Amazon voucher was provided to those who completed the study in appreciation for their time.

The sample was split by median binge drinking score in line with other research (Townshend et al., 2014). The median was used instead of the mean to get a balanced number of participants in each group.

3.4 Measures - Computer Tasks

3.4.1 Emotion Recognition

There are various tasks that can be used to test emotion recognition in participants. These can be grouped into two categories:

- Behavioural
- Non-behavioural

The non-behavioural category involves methods such as Magnetic Resonance Imaging (MRI), electroencephalography (EEG) and eye-tracking. Face processing leads to activation in different parts of the brain which can be identified using magnetic resonance imaging (MRI) technology. These methods are objective and measure automatic responses, which are outside of conscious control. These are expensive methods but have increased the knowledge about the neurobiology of facial emotion recognition (Haxby et al., 2002) in ways that psychological testing alone could not.

The behavioural methods on the other hand depend on conscious processing and generally require participants to recognise emotions based on presented stimuli. There are various forms of stimuli that can be presented; static human face, dynamic human face, static manipulated human face, static computer generated face, dynamic computer generated face and drawings, however, the most commonly used are based on static facial expressions (see de Paiva-Silva, Pontes, Aguiar, & de Souza, 2016, for a review). The behavioural method requires participants to push buttons or make selections and is often a forced choice design. That was the chosen design for the current study as was the most widely used paradigm for emotion recognition (de Paiva-Silva et al., 2016).

3.4.1.1 CANTAB Emotion Recognition Task

For this study, the Cambridge Cognition (CANTAB) Emotion Recognition Task (ERT) was chosen to measure the ability to identify emotions in facial expressions. Whilst being proprietary and requiring an annual license it had the benefit of being a plug and play test which requires no specific training to administer and automatically generates the data in an excel file. Cambridge Cognition is a specialist neuroscience digital health company, which develops products and services to specifically research, evaluate and treat conditions affecting brain health. The tasks designed by CANTAB have been tested and validated with over 30 years of data which contribute to creating normative data for many of the tasks. CANTAB has been cited in over 1500 peer-reviewed articles and has 17 studies using the ERT in the bibliography on their website (www.cantab.com). The tasks themselves are computer based and do not rely on language and hence avoid intercultural biases. The programme uses proprietary software CANTABeclipse V5.0.12 to run the programme and collect the data. The screen used was a DELL ST2220T 54.6cm multi-touch monitor with full HD resolution and typical touch response time of 15 milliseconds. As the task was computer based it could accurately and consistently present the images for the required length of time and collate and save the responses to output as a .txt file or an Excel file. Along with convenience this had the benefit of avoiding the risk of making errors while entering the data and enabled precision timing, eliminating the need for human interface.

The ERT is a complex emotion recognition task which measures the ability to recognise six basic emotions along a continuum of strength of expression. As mentioned in the previous chapter these emotions are broadly considered to be universal and frequently used and recognised (Ekman, 1992). Each image presented on screen represents morphed expressions of six emotions: Happy, Anger, Fear, Surprise, Disgust and Sad. Overall, participants saw 180 stimuli in two blocks of 90. There were 15 images for each of the 6 emotions and each displayed a different intensity of the emotion. The number of levels of intensity (15) for each emotion is a particular strength of this task as it makes it more sensitive to subtle impairments as it can monitor at which intensity recognition of the emotion degrades.

Participants were briefed, and a standard script of instructions was read out. Researcher bias and variability in instructions to participants was reduced by following a script produced by CANTAB which included the appropriate prompts (see Appendix 2). Participants sat in front of the touch screen which was placed at a comfortable distance so that they could reach out and react quickly and easily. Firstly, a white cross appeared on the center of a blank screen. Participants were asked to look at the cross. Then the first image appeared on the screen for 200ms. (see

Figure 5 for examples of emotion intensities**Error! Reference source not found.**).

Figure 5. Examples of emotions from the ERT at different intensities

It was then covered up by a speckled grey mask for 250ms to eliminate an after image. Six touch screen buttons each with one of the 6 emotions which could be expressed in the image appeared and the participant had to select which emotion was represented by touching the appropriate button on the touch screen (see Figure 6)

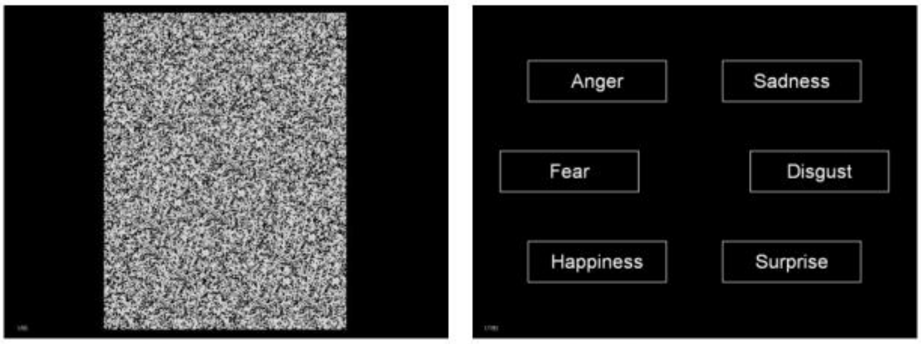


Figure 6. Example of the grey mask and touch screen layout to select emotions on the CANTAB ERT

Once the participants had selected an emotion the white cross appeared again for 2 seconds, and the next emotion appeared. The task took approximately 12 minutes to complete, and outcomes were measured in terms of correct/incorrect responses overall and by emotion. Response latencies were also captured.

3.4.2 Emotion Experience

It has been suggested that deficits in emotion recognition are paired with deficits in experiencing emotions (Goldman & Sripada, 2005). It was proposed therefore to test this by including images that evoke positive and negative emotions, but which were not just faces. The aim was to see if there was a relationship between the strength of the rating of the emotions evoked by the images and the ability to recognise the emotions in the facial expressions. The semantic meaning and understanding of emotion is suggested to be dimensional along a hedonic valence scale and an arousal scale (Lang et al., 1993). The hedonic valence ranges from pleasure emotions such as unhappy, annoyed, despairing at one end and happy, pleased, hopeful at the other. The other dimensional element is arousal and this includes calm, relaxed, sleepy at one end and stimulated, excited, wide awake at the other extreme (Bradley & Lang, 2007). A dimensional theory of emotions was first proposed by Wundt (1896) who argued that affect largely ran along dimensions of pleasure and arousal and this was supported and clarified in later research (Osgood, Suci & Tannnenbaum, 1957; Russell & Mehrabian, 1978, cited in Lang & Bradley, 2007, p. 30).

Images from the International Affective Picture System (IAPS) (Lang, Bradley & Cuthbert, 2008) were chosen for this study. IAPS is a widely used set of normative emotional stimuli collated and rated for the specific purpose of providing standardised stimuli across a range of contexts for experimental investigations of emotion and attention. This normative database eliminates at least some of the subjectivity of image choice and facilitates better experimental control in the selection of images as each could be chosen within desired valence and arousal parameters. A total of 18 pictures which evoke either neutral, positive or negative emotions equally, were presented on screen. It was important to strike a balance between distressing the participants with blatantly disturbing images and having images strong enough to evoke some reaction. The positive images chosen had a mean valence of 7.34 (SD=0.74) and a mean arousal score of 6.44 (SD=0.89); the neutral images had a mean valence of 4.97 (SD=0.34) and a mean arousal of 2.51 (SD=0.54); whilst the negative images had a mean valence of 2.13 (SD=0.69) and a mean arousal of 6.47 (SD=0.42).

Participants were asked to rate the images along the two dimensions previously mentioned of pleasure and arousal. There were aspects other than the content of images, such as luminosity and colour, which could impact how the image was perceived. Therefore, images were carefully chosen to ensure there was no significant difference in the luminosity across the different emotions. The mean luminosity was calculated for each image using data acquired through Photoshop and mean differences between emotions were tested using an analysis of variance (ANOVA) which were non-significant. Figure 7 shows samples of the positive, negative and neutral images chosen for this study. Appendix 13 contains all the IAPS images used.

Positive Negative Neutral

Figure 7. Sample positive, negative and neutral images presented to participants for rating on valence and arousal

The self-assessment manikin (SAM) was used to rate the images (Bradley & Lang, 1994). This scale does not rely on language and is a 9 point scale which permits for fine sensitivity in ratings. It ranges from a smiling Happy figure at one end to a frowning Unhappy figure at the other when representing the pleasure scale and a wide-eyed excited figure to a sleepy figure on the arousal scale. The SAM scale has been shown to be just as effective as the semantic differential scale on the dimensions of arousal and pleasure and is quick and easy to administer (Bradley & Lang, 1994). Participants were asked to indicate on the pleasure scale which level of emotion the picture evoked in them and on the arousal scale the strength of the emotion.

In order to ensure there were no misunderstandings regarding how to rate on these scales standardised instructions were provided.

Participants were then presented with a trial run of three sample images to rate prior to starting the test properly. At this point they were able to ask for clarifications if anything was unclear with regards to the rating instructions or the task. If the simulationist model as proposed by Goldman and Sripada, (2005) is correct then there would be a correlation between the accuracy of emotion recognition in faces and the ratings of the emotions evoked by the IAPS pictures.

3.4.3 Eye Movement

Eye movement was measured using an eye-tracker. Eye-tracking is the process of measuring either point of gaze, in other words where one is looking, or the motion of the eye relative to the head. See Section 1.7 for history and use of eye tracking.

There are many different methods of exploring eye data. The most common is to analyse the visual path of a participant as they look across stimuli presented on a computer screen. This involves creating a set of pixel coordinates for each observation of eye data. From there, the presence or absence of eye data points in different screen areas, predefined as areas of interest (AOI), can be examined. This type of analysis is used to determine which features are seen, when a particular feature captures attention, what content is overlooked and virtually any other gaze-related question. In addition to the analysis of visual attention, eye data can be examined to measure the cognitive state of a participant. The type of data that was collected and analysed by the eye-tracker is detailed in Table 2.

Table 2. Definitions of the output measures collected by the eye-tracker

Time to first fixation (TFF):	measures how long it takes before a participant fixates on an AOI for the first time. The measurement starts when the image is first displayed and stops when the participant first fixates. (seconds)
First fixation duration (FFD):	Duration of the first fixation on an AOI. (seconds)
Total fixation duration (TFD):	measures the sum of the duration of all fixations within an AOI. If during the recording the participant returns to the same AOI then the new fixations on the AOI will be included in the calculation of the metric. (seconds)
Fixation count (FC):	measures the number of times a participant fixates on an AOI. If during the recording the participant leaves and returns to the same media element, the new fixations on the media will be included in the calculations of the metric.
Visit duration (VD):	measures the duration of each individual visit within an AOI. The n value used to calculate the descriptive statistics is based on the number of visits. A visit is defined as the interval of time between the first fixation on the AOI and the next fixation outside the AOI. (seconds)
Total visit duration (TVD):	measures the duration of all visits within an AOI. In this case, the N value used to calculate the descriptive statistics is based on the number of recordings. A visit is defined as the interval of time between the first fixation on the AOI and the next fixation outside the AOI
Visit count (VC):	measures the number of visits within an AOI. Each individual visit is defined as the interval of time between the first fixation on the AOI and the next fixation outside the AOI

3.4.3.1 Images used for passive viewing of emotional faces

One of the research aims was to test if there were differences in the way that respondents visually scanned faces to gather information regarding the emotions being portrayed. Facial stimuli for the visual scan path experiment included 4 basic emotions, Happy, Angry, Fear, and Sad as identified by Ekman (1992). It was important that the stimuli used in this element of the study were validated and expressed the intended emotions with some clarity. Whilst the Ekman and Friesen, (1976) database is the original, the images are proprietary and expensive to purchase. There are many free options available now which have been validated, including but not limited to Penn database (Kohler et al., 2003); Mazurski and Bond, 1993; the NimStim database (Tottenham et al., 2009); The Radboud database (Langner et al., 2010). For this study images from the Penn database were selected. This database used actors of different ethnicities and age ranges both male and female and the images were presented in colour. The database was created in accordance with Gur et al. (2002) to generate high quality 3-D images. A selection of 4 images for each emotion were used balanced for sex and ethnicity. Other databases such as the Radboud consists only of Caucasian images and therefore is less diverse and ecologically valid. For the current study this element only needed to include clear emotions of a high and low intensity. The objective was to identify if there was a difference in the way respondents gathered information for processing depending on the emotion type portrayed and whether there was a difference between the way the high and low binge drinkers gathered information. The Gur/Kohler stimuli have been deemed reliable representations of emotional expressions and have been widely used in emotion and face processing studies (see Palermo & Coltheart, 2004 for a review). As these images were different to the ones used in the ERT the participants were passively viewing the images for the first time when the scan path was being recorded. There is conflicting evidence about whether adding a cognitive task, such as recognizing emotions will impact on the scan pattern by activating top-down attention processes (Hayhoe & Ballard, 2005). Any interference therefore was avoided by passive viewing. See Appendix 14 for full details of the images used.

3.5 Measures - Questionnaires

3.5.1 FAST Alcohol Screening Test

It was important to identify if any of the binge drinkers were drinking in a pattern suggestive of an alcohol use disorder even if not with a current diagnosis. This would not exclude them from the study immediately but would be flagged for further analysis. Several measures were considered for use to identify this vulnerability, the most widely used being the Alcohol Use Disorders Identification Test (AUDIT). This is a is a 10-item screening tool developed by a cross country collaboration under the governance of the World Health Organization (WHO) for early identification and assessment of alcohol consumption, drinking behaviors, and alcohol-related problems (Saunders et al., 1993). Since its development, it has been extensively used in both clinical and non-clinical settings and a review of the research was conducted by Reinert and Allen (2007). They concluded that the AUDIT consistently performed well with good sensitivities across different samples including those with alcohol dependence, adolescents, and women. There are several short form tests derived from the AUDIT including the AUDIT-C and the AUDIT-PC and the FAST. Shorter screening instruments were considered preferable for the current study, provided they were still effective, in order to minimise participant fatigue whenever possible. The FAST Alcohol Screening test was chosen as it consisted of just four questions, which had good sensitivity and specificity across a range of settings (Hodgson, Alwyn, John, Thom, & Smith, 2002). The FAST had been shown to be effective for screening for alcohol misuse (Hodgson et al., 2003) and compared well with other short screening questionnaires in a clinical environment (Kelly et al., 2009).

3.5.2 Alexithymia Questionnaire TAS-20

Alexithymia is characterized by difficulty in describing and identifying emotional states and having an externally oriented thinking style (Moriguchi & Komaki, 2013). It has been suggested that the prevalence of Alexithymia amongst a student population in the UK could be as high as 17% which is in line with findings in other countries (Mason, Tyson, Jones & Potts, 2005). It was important therefore to screen for this to rule out the possibility of Alexithymia confounding the results. See Section 1.5.1 for more details.

There are several measures used to identify and measure Alexithymia. These include interview led scales such as the Beth Israel Psychosomatic Questionnaire (BIQ) or the Karolinska Psychodynamic

Profile (KAPP), whilst the Observer Alexithymia Scale (OAS) is a self-report questionnaire completed by an acquaintance of the subject. However, for the purpose of the current study these are too time intensive in terms of both administration and analysis. The current study required only top-level information on whether Alexithymia is present or not in order to control for this factor in the results. The Schalling-Sifneos Personality Scale (SSPS), the Amsterdam Alexithymia Scale (AAS) and the Toronto Alexithymia Scale (TAS-20) all matched those criteria. The SSPS had certain flaws and demonstrated poor internal reliability although there was acceptable test-retest reliability after a short period (Linden et al., 1995) and the Amsterdam Alexithymia Scale (AAS) is a 40 item scale and whilst including the fantasy aspect of Alexithymia and showing promising results for internal consistency of the factors and replicability of factor structure (Taylor et al., 2000) it would have taken longer to administer than the Toronto Alexithymia Scale (TAS-20) which was chosen for the current study.

The Toronto Alexithymia Scale has been translated into several languages, both European and Asian and has also been administered in North America indicating its widespread use. The TAS-20 is based on 3 subscales: Difficulties in identifying feelings and distinguishing between emotional and physical sensations (DIF); difficulties in describing feelings (DDF): externally oriented thinking (EOT). At conception it did include diminished daydreaming which was intended to represent a limited fantasy life however, this was dropped from the TAS-20 as at validation these items had low factor correlations. The TAS-20 is the most widely used

Alexithymia scale amongst both clinical and non-clinical populations (Kooiman et al., 2002; Meganck et al., 2011;Taylor et al., 2000). It has good test-retest reliability and factor replicability amongst both clinical and non-clinical population (Bagby, Parker, et al., 1994; Bagby, Taylor, et al., 1994;Taylor et al., 2000). However, it is not perfect and Kooiman et al., (2002) in a review of literature and a psychometric study of the TAS-20 highlight the absence of the fantasy dimension of Alexithymia in the TAS-20. Also, in clinical and non-clinical populations the Externally Oriented Thinking dimension of the scale cannot be reliably measured. Due to lack of criterion validity (the extent to which a measure is related to an outcome it is designed to test), it is recommended not to use the TAS-20 on its own but rather with another measure such as the BIQ which is an interviewer led assessment tool (Kooiman et al., 2000). In the same critique the authors also recommend just using the overall score and not breaking the results down into the three subscales as from their studies and others the DIF and DDF were found to group together in a factor analysis and may therefore represent the same dimension of Alexithymia whilst the reliability of the EOT has been shown to be questionable across different studies (Meganck, et al., 2011).

Notwithstanding the short-comings of the TAS-20 outlined it is still the most widely used instrument in Alexithymia research (Meganck et al., 2011). The psychometric properties of the scale including the reliability and convergent, discriminant and concurrent validity have all been shown to be acceptable (Bagby, Parker, et al., 1994; Bagby, Taylor, et al., 1994; Parker et al., 2003; Taylor et al., 2003). It was therefore selected as an appropriate measure for the current study. The TAS-20 uses a 5 point Likert scale ranging from strongly disagree to strongly agree: Factor 1, difficulty identifying feelings, is assessed by items such as, 'I am often confused about what I am feeling'; Factor 2, difficulty describing feelings, with items such as 'people tell me to describe my feelings more'; and Factor 3, externally oriented thinking, with items like, 'I prefer talking to people about their daily activities rather than their feelings'. See the full questionnaire in Appendix 6.

A total of five items on the scale are reverse coded to avoid response bias and once these items are reverse coded the total over all items is summed. High scores (61 and over) have been suggested to indicate alexithymia tendencies (Bagby, Taylor & Parker, 1994).

3.5.3 Mood Measurement

Mood needed to be accounted for in any analysis as it could impact the recognition of emotions and therefore influence the results in an unintended way. See Section 1.5.2 for an overview of Mood. Two general factors, Positive Affect (PA) and Negative Affect (NA) emerged in research as the dominant dimensions of emotional experience (Watson & Tellegen, 1985). There were several different measures that could be used and these needed careful consideration. The Hamilton Anxiety and Depression Scale-Anxiety (HAM-A) (Hamilton, 1959), and the Hospital Anxiety and Depression Scale-A (HADS-A) (Zigmond & Snaith, 1983) are mostly used in clinical settings and were therefore discounted. A Visual Analog Scale (VAS) was also discounted as how the mood is operationalised varies across different studies, which makes it difficult to make comparisons with other studies for a cross-sectional study, and measurement is done in millimeters with a ruler which is time consuming for the researcher and open to errors.

The Profile of Mood States (POMS) (McNair et al., 1971) was also considered. This is a 72-item inventory that assesses six dimensions of the mood construct: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Confusion-Clarity, Vigor-Activity and Fatigue-Inertia plus two composite factors. This was widely used and validated (Nyenhuis et al., 1999; Terry & Lane, 2003; Watson & Clark, 1997) However with 72 items it took a lot of time to administer. Shortened versions were developed to make it more flexible. (McNair et al., 1992; Shacham, 1983; Terry et al., 1999). Shortened versions were more desirable for physically ill or otherwise impaired populations or, as in the current study, inclusion in multi-instrument assessed protocols. The Short Form POMS (POMS-SF: Shacham, 1983) had 37 items and maintained the 6 subscale scores which other short POMS do not. The psychometric properties of the questionnaire were examined (Curran et al., 1995) and it was found to have good internal consistency. At 37 items, it was considered quite long to include in this multi measure study when other shorter measures were available.

The Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988) was chosen for the current study due to its reliability and brevity. Although the terms of positive affect and negative affect might suggest these mood factors are opposites on the same dimension they have been shown to be separate dimensions (Emmons & Diener, 1985; Tellegen, 1985). Positive Affect (PA) refers to the extent to which a person feels enthusiastic, alert and awake whilst Negative Affect (NA) is a state of subjective distress and uncomfortable interactions. Therefore, high PA is a state of high energy full concentration and pleasurable engagement whereas low PA is characterised by sadness and lethargy whilst high NA consists of a variety of negative mood states, including Anger, contempt, Disgust, guilt and Fear with low NA being a state of calmness and serenity (Watson, Clark & Tellegen, 1988). Telegen (1985) linked PA and NA to the psychobiological and psychodynamic constructs of sensitivity to signals and reward and punishment. This operationalisation of mood coincided with some elements of the SAM measurement scale to be used for rating the IAPS images in this study. The PANAS has been shown to be valid and reliable in the studies conducted for the development of the scale (Watson et al., 1988) and in later studies (Crawford & Henry, 2004). Although Crawford & Henry (2004) were not able to confirm the complete independence of the two dimensions of PA and NA they nonetheless concluded that it was fit for purpose.

The PANAS is composed of 20 self-rating items corresponding to adjectives (e.g., Interested, Distressed) that describe different states, feelings and emotions. The PA factors include items such as interested or excited whilst the NA factors include items such as irritable or afraid. There are 10 terms each linked to either the NA or PA and they each require a score on a 5 points Likert scale. Each rating seeks to measure the intensity of that specific feeling or emotion during a given timeframe for the participant (1 = very slightly or not at all; 2 = a little; 3= moderately; 4= quite a bit; 5 = extremely). For the current study the time frame of ‘right now’ was used. See Appendix 7 for the full questionnaire.

3.5.4 Impulsivity Questionnaire

Impulsivity has been linked with binge drinking and thus was included in the current study to monitor the traits of the recruited participants (Henges & Marczinski, 2012). Impulsivity is a tendency to react rapidly or in an unplanned manner to internal or external stimuli without regard for negative consequence or inherent risks (Shin et al., 2012). Impulsivity has been identified as a multifaceted concept and several personality dispositions have been implicated in rash or impulsive behaviour. Positive and Negative Urgency, where the former is the tendency to act rashly when experiencing an extremely positive mood and the latter a tendency to act rashly when experiencing an extremely negative mood (Cyders & Smith, 2007; Whiteside & Lynam, 2001) are two such facets. These have been shown to represent distinctly different aspects of rash behaviour relating to urgency (Cyders & Smith, 2007). Of course, these emotional aspects of Urgency are not the only ones that contribute differentially to impulsivity; impaired conscientiousness which includes lack of planning (acting without thinking ahead) and lack of perseverance (becoming easily bored, inability to stay focused on a task) and finally sensation seeking (tendency to seek out novel or exciting activities) (Whiteside & Lynam, 2001) are also implicated. The identification of these dispositions helps to clarify the processes that contribute to rash action and provides a means to explore the constructs in order to more accurately identify which facets impact alcohol consumption.

Impulsivity has been measured using both self-report and behavioural measures of impulsivity depending on which constructs are being targeted. A review by Dick et al. (2010) examined evidence for the construct of impulsivity and its relationship to alcohol use disorders. They distinguished between trait measures of impulsivity, seen as stable characteristic measures in terms of world view measured using self-report questionnaires, and state impulsivity, which is identified as cognitive processes measured using laboratory tests. Studies have revealed consistent associations between alcohol use and both self-report and behavioural measures of impulsivity (see Dawe et al., 2007 for a review).

The Barratt Impulsiveness Scale (BIS-11) (Patton, Stanford, Barratt, 1995) is considered to be amongst the most widely used in both research and clinical settings and is highly associated with many clinical disorders characterized by impulsive behaviour (Stanford et al., 2009). These include substance abuse (Lane, Moeller, Steinberg, Buzby, & Kosten, 2007), aggression (Stanford et al., 2003), and eating disorders (Galanti et al., 2007). The scale has also been associated with both structural and functional neuroadaptations within the prefrontal cortex (see Spinella, 2004 for review). As such it was considered more appropriate for the current study.

The BIS-11 is a 30-item self-report questionnaire which provides a total score of general impulsivity, by summing three nonoverlapping second-order subscales which demonstrate good reliability (Spinella, 2007). These comprise, Attentional Impulsivity (instability of attention and decision making), Motor Impulsivity (acting without thinking), and Non-planning Impulsivity (inability to plan ahead). These subscales are comprised of 6 first-order factors: attention (I do not pay attention), motor (I do things without thinking), self-control (I plan trips well ahead of time), Cognitive Complexity (I like to think about complex problems), Perseverance (I can only think about one problem at a time), and Cognitive Instability (I have “racing” thoughts). The BIS shows good test–retest reliability and demonstrates high convergent validity with similar self-report measures including the Zuckerman Sensation-Seeking Scale, the Eysenck Impulsiveness Scale, and the Behavioural Inhibition/Activation Scales (Stanford et al., 2009). The BIS-11 uses a four-point Likert scale ranging from 1 (rarely/never) to 4 (almost always). Higher scores indicate higher levels of impulsiveness. Scores between 52 and 72 are within normal impulsivity limits (Stanford et al., 2009). See Appendix 8 for the questionnaire.

3.5.5 Alcohol Use Questionnaire

There are many methods used to measure alcohol consumption and the research objective is key to which one is used. As this study is concerned with binge drinking specifically, how that is operationalized and measured is important. To be considered “binge” drinking it needs to raise the blood alcohol concentration (BAC) to 0.08 grams per cent or above. This is included in the National Institute of Alcohol Abuse and Alcoholism (NIAA; 2004) definition of binge drinking. An important aspect of binge drinking is that it is also followed by a period of abstinence in order to experience periods of intense intoxication followed by withdrawal. The absolute quantities of alcohol consumed are a poor indication of binge drinking as we perceive it. One can binge on relatively low amounts of alcohol if it is consumed quickly enough to raise the BAC to 0.08 grams per cent. It takes an hour on average for the body to process one unit of alcohol. When followed by a period of abstinence this creates a situation similar to a clinical one where patients with an AUD undergo cycles of recovery (withdrawal) and relapse (intense intoxication). In a review of the consequences of binge drinking (Stephens & Duka, 2008) it was concluded that the absolute amount of alcohol consumed is less important than the size of the effect it has on the individual and it is this that predicts cognitive impairment.

The accuracy of questionnaires as self-report measures of alcohol consumption has been questioned. This was explored in a study which compared the effectiveness of the Alcohol Use Questionnaire (Mehrabian & Russell, 1978) and a four-week diary entry (Townshend & Duka, 2002). A total of 55 students were recruited and they completed the AUQ and then completed a four-week diary entry of alcohol intake. The two were found to be highly correlated however there was a tendency to underestimate the absolute quantity of alcohol consumed as recorded on the AUQ. This was consistent with previous studies (Lemmens et al., 1988) who also found the quantity of alcohol consumed to be underestimated on a self-report retrospective questionnaire in comparison with a diary. When looking at other elements such as number of times getting drunk and percentage of time drinking to get drunk, low drinkers tended to overestimate consumption and higher drinkers tended to underestimate consumption.

One issue with the AUQ is that there is a timing difference between the information requested for alcohol consumption which is weekly and the number of times being drunk is requested for the previous six months, hence, there were large differences between the diary and AUQ for this measure. However, as suggested previously the total amount of alcohol consumed is not necessarily a good indication of 'binge drinking'. The binge score as calculated in the AUQ has been effective in distinguishing between binge drinkers and non-binge drinkers in impulsivity and novelty seeking on tasks of spatial working memory and pattern recognition (Townshend & Duka, 2002). The researchers concluded that whilst the AUQ had the same tendency towards over/under estimation as other self-report measures, it did have the benefit of more closely identifying the pattern of drinking unlike some other measures such as the five/four measure (Wechsler & Austin, 1998) where the focus is on quantity of alcohol consumed. As the ability to identify the pattern of drinking, specifically binge drinking, is key to the current research this is the questionnaire that was implemented.

The revised Alcohol Use Questionnaire (Mehrabian & Russell, 1978) adapted by Townshend and Duka (2002) considers the type of alcohol, beer, wine and spirits on a weekly basis. This sums up to a Unit score. It also looks at the number of times the participant was drunk in the last 6 months and the percentage of time that they drink that they become drunk.

Finally, it asks about how many drinks they would consume in an hour. The binge score then is calculated on the number of drinks per hour and number of times drunk and the percentage of time becoming drunk. The binge score obtained therefore is not based solely on the quantity of alcohol consumed but rather the pattern of drinking. This score was used to classify participants into the low binge drinking group (LBD) and the high binge drinking group (HBD) using a median split for the current study.

3.5.6 Demographics Questionnaire

Demographics collected the following: Age, Gender, Year of Study, Ethnicity, current mental health diagnosis, previous diagnosis of alcohol use disorder, age of 1st drink, age first became drunk, age of drinking regularly, alcohol intake in the past 24 hours, caffeine intake in the past 24 hours, cigarettes smoked in the past 24 hours, details of medication or drugs (prescribed or illegal) regularly taken (daily/weekly). The full questionnaire is included in Appendix 5.

3.6 Ethical Considerations

Ethics approval for this research has been obtained from the School of Human and Social Sciences Ethics Committee at the University of West London. The study was conducted in line with British Psychological Society 2014 guidelines. Participants were fully briefed on the nature and purpose of the research. Each participant completed the study individually and they were advised it would take approximately 50 minutes. More time was allowed between slots so that participants did not feel rushed. Participants were given sufficient time to read the information and consider the implications and ask the researcher for any clarifications before making an informed choice about whether to participate. Written consent was obtained prior to proceeding with the study. Participants were advised that their data would be confidential and that they were free to withdraw at any time.

The Data Protection Act (2018) was adhered to. Consent forms to be retained until the project is written up and complete. A unique numeric identifier was allocated to each participant in order to make the data anonymous. Participants were also advised of the unique identifier to facilitate their withdrawal from the study if they wished. This use would be checked with the official record prior to being withdrawn. Only the unique identifier was associated with responses on the computer files. A password protected excel spreadsheet also linked the names with the participant number in case the participant lost their unique number and wished to withdraw from the study. Only the principal researcher had access to this file.

Completed questionnaires were kept securely in a locked room with limited access but there were no names attached to hard copies to maintain anonymity and confidentiality. The data will be retained for up to 5 years but may be destroyed sooner if the project is completed and there is no further need to review it. Only the principal researcher and supervisors had access to the data for the research purposes outlined in the consent form. Only anonymous data was analysed as no names were included in the data files.

Participants were debriefed at the end of the study and given time to ask any further questions. They were also provided with a debrief sheet which explained some of the research behind the study. Participants were provided with contact details for the researcher and offered an overview of results once the project was complete. The debrief sheet included details of different websites offering information and advice regarding recommended levels of alcohol use and sources of help if they were not comfortable with their consumption levels. In addition, they were provided with details of the university counselling service if they felt they needed to speak to someone following the study. The information sheet, and debrief documents are included in Appendix 11 and 12 respectively.

3.7 Summary

This chapter has set out the methods that were employed in the first part of this research project. The various measures that relate to either alcohol consumption or emotion recognition and the proposed methods to measure them have been presented in detail with the supporting rationale for their choice. In the methods sections in the following chapters the questionnaires and tasks outlined in detail here will be referred to as an overview with reference back to this section to avoid lengthy repetition. Where new materials are used in later studies more details are provided in the relevant chapters as appropriate.

Chapter 4 Study 1-Part 1: The impact of binge drinking on bottom-up complex emotion recognition

This chapter presents a brief rationale of why this study was carried out. It provides an overview of the materials and procedure which were explained in more detail in the previous chapter. Finally, it details the statistical analysis and a discussion of the results and future directions.

4.1 Introduction

The ability to read the emotions of others in specific situations is central to social interactions and an impairment in emotion recognition brings detrimental social consequences (Itier & Batty, 2009). Indeed, a key assumption for exploring these deficits is that impairment leads to direct negative effects on everyday social life (Brackett et al., 2006; Denham et al., 2003). The disruption of emotion recognition decoding may have adverse consequences for social integration as efficient processing seems to be necessary for the development and maintenance of satisfactory inter-personal relationships (D'Hondt, Campanella, et al., 2014). Alcohol consumption increases the likelihood of an ambiguous but negative facial expression being interpreted as angry (Attwood et al., 2009) which in a social context could lead to an aggressive defensive response that is inappropriate.

Those with an alcohol dependence (AD) have a pattern of alternating intense intoxications and withdrawal episodes and experience brain alterations associated with cognitive, emotional and behavioural impairments (Oscar-Bergman & Marinkovic, 2007). An interesting aspect amongst the alcohol dependent group is the impaired ability to recognise facial expressions or emotions (Maurage, Campanella, et al., 2009). Townshend and Duka, (2003) conducted a study amongst alcohol dependent (AD) inpatients and a matched sample of social drinking control participants. The aim was to examine biases in AD participants' recognition of emotions when presented as two closely related emotions. Participants were 14 inpatients with an AD and 14 age and sex matched controls who were social drinkers. Participants were presented with images of morphed faces containing a mix of two closely related emotions. The images contained different percentages of each emotion and participants were asked to rate how much of each of 6 emotions (Happy, Surprise, Fear, Sad, Disgust, Anger) they perceived in each image. In comparison to control participants, the inpatient group identified a greater proportion of Fear in all the images presented and a different way of responding to Anger and Disgust which may be related to orbitofrontal damage due to alcohol abuse (Moselhy et al., 2001). The heightened Fear recognition in the AD group was related to the previous number of intoxications. Taylor and Chermack (1993) put forward a model which argues that intoxication blocks access to the behavioural inhibition system. The focus of those intoxicated is narrowed and they are only able to attend to the most salient and dominant cues which tend to be those perceived as threatening and demand a fight or flight response leading to a hyper vigilance to threat.

The impact of alcohol on brain structures has been widely explored as those with an AUD experience a deficit in cognitive functions (Harper, 2009; Oscar-Berman & Marinkovic, 2003; Oscar-Berman & Marinković, 2007). Similar to those with alcohol dependence, binge drinkers also experience periods of intense intoxication followed by periods of withdrawal and deficits in executive function have been explored in relation to this (review Hermens et al., 2013). Binge drinking is associated with poorer cognitive performance (Molnar et al., 2018) including executive functions, specifically the capacity to retain and manipulate information (Parada et al., 2012). However, whilst Townshend and Duka, (2005) found that females were more likely to be negatively impaired than males, the findings of Parada et al. (2012) did not support this. Townshend and Duka, (2005) proposed that the difference they found could be due to the drinking pattern of the females in the sample, and not a true gender difference as the same effect had not been found in a previous study with lower BD scores. This interpretation of drinking pattern as instrumental was supported by Maurage et al. (2012) who compared 4 groups with different patterns of alcohol consumption (control non-drinkers, daily drinkers, low and high binge drinkers) of 20 students each. Event related potentials (ERP) were measured whilst participants carried out a visual oddball task. Binge drinking was associated with a reduced and slowed neuronal activation of the P100/N100 areas which are associated with early visual perception. Young binge drinkers also had lower activation of the N2b/P3a areas which reflects the voluntary switch of attention to different stimuli indicating an impairment in attention. Whilst P3b/B1 which is associated with high level decision making also had lower activation patterns. By including 4 patterns of alcohol consumption in the study the researchers were able to conclude that it was the specific pattern of alternating intense intoxications and withdrawal episodes characteristic of BD that was particularly damaging to the brain.

To date only two studies have been identified that explored binge drinking and complex facial emotion expressions (Lannoy et al., 2019, 2018; see Chapter 2 for more details). Binge drinkers appear to have a poorer performance overall in accurately identifying the emotional content of facial expressions and require a higher intensity of expression in order to do so (Lannoy et al., 2018). This impairment is not consistent across all emotions, and it has been suggested that there is a specific deficit for Fear and Sad (Lannoy et al., 2019). The question remains whether this deficit is due to the stimulus type or whether the stage in processing also has an influence. The previous relevant research above involved top-down processing of emotional faces, which are intrinsically social due to their special role in communication. It is unclear therefore whether other stimuli such as emotionally valanced images are impacted in a similar way. Furthermore, the previous research by Lannoy et al. (2019) presented the stimuli for 10 seconds. This involves top-down processing by the lateral pre frontal cortex (LPFC) and the anterior cingulate cortex (ACC) which has been shown to be impacted by alcohol consumption (see Abernathy, Chandler, & Woodward, 2010 for a review). In contrast automatic bottom-up processing involves the amygdala for rapid processing of emotional stimuli. It would be beneficial therefore to understand whether the different stages in processing have an impact on emotion recognition.

The current research aims to clarify whether the results indicating a deficit amongst binge drinkers in the recognition of facial emotion expressions, which was predominantly conducted by one research group in Europe, can be replicated and extended to the United Kingdom.

Based on the previous literature it is predicted

- the high binge drinking group (HBD) will have a poorer performance overall than the low binge drinking group (LBD) on emotion recognition and specifically that the recognition of Fear and Sad will be negatively impacted.

- there will be a difference in how HBD and LBD rate emotional images with HBD experiencing a dampened emotional perception and therefore providing lower ratings to the emotional images in terms of valency and arousal.

4.2 Method

The method for this study has been explored in detail in Chapter 3. In brief, the research was conducted using both cognitive computer tasks and standardised questionnaires. Participant responses were recorded and associations between drinking habits and performance on the computer tasks along with responses on the questionnaires were sought. Differences in high (HBD) and low drinkers (LBD) were examined for emotion recognition in faces.

4.2.1 Design

A cross-sectional quasi-experimental study was carried out. This was the most appropriate to explore the study objectives. The rationale for the choice of tools, specifically the CANTABeclipse software has been presented in Chapter 3. By identifying other factors, apart from alcohol, specifically mood and alexithymia, known to have an impact on emotion recognition it was possible to select appropriate measures to monitor and control for these in the analysis. This helped to reduce the opportunities for confounding results. The independent variables (IV) in the current study were the drinking patterns and the emotions presented whilst the dependent variables (DV) were the number of emotions correctly identified the latency of responses and the ratings of the IAPS images.

4.2.2 Participants

A total of 54 students, aged 18-35, who drank alcohol were recruited for this study and a total of 50 were included in the final analysis (Mean age = 23.04 (SD=4.23), with 33 females. A cut-off point of 35 years was used as this is the end of the 'young adult' category in other alcohol studies (Patton & Boniface, 2016; Littlefield, Sher & Steinley, 2010) and a broad definition helps in recruitment. More specific recruitment and exclusion criteria are outlined in the previous Chapter 3, Section 3.3. Participants were recruited via advertisements on university notice boards and announcements in class. Two rounds of recruitment were required in order to reach the target. Psychology students were credited with study participation points via the SONA system (a centralised participant management system) whilst non-psychology students were awarded £10 Amazon vouchers for completion of the study. All participants completed the Alcohol Use Questionnaire (AUQ) to measure alcohol consumption and binge drinking patterns. A total of 50 participants were included in the final analysis. (See Preliminary data cleaning, Section 4.6.1 for details on exclusions.) Two groups, high binge drinkers (HBD) and low binge drinkers (LBD) were created using the median binge drinking score and formed the basis of the analysis for this study. The HBD N=25 had a mean age of 22.32(SD=3.76), 14 females whilst the LBD N=25, mean age of 23.76 (SD=4.61), 19 females.

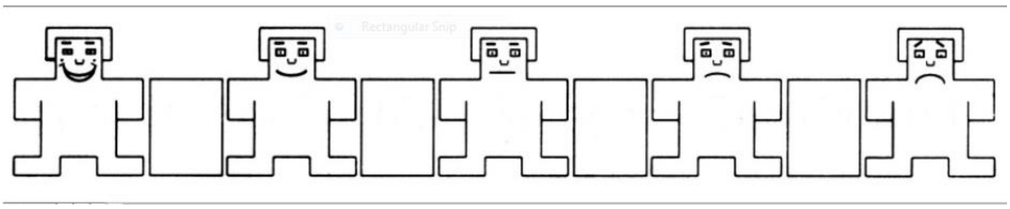
4.3 Measures: Computer tasks

4.3.1 ERT Task

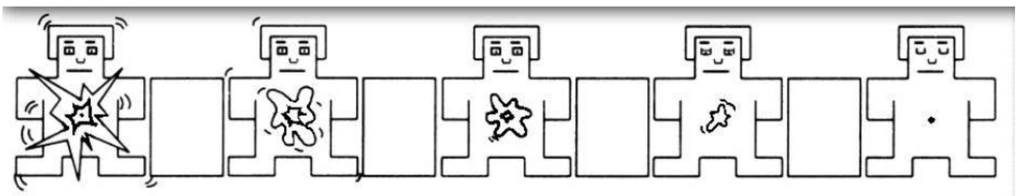
The Cambridge Cognition (CANTAB) Emotion Recognition Task (ERT) was chosen to measure the ability to identify emotions in facial expressions for the current study. The ERT measures the ability to recognise six basic emotions along a continuum of strength of expression using 15 intensity levels of each emotion. Each image was presented on screen for 200ms and each represented different degrees of six emotions; Happy, Anger, Fear, Surprise, Disgust and Sad. Overall, participants saw 180 stimuli in two blocks of 90. There were 15 images for each of the 6 emotions and each displays a different intensity of the emotion. Subsequent to presentation, a backward mask of noise is presented for 250ms, which aims to prevent processing of after-image, and a fixation cross is presented for 2000ms prior to each image to center participant focus. In a forced choice task, participants must choose the most likely expression seen from a list of the six possibilities. There is no time limit on how long participants can take to make this decision, but they are encouraged to do it as quickly as possible. See Chapter 3, Section 3.4.1.1 for more details and example images for this task.

4.3.2 Emotion Experience

Emotion experience was measured using images from the International Affective Picture System (IAPS). See Chapter 3, Section 3.4.2 for more details. A total of 18 pictures, six each evoking either positive, negative or neutral emotions, were presented on screen for 5 seconds each. Images were chosen which had a similar valence, arousal and luminosity within each condition. The initial presentation was followed by the self-assessment manikin (SAM) rating scale for pleasure and arousal. This is a nine-point image-based rating scale. See Figure 8 below.



Pleasure Scale



Arousal Scale

Figure 8. Self Assessment Manikin (SAM) rating scale for valence and arousal

Participants were asked to rate the images along the two dimensions of pleasure and arousal.

4.4 Measures Questionnaires

4.4.1 Alcohol Use Questionnaire

The Alcohol Use Questionnaire (AUQ) (Mehrabian & Russell, 1978) is a behavioural and potentially more conservative measure of BD (Stephens & Duka, 2008) compared with the Wechsler and Austin (1998) questionnaire that uses the standard binge measure of consuming 5 or more drinks in a row for men (4 or more drinks for women) per occasion within 2 weeks. The AUQ was used to obtain information from all participants about the quantity and frequency with which they consume alcohol and the type of alcohol consumed. The questionnaire was used to classify participants into the low binge drinking group (LBD) and the high binge drinking group (HBD) based on the median score. The binge drinking score obtained was not based on the quantity of alcohol consumed but the pattern of drinking. (See Chapter 3, Section 3.5.5 for more details.) The questionnaire also gathered data which produced a Unit score based on the quantity of alcohol consumed and an AUQ score which took both the quantity and pattern of consumption into account.

4.4.2 Positive and Negative Affect Schedule

Two general factors, Positive Affect (PA) and Negative Affect (NA) have emerged in research as the dominant dimensions of emotional experience. The PANAS questionnaire (Watson, Clark & Tellegen, 1988) has been shown to be a reliable and valid measure of these constructs (Crawford & Henry, 2003), (see Chapter 3, Section 3.5.3 for more details). The questionnaire consists of twenty items, 10 each for PA and NA to be rated on a scale of: very slightly or not at all/a little/ moderately/quite a bit/extremely. The PA factors include items such as interested or excited whilst the NA factors include items such as irritable or afraid. The PANAS was administered at the start of the testing session and asked participant to rate how they felt at that moment. High PA indicates enthusiasm, alertness and high pleasurable engagement whilst low PA indicates sadness and lethargy. High NA on the other hand indicates subjective distress and unpleasurable engagement whilst low NA indicates calm and serenity.

4.4.3 Toronto Alexithymia Scale (TAS-20)

Alexithymia was measured using the Toronto Alexithymia Scale(TAS-20; Bagby, Parker, & Taylor, 1994). The TAS-20 is a 20-item self-report inventory, which has been found to have adequate construct, discriminant, and convergent validity, and good internal consistency and test–retest reliability (Bagby et al., 1994; Bagby, Taylor, & Parker, 1994). (See Chapter 3, Section 3.5.2 for more details.) However, there are inconsistencies with regards to the replicability of the subscales and therefore as recommended by Kooiman et al. (2002), only the total score is analysed in the current study. High scores (61 and over) have been suggested to indicate alexithymic tendencies.

4.4.4 Barratt Impulsiveness Scale (BIS – 11)

Impulsivity is a tendency to react rapidly or in an unplanned manner to internal or external stimuli without regard for negative consequence or inherent risks (Shin, Hong & Jeon, 2012). Impulsivity was measured using the Barratt Impulsiveness Scale (BIS – 11: Patton, Stanford & Barratt, 1995). This is a reliable and valid 30 item scale measuring the personality dimension of impulsivity (Henges & Marczinski, 2012). Factor analysis indicates that it measures three dimensions of impulsivity: motor impulsiveness, non-planning impulsiveness, attentional impulsiveness. Participants rate statements on a 4-point Likert scale ranging from rarely/never to almost always/always. Eleven items are reverse scored. The higher the summed score the higher the self-reported impulsivity. See Section 3.5.4 for more details.

4.4.5 Demographics questionnaire

The following demographics were also collected and used to categorize the participants and identify additional drinking behaviours not included on the standardized questionnaires: Age, Gender, Year of Study, age of 1st drink, age first became drunk, age of drinking regularly, alcohol intake in the past 24 hours, caffeine intake in the past 24 hours, cigarettes smoked in the past 24 hours, details of medication or drugs (prescribed or illegal) regularly taken (daily/weekly), sleep quality. The following questions were used to screen ineligible participants, which included students with a current mental health diagnosis, or previous diagnosis of alcohol use disorder.

4.5 Procedure

Participants were invited to attend a specialist laboratory at the University of West London at a mutually convenient time. All participants followed the same procedures. Participants were asked not to consume alcohol for 12 hours before participation in line with previous research (Attwood et al., 2009). This is so that any alcohol in the system has time to be eliminated as it was the long-term impact of alcohol that the current study was interested in and not the acute impact. Participants attended individual sessions where they were greeted by the researcher, a standard briefing note was read explaining the aims of the research and written consent was obtained (sample in Appendix 12). Further details are included in the Ethics Chapter 3, Section 3.6 of this thesis.

Participants firstly completed the Demographics Questionnaire followed by the Alcohol Use Questionnaire and the PANAS. The CANTAB ERT was explained and again, a standard briefing note read out so that everyone had the same instructions, and hence researcher influence would be minimised. The participants were advised to complete the task as quickly as possible although there were no time limits on the forced choice aspect of the study. (See Chapter 3, Section 3.4.1.1 for more details.) Once finished, the participants proceeded to complete the final two questionnaires, the BIS-11 followed by the TAS-20. Participants were debriefed at the end of the session. They were also provided with an information sheet to take away, which included details of support groups for alcohol use in case they were in any way concerned about their drinking habits.

4.6 Statistical Analysis

4.6.1 Preliminary Data Cleaning

The data set was screened for accuracy prior to any analysis being carried out, to ensure the underlying assumptions were not violated. All data were checked for input errors on the data file using descriptive statistics in SPSS to identify any out-of-range values. Two anomalies were identified on re-examining the original questionnaires and these were rectified. Two participants were removed as they were outside the specified age range (over 35). A further two participants were removed due to missing key data. Finally, two participants had not completed all the TAS-20 and one participant had not completed the PANAS. Rather than lose the remaining data and delete these three additional participants it was decided to insert the mean score, based on the whole sample, for each variable keeping the overall mean constant for these variables (Tabachnick & Fidell, 2014). This is considered a conservative solution as the mean for the distribution is not changed (Tabachnick & Fidell, 2014).

4.6.2 Normal distribution

Some statistical tests require that the data is parametric or in other words has a normal distribution. Normally distributed data means that data would be distributed symmetrically around the central tendency (Field, 2013). This also ensures the linearity and homoscedasticity of the data. The distribution of scores therefore was initially examined using histograms and the normality curve (SPSS Descriptives/Explore) to identify the overall shape of the distribution curve. Normality tests Shapiro-Wilks were also examined for significance. As it is the absolute size of the skew and kurtosis relative to their standard errors that matters, where abnormal distribution was indicated by the Shapiro-Wilks this was also tested by dividing values of skewness and kurtosis by their respective standard errors and thus converting them to z-scores. (Tabachnick & Fidell, 2014). A score of 1.96 or less is considered acceptable for a sample of up to 50 participants (Ghasemi & Zahediasl, 2012).

With regards to alcohol consumption measures, where clear outliers were identified the data was Winsorized where appropriate. This is a process which involves replacing outliers with the next highest score which is not an outlier (Field, 2013). The changed scores involved the higher binge drinking group only which contained 2 outliers relative to the rest of the group for the alcohol consumption scores. The actual amounts of alcohol consumed for these participants whilst high relative to the rest of the group were not in themselves extreme. The number of units consumed was 51 per week (the equivalent of between 15 – 20 drinks depending on the alcohol strength) but it was the speed of drinking that increased the binge score (BS). Adjusting these down improved the accuracy of the model and retained the higher binge drinkers in the data. Given that this factor was pivotal to the study and the relatively low sample size it was important not to lose any data on this measure. Adjusting these scores down did not impact this as mean scores moved closer to the median which remained constant. The current research aimed to identify any differences between the HBD group and the LBD group and therefore any differences would not be impacted by retaining this data in the same relative order.

The key variables are high and low binge drinking, calculated using the median binge score, and the distribution of both groups were checked against independent variables. *Age at first drink*, and *age first drunk* were normally distributed for both HBD and LBD whereas *age drinking regularly* was not normal for either group. The AUQ, Unit score and BS were normal for HBD but only the AUQ was normal for LBD according to the Shapiro-Wilks test. However, the absolute values were below 1.96 which is considered an acceptable level of deviation from normality for a sample of 50 or less (Ghashemi & Zahediasl, 2012) permitting parametric tests using these variables. The data for the TAS-20 and BIS-11 was also normally distributed for both the HBD and LBD groups however the PANAS negative affect was not normally distributed for the HBD group which had a positive skew. The data was transformed using a Log10 transformation which improved the normality somewhat but not sufficiently and neither did an inverse transformation normalise the data so that non-parametric tests were required for this variable.

The data were also checked for multivariate outliers of the drinking scores using SPSS regression and mahalanobis distance (MD). In all cases MD = $p<0.001$ indicating an acceptable distance from the overall mean or centroid for multivariate data analysis (Tabachnick & Fidell, 2014).

4.6.3 T-Test

Once the normality of the data was established an independent samples t-test was run on the key measures. A t-test is a parametric test and as such requires normally distributed data and that the data be interval or ratio in nature. It is used to establish if two sets of data are significantly different from each other. As a normality test had already been conducted this was the appropriate test to identify if the differences between the mean scores from the independent groups were statistically significant. For non-normal data the non-parametric Mann-Whitney U test was conducted.

4.6.4 Unbiased Hit Rate for Accuracy of Emotion

Wagner (1993) noted that accuracy which is directly measured by the hit rate (actual number correct) does not take all the available information into account. That is, research into non-verbal communication should not only consider the raw hit rate for an emotion correctly identified, but also the participant personal bias in use of that emotion which may inflate the hit rate of that emotion. Wagner proposed that a more accurate measure of category judgement of non-verbal behaviour studies such as the current study should calculate an unbiased hit rate.

This was done therefore for the current study and a confusion matrix (6 x 6) created for each respondent by emotion and the unbiased hit rate was calculated

Table 3 shows how the matrix was created and the calculations performed according to the following formula.

Equation 1. Unbiased hit rate

Unbiased hit rate for Happy = sum(a/a +b+c+d+e)*(a/n)

Table 3. Template for the confusion matrix created for each respondent with respect to emotions chosen

		Judgement				
Stimulus	**Happy**	**Sad**	**Fear**	**Surprise**	**Angry**	**Total**
Happy	a	b	c	d	e	a+b+c+d+e
Sad	f	g	h	i	j	f+g+h+i+j
Fear	k	l	m	n	o	k+l+m+n+o
Surprise	p	q	r	s	t	p+q+r+s+t
Angry	u	v	w	x	y	u+v+w+x+y
Total	a+f+k+p+u	b+g+l+q+v	c+h+m+r+w	d+i+n+s+x	e+j+o+t+y	N

4.6.5 Correlation tests

Correlations were used initially to identify any relationships between the overall drinking habits and the measures of emotion recognition taken from the CANTAB ERT data. The other measures of interest including smoking, the TAS-20, BIS-11, and the PANAS were also checked for associations with emotion recognition. Finally, the scores on the IAPS data were checked. Where a relationship was identified, a more detailed analysis was undertaken.

4.6.6 Mixed-design analysis of variance (ANOVA)

ANOVA was used to identify if there are differences between groups by examining the variances in the mean scores of each group. It was used in the current study to identify differences between high binge drinkers (HBD) and low binge drinkers (LBD) and how they responded to the different emotions and whether these differences were group specific. Where the results indicated significant main effects or interactions, these were followed up with post-hoc independent samples *t*-tests corrected for multiple comparisons.

4.6.7 Recognition Threshold Calculation

Each image was presented, in random order, at 15 levels of increasing intensity from 1 which was very weak to 15 which was a strong representation of the emotion. In order to compare the intensity of emotion required for recognition between HBD and LBD groups the mean threshold was calculated for each emotion for each participant. This used the average of the first level of accurate recognition plus the average of the level after which recognition is perfect that is:

Equation 2 Threshold calculation

[first threshold+perfect threshold/2].

This is a validated method and has previously been used by Lannoy et al. 2018 in similar research.

4.7 Results

4.7.1 Demographics

The results are calculated based on 50 participants (33 females). The primary outcome of the study was to identify if there were differences in the ability to identify emotions between high and low binge drinkers. The sample was therefore split using the median binge score for the whole group in line with other studies (Townshend et al., 2014). Table 4 shows the descriptive statistics for the total sample and split by the binge drinking groups. The table also includes the results of an independent samples *t*-test conducted for the key measures and highlights where there are significant differences between groups on key measures with potential to impact on emotion recognition.

There was an unequal gender split across the sample. Whilst gender differences were not a specific hypothesis in the study, this was also checked to identify if results showed a gender bias. An examination of the descriptive tables shows that the age group of the low binge drinkers was slightly older than that of the high binge drinkers; M = 23.76 (4.61) and M = 22.32 (3.76) respectively, however this was not a statistically significant difference. An independent samples *t*-test revealed that there was no significant difference between groups on when they had their first drink. There was a significant difference between groups for when they first got drunk with HBD getting drunk over 2 years earlier than LBD on average *M* = 15.6, *SD* = 1.89 for HBD and *M* = 17.71, *SD* = 2.25 for LBD $t(47) = 3.55$, *SEM* =0.59, $p<0.01$.

For binge drinking behaviour, as expected, the HBD had significantly higher scores than the LBD for the three drinking measures; AUQ score $t(48) = -10.54$, $p<0.001$, Unit score $t(48) = -6.20$, $p<0.001$ and Binge score $t(48) = -10.26$, $p<0.001$. With regards to gender, whilst there was no significant difference between males and females for when they started drinking or first became drunk, there was a significant gender difference for scores relating to the amount of alcohol consumed AUQ $t(48) = 2.53$, $p<0.05$, Units $t(23.09) = 2.15$, $p<0.05$ and Binge Score (BS) $t(48) = 2.14$, $p<0.05$ with males consuming more alcohol per week (Units mean = 23.18, Std = 16.14) than females (Units mean = 15.1, Std = 10.73).

There was a significant between-group difference for Attention on the BIS-11 Impulsivity Scale $t(48) = 2.79$, $p<0.05$ with HBD having higher attentional impulsivity (M=19.01, SD=4.6) than LBD (M=16.38, 3.80). There were no significant differences for the other key measures. See Table 4 for details of the results.

Table 4. Demographics, drinking variables and key variables that may influence emotion recognition

	All n=50 Mean (SD)	HBD n=26	LBD n=24	*t*
Gender (Female/Male)	33/17	14/11	19/6	
Age	23.04 (4.23)	22.32 (3.76)	23.76 (4.61)	1.07
Age of 1st drink	14.61 (2.84)	14.44 (2.26)	14.79 (3.39)	0.83
Age 1st got drunk	16.63 (2.32)	**15.60 (1.89)**	**17.71 (2.25)**	**3.55****
AUQ Score	39.25 (28.86)	**60.68 (20.99)**	**17.88 (8.99)**	**-10.54*****
Unit Score	14.93 (11.72)	**24.28 (1.83)**	**9.52 (5.10)**	**-6.20*****
Binge Score	24.14 (20.74)	**36.64 (13.22)**	**9.04 (4.42)**	**-10.26*****
TAS	48.18 (10.08)	47.89 (8.26)	48.48 (11.79)	1.22
Attention BIS	**17.69 (4.39)**	**19.10 (4.62)**	**16.38 (3.81)**	**-2.28***
Motor BIS	22.52 (3.75)	23.00 (2.78)	22.07 (4.48)	-0.88
Non-planning BIS	24.54 (4.54)	24.15 (4.41)	24.15 (5.05)	-0.28
PANAS – Positive	32.73 (7.37)	31.83 (7.48)	32.63 (7.30)	-0.13
PANAS - Negative	12.56 (2.66)	12.22 (2.78)	12.90 (2.55)	1.56

significant differences between the heavy and light social drinkers *** p<0.001, ** p<0.01, * p<0.05

4.7.2 Impulsivity, Mood, Alexithymia and

In order to confirm the internal reliability of the key measures of the self-report questionnaires in the current sample a Cronbach's alpha test was carried out. The results are illustrated in Table 5.

Table 5. Scale reliability for key measures of TAS-20, PANAS and BIS-11

	Mean	SD	Variance	Alpha
TAS-20 Total	48.28	10.05	101.06	0.76
Identifying feelings	16.72	6.09	37.10	0.85
Describing feelings	13.94	4.85	23.57	0.79
Externally oriented thinking	17.62	4.56	20.85	0.65
PANAS				
Positive	32.73	7.37	54.13	0.89
Negative	12.56	2.66	7.1	0.61
BIS-11				
Attention	17.69	4.39	19.29	0.80
Motor	22.52	3.75	14.09	0.47
Non-planning	24.34	4.78	22.73	0.69
BIS Total	64.55	9.93	96.61	0.80

Motor impulsivity has a Cronbach alpha score of 0.47. It is generally accepted that a score of 0.7 or above demonstrates good reliability (Tavakol & Dennick, 2011) whilst a score between 0.5 and 0.69 is of moderate reliability (Hinton, Brownlow, McMurray & Cozens, 2004). Any analysis using the motor aspect of the scale therefore needs to be interpreted with caution due to this low reliability. The remaining scales are all an acceptable level (Kline, 1999).

Inspection of questionnaire measures revealed that there were no significant between group differences on the PANAS measures and data did not violate homogeneity of variance for these measures. Also, there was no significant difference between groups on the TAS-20 or the total BIS-11 scale, indicating that it was not necessary to include these as covariates in further analysis. LBD scores for the BIS-11 were in line with normative data for healthy participants (see Stanford et al., 2009 for a review) whilst the scores for Attention (a subscale of attentional impulsivity) on the BIS-11, revealed greater attentional impulsivity amongst the HBD than LBD. However a study testing the relationship between emotion recognition and impulsivity only found a predictive relationship with Non-planning scale from the BIS-11 and emotion recognition (Preti et al., 2016). In addition, a correlation analysis on the current data found no relationship between any of the measures of Attention on the BIS-11 and emotion recognition, $p>0.05$ for all measures, therefore it was not included in further analysis. In addition, there was no correlation between caffeine intake or smoking in the previous 24 hours and emotion recognition and these were therefore not included in further analysis. Furthermore, the results for the TAS-20 were in line with normative data (Parker et al., 2003) which indicates an overall score of 45.57 (STD=11.53) in a normal population compared with 48.18 (STD=10.08) for the current study overall.

Given the gender inequality in the sample the male and female results for the PANAS, BIS-11 and TAS-20 were also checked for differences. There were no gender differences except for one of the subscales on the BIS-11 relating to attention $t(48) = -2.20$, $SEM = 0.78$, $p=0.03$, however, this was not sufficient to impact the overall attentional scale which was non-significant $t(48) = -1.53$, $SEM = 1.29$, $p=0.13$.

4.7.3 Emotion recognition task

With regards to emotion recognition, Figure 9 illustrates the mean scores for the correct identification of emotions. Within emotions both Fear and Anger were least likely to be correctly identified in both LBD and HBD, however, independent *t*-tests confirmed there was no statistically significant difference in emotion recognition between the high and low binge drinkers for any of the emotions.

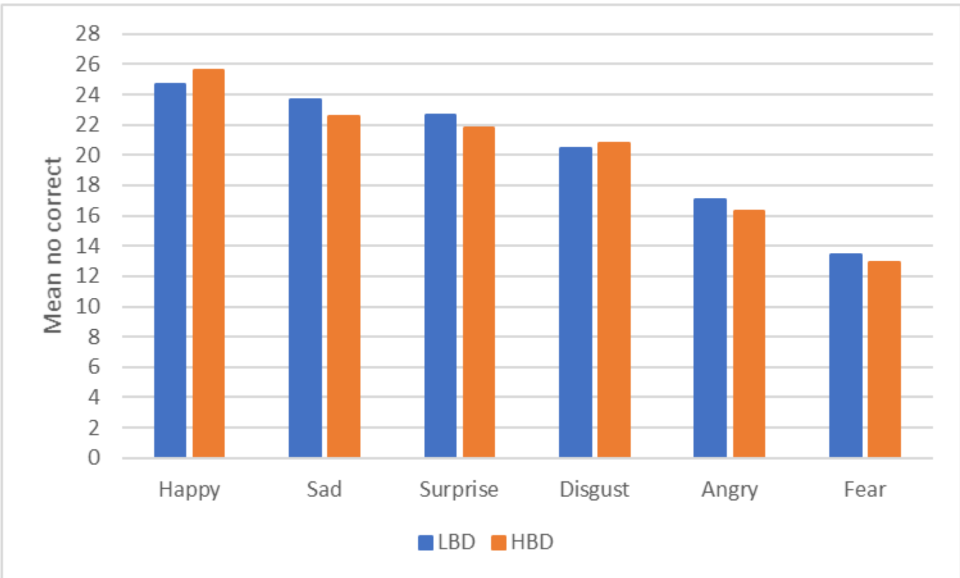


Figure 9. Emotions correctly identified from a possible 180 images split by LBD and HBD

Table 6. Mean and Standard deviation of the number of emotions correctly identified by drinking pattern

	Happy		Sad		Surprise		Disgust		Angry		Fear	
N=50	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD	Mean	STD
LBD	23.65	3.08	23.65	3.01	22.65	2.91	20.46	5.74	17.04	3.87	13.38	6.39
HBD	25.58	3.35	22.54	3.13	21.79	3.84	20.75	6.28	16.29	3.62	12.96	4.46

Unbiased Hit Rate

The unbiased hit rate (Hu) was also calculated as outlined in Section 4.6.4 and as this was a proportion value it first needed to be arcsine transformed before being analysed (Wagner, 1993). Results were non-significant across emotions although identification of Happy was approaching significance $t(48) = 1.93$ $p=0.06$. When bias was taken into consideration then there was a trend towards HBD being more likely to incorrectly attribute Happy to an ambiguous emotion than LBD.

Relationship between drinking measures and ability to identify emotions correctly

A Pearson correlation was carried out to identify any relationship between the drinking variables including Age of First Drink, Age First Drunk, Number of Years Drinking, Units and Binge Score and the six emotions presented, see Table 7 for details.

Table 7. Relationship between drinking measures and the emotions correctly identified taking bias and probability into account

	Overall	Sad	Happy	Surprise	Fear	Anger	Disgust
1st drink	-.09	-.11	.03	.12	.03	-.03	.21
1st drunk	-.05	-.09	.22	-.004	-.05	-.003	.21
Years drinking	-.28	-.17	-.16	-.09	-.09	-.22	-.20
Units	-.07	.008	**-.36****	-.16	-.04	.03	.02
Binge	-.02	.11	-.21	-.13	-.06	.07	.05

*Correlation is significant at ** p<0.01, * p<0.05 (2-tailed)*

As seen in Table 7, taking bias and probability into account, except for the recognition of Happy, there was no other relationship between any of the drinking scores and the emotion accuracy. A negative moderate relationship between units consumed per week and Happy, $r(50) = -0.36$, $p = 0.01$, such that the more units consumed per week the poorer the recognition of Happy.

Bias for choice of emotion when identifying incorrectly

Correlations were also run on the emotions incorrectly chosen to identify if there were any biases in the chosen emotion. There was a negative correlation with Age of 1st Drink and Anger incorrectly chosen, $r(49) = -.31$, p=0.03, indicating the younger participants were when they had their first drink, the more likely they were to incorrectly choose Anger. There was also a negative correlation for incorrectly choosing Sad and BS, $r(50) = -0.39$, $p = 0.01$, such that the higher the score the less likely they were to incorrectly chose Sad. The moderate correlation between the binge score (BS) and incorrect choice of Happy was also significant and in a positive direction, $r(50) = 0.33$, $p = 0.02$, such that the higher the score BS the more likely participants were to incorrectly identify Happy expressions.

Emotion Intensity of display

The intensity required before each emotion was accurately identified was checked for the HBD and LBD groups. An independent samples *t*-test found there was a significant difference between groups in the intensity required for the emotion of Fear, $t(47) = -2.23$, SEM 0.46, $p=0.03$, where HBD required a greater intensity threshold for identification, HBD M=8.96 (SD=1.99) and LBD M=7.94 (SD=2.04).

Latency of response

The latency of response in this context is the delay between the stimulus onset and the identification of the emotion. The latency of response for each emotion correctly chosen was examined. There was no correlation between the binge score (BS), the Unit Score (US) or the AUQ score and the latency of response. A mixed-design ANOVA 6 (emotions) x 2 (block 1 and 2 of stimuli presentation) x 2 (high and low binge score) found a main effect of emotion $F(4.5, 217) = 21.34$, $p<0.001$, $\eta^2 = 0.31$ and a main effect of time $F(1,48)$ 72.32, $p<0.001$, $\eta^2 = 0.60$ but no main effect or interaction with binge score $p>0.05$.

4.7.4 Emotion experience

A correlation analysis was conducted on the ratings for valence and arousal for the IAPS images and the number of emotions identified correctly. A negative relationship was identified between the mean arousal score for neutral images and the total number of emotions correctly identified, $r(50) = -.29$, $p<0.05$. Ratings for the IAPS images were also checked for correlations with the drinking measures. There was a negative correlation with binge score and the mean score provided for arousal to neutral images r(50) = -.3- p<0.05, such that the higher the binge score the lower the arousal rating for neutral images.

An independent samples t-test was conducted to check for differences between groups for the rating of the neutral IAPS images using the BS as the between groups variable. There was a significant difference between HBD and LBD for the mean score of arousal on neutral images, $t(1,48) = 2.25$, $p=0.02$, with M= 2.87 (SD=1.53) for the low binge group and M= 2.03 (SD=1.09) for the high binge group.

A 3x2x2 mixed ANOVA examined the ratings given to each of the IAPS pictures. The within measures were the ratings for image emotion (positive, negative and neutral) image intensity (valence and arousal) and the between measure was the drinking pattern (HBD and LBD). There was a significant main effect of image emotion, $F(2,96) = 138.02$, $p<0.001$, $\eta^2=0.74$ but no main effect of intensity, $F(1,48) = 0.07$, $p>0.05$. There was no interaction with drinking patterns. The emotion by intensity interaction was significant, $F(1.77, 85.11) = 207.69$, $p<0.001$, partial eta $\eta^2 = 0.81$ but there was no three-way interaction between emotion, intensity and binge drinking group, $F(2,96) = 0.640$, $p>0.05$, partial eta $\eta^2 = 0.01$.

Controlling for gender, which was unequally represented in the low binge drinking group, did not impact the interaction for the between emotions or intensity scores and group. It did however reveal a significant interaction between intensity and gender, $F(1,47) = 8.55$, $p<0.001$, partial eta $\eta^2 = 0.15$. An examination of the descriptive statistics shows that males give lower scores for arousal than women and higher scores for valence than women. See Table 8 for details.

Table 8. Mean ratings and standard deviation ( ) of valence (V) and arousal (A) of IAPS images

Gender	***Positive V***	***Positive A***	***Negative V***	***Negative A***	***Neutral V***	***Neutral A***
Male	6.91 (.90)	5.69 (1.61)	2.72 (.95)	5.27 (1.43)	5.31 (.59)	2.12 (1.23)
Female	7.30 (.90)	6.18 (1.31)	1.90 (.72)	6.59 (1.92)	5.03 (1.33)	2.62 (1.45)

4.8 Discussion

The objective of the current study was firstly to investigate whether there was an impact of binge pattern drinking on bottom-up emotion recognition, and secondly whether there was a difference between high and low binge drinkers in how they experienced and therefore rated emotional images in terms of arousal and valence. Mood, alexithymia and impulsivity were included as possible confounding variables as they might have an impact on emotion recognition.

The analysis of the general characteristics of the high binge group compared with the low binge group were carried out before examining the factors related to alcohol consumption. The general characteristics revealed no significant differences in age, although the low binge group tended to be slightly older. There were also more females in each group with a 76/34 (female/male) percentage split in the low binge group and a 56/44 percentage split (female/male) in the high binge group. This led to gender being explored as a possible influencing factor.

4.8.1 Age first became drunk

There was a significant difference between the groups for the age they first became drunk, with the high binge group getting drunk on average two years earlier. This is consistent with other research (DeWit et al., 2000) which identified a higher propensity to binge drink amongst those who first got drunk at an early age (11 to 14 years in this instance). This can lead to a higher propensity to develop alcohol abuse and even dependence (Jennison, 2004). That it is a risk factor for alcohol dependence and cognitive impairment (Hermens et al., 2013; Mota et al., 2013) may indicate it is also a risk factor for emotion recognition impairment. Whilst the Age of First Drunk was not specifically related to impaired emotion recognition in terms of the numbers of correctly identified emotions in the current study, there was a significant difference in the choice of Anger when incorrect, amongst those who became drunk at an earlier age, such that the younger they were when they became drunk for the first time the more likely they were to choose Anger incorrectly.

4.8.2 Impulsivity

HBD were identified as having greater 'attentional impulsivity' than the LBD but not for any of the other factors or overall impulsivity. That there was some difference is consistent with other studies which have found a relationship between alcohol and impulsivity (Dick et al., 2010; Papachristou, Nederkoorn, Havermans, Van Der Horst, & Jansen, 2012; Townshend et al., 2014). Papachristou et al., (2012) found that higher drinkers scored significantly higher on the subscales of motor impulsivity and non-planning whilst Fox, Bergquist, Peihua, and Rajita, (2010) found significantly higher scores in all three of the subscales to be predictors of alcohol use disorders.

It is interesting that the only significant difference identified between groups for the various subscales of impulsivity in the current study was for attention, meaning the ability to focus attention and concentrate; motor impulsivity, which assesses a tendency to act on the spur of the moment and non-planning which assesses thinking to the future were not implicated. This may be explained by how the binge groups were operationalised as the median binge score at 16 was quite low. Furthermore, as previously mentioned, results in other research in the area of emotion recognition are inconsistent. In addition, motor impulsivity had low reliability in the current sample and should therefore be treated with caution.

4.8.3 Emotion Recognition

Across the whole cohort emotion recognition of Fear and Anger were the two emotions least recognised and this is in line with other research (Calder et al., 2003). For example, in a comparison of emotion recognition across the lifespan, Calder found that Happy was the most easily recognised emotion and Anger, Fear and Disgust the most difficult even amongst non-clinical populations. This is consistent with the results in the current study.

There were no significant differences between high and low binge drinkers in the number of emotions correctly identified. This is consistent with the findings of a cross-modal study on emotion recognition and binge drinking (Lannoy et al., 2017). It is at odds, however, with Lannoy et al. (2018) who found a lower performance amongst BD across all emotions, and this was not driven by any specific emotion. However, in a later study with a larger sample, binge drinkers were found to have a specific deficit for Fear and Sad recognition (Lannoy et al., 2019). The lack of consistency in previous studies has been attributed to the over simplicity of the task (Lannoy et al., 2017) or, in the study where a more complex emotional discrimination task was employed, a lack of power due to small sample size (Lannoy et al., 2018). The lack of significant findings in the current study could equally be as a result of the duration of presentation of the stimuli. The current study presented the stimuli for 200ms which recruits automatic bottom up processing involving the amygdala for emotional stimuli whereas the studies outlined above presented the stimuli for 10s which involves top down processing involving the lateral pre frontal cortex (lPFC) and anterior cingulate cortex (ACC) which has been shown to be impacted by alcohol consumption (see Abernathy, Chandler, & Woodward, 2010 for a review). In addition, the current study had a low median binge score which may not yet be sufficient to reveal any behavioural differences. When split by the number of units consumed per week the results were approaching significance for overall accuracy, suggesting that a higher binge drinking group who also consume greater quantities of alcohol may reflect similar results to Lannoy et al. (2018), who had a sample with higher BS and Units consumed then the current study, and show an overall deficit in emotion recognition.

Looking specifically at the emotions incorrectly chosen, the younger participants were when they had their first drink, the more likely they were to incorrectly choose Anger. This is supported by Freeman et al. (2018) who examined those with an AUD and a control group and found no group differences in accuracy of emotion recognition but did identify differences in misidentification patterns. Those with an AUD were more likely to misidentify emotions as Anger or Disgust. Young people who start drinking at an early age are at higher risk of an AUD (Addolorato et al., 2018) and it may be that a bias towards threatening interpretations, where the stimulus is ambiguous, is a contributory factor when drinking is used for social motives and to ease social distress (Lammers et al., 2013). Those higher on both the binge score and the AUQ (which takes both binge pattern and quantity into account) were more accurate in the choice of Sad images and more likely to incorrectly choose Happy images when in doubt. This is contrary to the findings of Lannoy et al., (2019) where HBD demonstrated poorer recognition of Sad and Fear than the control group, however, there was no main group effect.

In the current study, when taking bias into account there was a tendency for high binge drinkers to incorrectly attribute Happy as the misidentified emotion. Binge drinking is associated with good social integration and social adjustment (Pedersen & Von Soest, 2015). Most young people drink for social motives and some for enhancement which are associated with moderate and heavy alcohol use respectively (Kuntsche et al., 2005; Sayette, 2017). Making negative attributions hinders positive social interactions (Brissette et al., 2002) and it may be, therefore, that in ambiguous situations HBD have a bias towards positive emotions. It should be noted that participants in the current study had a low median binge score and that at higher binge drinking levels this positive bias may be impacted.

Fear was the only emotion that required a greater intensity to be consistently identified as correct by HBD in comparison with LBD in the current study. This is supported by a review of studies on those with an AD and recognition of facial emotion expressions which identified greater intensity of emotion was required for the recognition of Fear and Anger

(Donadon & Osorio, 2014). This could be as a result of the attenuating impact of alcohol on the amygdala rendering it less efficient in the recognition threat related images (Sripada et al., 2011). Indeed, amygdala dysfunction has been identified in rats in binge studies and binge drinkers (Stephens et al., 2005) as well as those with an alcohol dependence (Townshend & Duka, 2003). A study with heavier binge drinkers and using similar morphed images to the current study, with different intensities from neutral to the full-blown emotion (Lannoy et al., 2019) found a deficit in the recognition of Fear. The current study did not identify any difference between the HBD and LBD groups for accuracy in recognition of Fear although greater intensity was required indicating some impairment. It could also be explained by the low binge drinking score of the sample which meant participants had not reached a threshold to be impacted behaviourally. Future studies therefore need to recruit heavier drinkers in order to identify whether the deficits identified by Lannoy et al., (2019) can be found consistently.

With regard to latency measures, differences in response times occur when there is facilitation, leading to a quicker response, or conflict, leading to a delayed response, to a particular stimulus (Chen & Spence, 2011). There was no significant difference in the current study between the high and low binge drinkers in latency of response to the different emotions suggesting that these brain mechanisms have not been impacted by current levels of alcohol consumption.

4.8.4 Emotion experience

As would be expected, there was a difference in the ratings of the emotional images in terms of valence and arousal, nevertheless there was no difference in how they were rated by the high and low binge drinkers. The only exception was of neutral images which were rated significantly lower in terms of arousal by HBD in comparison with low binge drinkers. This is not fully in line with expectations which predicted high binge drinkers would be expected to have a dampened response to both positive and negative images (de Arcos et al., 2005). This again could be as a result of the low binge score of the group such that the cerebral mechanisms involved in the experience of emotions, the meso-limbic-cortical areas, have not yet been altered to produce long-term disruption of emotional experience. However, the lower rating of Neutral images by HBD remains an anomaly. Research on brain responses of AUD and emotion experience tends to look at responses to emotional images in comparison with Neutral images (Sawyer et al., 2019) rather than across Neutral images per se which suggests further exploration is required in this area.

4.9 Summary

The main hypothesis of a difference between groups for emotion recognition was not upheld but approached significance when the unbiased hit rate was calculated for the total of each emotion. In this instance, there was a trend for the positive emotions of Happy with high binge drinkers being more likely to inaccurately attribute Happy. It has been proposed in other research that alcohol only impacts negative emotions and positive emotions are preserved (see review Donadon & Osario, 2014). These conflicting findings suggest there may be a methodological difference and when more than one positive emotion is included this preservation effect disappears. The current study also identified the need for a greater intensity of Fear was required by HBD in comparison with LBD to achieve accurate recognition. Whilst this did not translate to a behavioural difference it does indicate an early impact on Fear recognition which is in line with previous research (Lannoy et al., 2019). Inconsistencies with previous research may also be influenced to the processing stage being tested with early and rapid processing being less impacted than the later processing brain areas.

The findings in the current study highlight the importance of developing a standardised way to operationalise both the binge drinking measure in terms of what constitutes a high binge score and a low binge score and also the accuracy of emotion recognition in a forced choice paradigm where participants may have a bias towards selecting a particular emotion when they are uncertain.

4.9.1 Limitations and Future Research

The main limitation of the current study was the low median binge score of the cohort which may have impeded the identification of differences between high and low binge drinkers. If the continuum of alcohol exposure-linked impairment is assumed, it may well be that moving further along the binge drinking scale will incur emotion recognition deficits. The fact that the unbiased hit rate was higher for low binge drinkers indicating better recognition and less false attribution of the positive emotions, supports the need for further exploration particularly amongst a cohort of high binge drinkers.

In addition, the current study had relatively few males in the low binge drinking group. Gender has been identified in the current study as a differentiating factor in the rating of the IAPS images for valence and arousal. There were also significant gender differences in binge score and this gender imbalance should be addressed in future research.

To build on the current study a cohort with a higher median binge score needs to be achieved. There was very little difference between high and low binge drinkers in the IAPS image rating section of the study, whilst other studies have identified differences between groups for the rating of the strength of emotions. Those with an alcohol dependence have been found to rate the intensity of emotion expressions higher than controls and this could be another indicator of the impact of alcohol on emotion expression (Kornreich et al., 2013). It would be useful therefore, to focus on the rating of emotions in faces to see if this extends to binge drinkers before exploring other emotional images.

4.10 Conclusions

The study has not identified any behavioural difference in recognition accuracy of emotions between high and low binge drinkers although a significantly greater intensity was required by HBD for Fear recognition in comparison with LBD and a bias for misidentification of

Happy expressions has been suggested in the high binge drinkers. The lack of consistency with research in this area can be in part explained by two important factors that are seen repeatedly in research on emotions and alcohol use. The first is the range of paradigms used to explore emotion recognition. The current study tapped on automatic, bottom up, identification of emotions as stimuli were presented for 200ms, expanding the research previously conducted which presented a range of emotions for up to 10 seconds tapping on later top-down processing. Secondly, the definition of high binge drinkers varies across studies and even when similar methods are used to calculate binge drinking based on the Townshend and Duka (2002) there is still no standardised cut-off for high and low binge drinkers. These differences suggest slightly different processes may be measured in each study. The study of emotion recognition amongst binge drinkers is still in its infancy and is best examined using both behavioural and objective measures such as eye-tracking or physiologic responses. The next step is to identify whether at low alcohol binge drinking levels such as in the current study, there are differences in how HBD and LBD perceive and look at images to gather information prior to processing. This is addressed in the next chapter before moving on to explore emotion recognition in a cohort with a higher binge score.

Chapter 5 Study 1-Part 2: The impact of binge drinking on the visual scan path across emotional faces and images

Following on from emotion recognition which was reported in the previous chapter this part of the research had the objective to explore, using an eye-tracker, the pattern of how both high and low binge drinkers scanned faces for information for processing. It sought to identify whether there were any differences in how HBD and LBD gathered information which might be related to their pattern of drinking alcohol.

5.1 Introduction

Decoding of facial expressions is an important skill used in everyday communication and most people are very effective at accomplishing this task (Ruffman et al., 2008). D'Hondt et al., (2014) suggest that the disruption of emotion recognition decoding may have adverse consequences for social integration as efficient processing is necessary for the development and maintenance of satisfactory inter-personal relationships. As explained in the Introduction of Chapter 4 (page 102) the impact of an impairment in emotion recognition can lead to misunderstandings and difficulties in relationships with family, friends and employment (Levola et al., 2014).

Emotion recognition decoding has been shown to be impaired amongst those with an alcohol dependence (AD) (see Donadon & Osorio, 2014 for a review) and this deficit has been linked with the number of previous detoxifications (Townshend & Duka, 2003). A review of the psychosocial difficulties encountered by those with an AD concluded that it is interpersonal interactions, economic and professional life, dealing with aggression and legal problems that are the most frequently reported difficulties (Levola et al., 2014). Those with an AD tended to have a negative bias when interpreting non-threatening facial expressions (Freeman et al., 2017) and an ambiguous negative expression was deemed angry in other research (Attwood et al., 2009) which in a social context could lead to an aggressive, inappropriate response leading to negative consequences.

As detailed in Chapter 1, Section 1.4.2 page 32, binge drinking has been variously defined but according to the WHO is the consumption of at least 60 grams or more of pure alcohol, 5 or more standard alcoholic drinks, at least once in the last 30 days (WHO, 2018). This has been a troublesome pattern of alcohol consumption particularly among young people (WHO, 2018). Whilst there is much evidence to indicate that BD impacts cognition in terms of executive function (Montgomery et al., 2005; Maurage et al., 2012; Parada et al., 2012; Townshend and Duka, 2005; Field, Schoenmakers, and Wiers, 2008; Petit, et al., 2014) less focus has been placed to date on social cognition and specifically emotion recognition, however, this is now beginning to be addressed (Lannoy et al., 2017; Lannoy et al., 2018; Lannoy et al., 2019). See Chapter 2 for a review of these studies.

A global deficit in emotion recognition has been identified in binge drinkers (Lannoy et al., 2018) and this has been driven by a specific deficit in the recognition of Fear and Sad (Lannoy et al., 2019). A stimulus needs to be seen to be recognised and to have meaning attributed to it. What is presented in the visual field is not all processed equally and the visual systems limited resources are not randomly allocated to sections of the visual field but rather they come under attentional control (Wolfe, 1994). It is attention therefore that guides more detailed processing of stimuli in the environment, and faces are particularly effective at capturing attention (Frank et al., 2009; Itier & Batty, 2009). Hence, it is attention that is examined in the next section.

5.2 Attentional biases to facial expressions of emotion

The surrounding environment is complex and there is intense competition for the limited mental resources to process stimuli in the visual field. In order to function efficiently strategies are developed to scan the environment and direct attention to select stimuli and features for more detailed processing depending on our motivations. Attention can be stimulus driven (automatic) or goal directed (deliberate) (Yantis, 2000). Attention functions using two main processes; selection and orienting (Yang et al., 2012). The capture of attention occurs in a bottom-up approach, sensory driven, such as stimulus driven attention, but is mediated by top-down evaluation of the stimuli (Yiend, 2010), which draws on previous experience and knowledge. Orienting of attention is the process of shifting attention to an object of spatial location. This has three steps: shifting, engagement, disengagement (Posner et al., 1984).

Babies and infants as young as three months old, demonstrate a bias and preference for faces and stimuli that resemble faces over other stimuli with low-level perceptual salience (Frank et al., 2009). Schyns, Petro, and Smith, (2009) observe that the face has evolved as a social signaling system to transmit intention, attention and the internal emotional state of the individual. Evidence suggests that emotional faces engage attention for longer than neutral faces (Fox et al., 2002). This could be interpreted as an adaptive function as the emotional state of others could be important for signaling threat to neighbours and the individual needs to be able to both transmit those signals and read them in others (Schyns et al., 2009). The shift in attention to relevant emotional stimuli has not been explored in binge drinkers but has been identified in individuals with anxiety (Cisler & Koster, 2010; Haller et al., 2017). These demonstrate an attentional bias for threatening stimuli manifesting itself as a rapid automatic capture of attention and a difficulty in disengaging from threatening stimuli (Bar-Haim et al., 2007; Fox et al., 2002). This sensitivity to threat, whilst adaptive in a healthy population, can be debilitating in those with anxiety as they are more likely to perceive threat in the environment which reinforces their anxious state and helps to maintain it (Weierich et al., 2008). This is particularly true if the vigilance-avoidance hypothesis on the time course of attention in anxious individual holds true. The vigilance-avoidance hypothesis suggests that after an initial capture of attention the threatening stimuli is then avoided so the individual has no further information to elaborate the stimulus and evaluate the true level of threat (Mathews, 1990). This should be testable using different timings of stimuli onset to capture attention. The time-course of attention was tested, in a non-clinical anxious population, using paired word, threat and neutral, stimuli in a visual dot probe task, testing different stimulus onset asynchrony (SOA) or in other words different durations between the presentation of stimuli in order to identify the time-course of attentional bias for threat (Mogg et al., 1997). The timings of stimulus presentation were intended to represent different aspects of processing. The shortest was 100ms as it was thought to consist of automatic attention capture but not be long enough for controlled strategies or shifts in attention to occur. The second was 500ms, whilst the final timing was 1,500ms which was considered long enough for several shifts in attention to occur between the threat and non-threat related words (Mogg et al., 1997). The hypothesis that this longer duration would facilitate the identification of the process for the maintenance of attention, either vigilance-avoidance or a difficulty in disengaging was explored. The procedure involved a threat and non-threat word appearing on the screen, one above the other in random order for a duration of 100, 500 or 1,500ms. This was immediately followed by a dot probe in place of either the upper or lower word. Participants had to indicate the position of the probe as quickly as possible by pressing one of two keys and were cautioned to be careful about errors. The results indicated an attentional bias for threat with faster response times to the location of the threatening stimuli particularly in the 100ms condition. The quicker response times were related to the anxiety score with more anxious responding faster but there was no effect of stimulus onset asynchrony (SOA) on attentional bias. This was contrary to expectations as a vigilance-avoidance strategy towards threat had been indicated for those high in anxiety even in a non-clinical population.

A later study by Koster, Verschuere, Crombez and Van Damme, (2005), also used the visual probe detection task with non-clinical high and low anxious participants with the addition of a cognitive load task. The time course of attention in high trait (HT) anxious and low trait (LT) anxious participants was tested using images from the international affective pictures set (IAPS: Long, Bradley & Cuthbert, 1999). Images were either neutral (household objects), Mid threat (e.g. a man with a gun) or high threat (e.g. a mutilated body). The authors used the SOA of 100, 500 and 1,250ms. Similar to Mogg et al. (1997) they found all participants attended to the high threat stimuli for the 100ms condition suggesting automatic orienting of attention to threat for all participants. However, contrary to the Mogg et al. (1997) study, only the HT participants showed an attentional bias for the mid threat stimuli, whilst for the 1,250ms condition the HT participants avoided the high and mid threat stimuli supporting the vigilance-avoidance theory of attention. In an earlier study Koster, Crombez, Verschuere, and De Houwer, (2004) also using non clinical participants and a dot probe with IAPS pictures of HT, MT and LT as outlined in the previous study but only one time presentation of 500ms, concluded there was no vigilance to threat but rather a difficulty in disengaging from threat. The authors did not find a facilitated response on congruent threat trials compared with neutral trials. However, there was a delayed response in the mid threat incongruent trials compared with neutral trials suggesting a difficulty in disengaging from threat but not vigilance.

These inconsistent results could be due to methodological differences across studies, for example different stimulus types, different ways of operationalising high and low anxiety or different populations but it could also reflect a different process of the time-course of attention not picked up in snapshot studies. Paradigms such as the dot-probe task and the emotional Stroop are a relatively cheap and effective method of identifying interference of emotional stimuli in carrying out a task. They provide a snapshot and rely on reaction times. However, they are less efficient at elucidating the shifts in attention over time.

5.3 Visual scan path

This difficulty of identifying the time-course of attention can effectively be overcome by using eye-tracking. Eye-tracking can reliably go beyond the snapshot of attention identified by reaction time tasks such as the dot-probe or emotional Stroop to unfold a continuous measure of dynamic attentional processes (Armstrong & Olatunji, 2012). Whilst eye-tracking does not provide a measure of covert attention (an orienting to stimuli using internal neural adjustments that do not involve eye movement), it provides a direct measurement of overt attention (shifting of attention in space using muscular movements to perform saccades and fixations to selectively access environmental information) (Blair et al., 2009). This limitation does not undermine the value of eye tracking as a methodology as it does indicate where participants look and for how long unlike brain activity and other internal mechanisms. Overt attention and covert attention are closely linked, with overt attention closely following behind covert attention and being effectively guided by it in normal circumstances (Hayhoe & Ballard, 2005; Liversedge & Findlay, 2000). In a review of studies on eye tracking of attention in affective disorders (Armstrong & Olatunji, 2012) the authors emphasize the benefit of using eye-tracking particularly in evaluating the time-course of attention to threatening stimuli.

Gerdes, Alpers, and Pauli, (2008) combined both reaction times and eye-tracking to explore whether peripheral visual cues capture initial attention and distract from goal-directed eye-movements. Gerdes, et al. (2008) wished to overcome the limitations of dot-probe tasks by using eye-tracking to separate initial attention capture by threat and difficulty in disengaging from threat as identified in the studies above (Koster et al., 2004, 2005; Mogg et al., 1997). Participants were either spider phobic or a control group. Participants had to identify the orientation of a letter in a circle amongst other circles on the screen in their peripheral vision. A distractor circle which was empty or contained an image of a mushroom, a flower (spider shape) or a spider also appeared on the screen. Reaction times by the spider phobic group showed interference of the distractor images with increasing delays as the image became more spider-like and no interference for the blank circle compared with RTs of the control group. These findings support a vigilance to threat. However, the eye-tracking data revealed the first fixations by spider phobic participants were more likely to be on the distractors rather than the target regardless of the content of the distractor. Therefore, attentional capture is not related specifically to the Fear of spiders. There is however a hypervigilance to the possibility of a threat and when the threat, in this instance spider, is present there is greater difficulty in disengaging from this threat to carry out the task resulting in greater reaction time. It is only by using the combination of a reaction time paradigm and the eye-tracking that this clarity in the process can be identified.

Eye-tracking has also proved to be a useful tool in emotion recognition tasks amongst those characterised by marked social difficulties. Difficulties in emotion recognition have been associated with aberrant ways of scanning for information, for example people with conditions such as schizophrenia (Sasson et al., 2007) or autism (Hernandez et al., 2009; Spezio et al., 2007) scan faces in a qualitatively different way to healthy and neurotypical controls. People with schizophrenia have demonstrated a deficit in the perception of facial emotions with some studies identifying a specific impairment of facial emotion perception (Hall et al., 2004; Kosmidis et al., 2007), whilst others suggest a more generalized deficit in face perception (Baudouin et al., 2002; Kohler et al., 2000), see Chan, Li, Cheung and Gong, (2010) for a review. Using eye-tracking makes it possible to uncover the different eye-movement strategies used by those with schizophrenia in comparison to controls (Streit et al., 1997). Streit et al. (1997) identified differences in the length of scan paths and the duration of fixations among those with schizophrenia. This manifests itself as a restricted scanning behaviour, reflecting a shorter mean scan path and longer duration of fixations, and was related to affective flattening (a measure of expressive behaviour on the scale for the assessment of negative symptoms SANS: Andreasen, 1982).

Atypical scanning of facial features by those with schizophrenia can be improved with training as was discovered using eye-tracking (Russell et al., 2008). Russell et al. (2008) found that by redirecting visual attention to the relevant facial features, emotion recognition could be improved, and the gain was directly related to the increased number of fixations and dwell time on the eyes, nose and mouth. Abnormal scanning by those with schizophrenia is not limited to face but also extends to landscapes, fractals and noise patterns (Bestelmeyer et al., 2006). Bestelmeyer et al. (2006) found those with schizophrenia generally have fewer fixations, longer fixation duration and longer saccade duration compared with healthy controls regardless of the image type. In line with Bestelmeyer et al., (2006), an earlier study, (Loughland, Williams, & Gordon, 2002), found that participants with schizophrenia showed reduced attention to the salient features of the face including the eyes.

Although eye-tracking facilitates the objective assessment of real-time neurocognitive strategies whilst viewing face stimuli, the results are not all consistent. Zhu et al., (2013) investigated the processing strategies and processing efficiency in individuals with schizophrenia with respect to face recognition. They found participants with schizophrenia had significantly more fixations to the interest areas of the face and had fixations of increased durations compared with control participants. The authors concluded that the increased staring behaviour of participants with schizophrenia was due to reduced cortical activity, suggesting a lack of interest in facial images therefore requiring extended fixation duration and an increase in fixation numbers to successfully encode facial images. Zhu et al. (2013) identified that negative images have lower fixation numbers compared with positive or neutral faces, suggesting they are relatively inefficient at processing negative faces. This has been attributed to a desire to avoid negative interactions, but a requirement of the task meant the participants had to remember the negative faces and therefore take more time to process them.

Qualitative differences in the way people scan faces are measured by identifying the pattern of fixations over the face and the areas of fixation concentration. Certainly, attention to the eyes is important for emotion recognition (Baron-Cohen et al., 1997), and eye-tracking has identified that the eyes are particularly important for the recognition of Anger and Sad expressions (Calvo et al., 2018). A reduction in attention to the eyes has been associated with reduced or impaired activation of the amygdala (Gamer & Büchel, 2009; Kennedy & Adolphs, 2010). The amygdala in turn is implicated in alcohol use with a reduction in amygdala volume identified in those with an AD (Fein et al., 2007; Wrase et al., 2008). Indeed it has been suggested that alcohol creates alterations in the functional connectivity between the amygdala and left orbitofrontal cortex (OFC) during the processing of Happy faces and the right OFC for threat (Anger and Fear) faces (Gorka et al., 2013). This alteration is likely to have an important impact on the processing of socio-emotional signals as the OFC is thought to have a top-down inhibitory control that prevents emotional information from interrupting attention and impacting goal-driven behavior (Crane et al., 2018).

In summary, there is evidence of a role for the amygdala in emotion recognition, particularly in directing attention to the eye region (Gamer & Büchel, 2009). There is also evidence that the amygdala is impacted by alcohol which affects the functional connectivity with the OFC (Gorka et al., 2013). In addition, reduced amygdala – OFC functioning is associated with increased alcohol consumption in binge drinkers (Crane et al., 2018). It would be appropriate therefore to investigate how those who binge drink scan faces for processing and whether this is related to emotion recognition. No study has been identified to date that used eye-tracking to examine *how* binge drinkers gather information on facial emotion expressions (FEE). This technique may provide some insight into the processes of attention behind any impact of BD on facial emotion recognition.

The current research therefore aimed to explore whether there was a difference between High binge drinkers (HBD) compared with Low binge drinkers (LBD) on how they scan faces and whether any variation in scan patterns extended beyond directly social stimuli to other image types with a positive, negative or neutral valence and arousal. As there is no previous research to generate the direction of the predictions the current research addressed the following questions:

- Do those with a low binge score (LBD) and high binge score (HBD) produce different scan patterns for faces?

- Does the scan pattern differ depending on whether the image is directly social (e.g. face), neutral (e.g. household object) or more complex valenced scenes (e.g. a beach scene or angry dog)

5.4 Method

The current study employed a repeated measures (4 x 3 x 2) mixed design. The independent variables were emotion type (Anger, Happy, Sad, Fear) and image (positive, negative, neutral), binge group (HBD, LBD) being the between group measure. The dependent variables are the length of the scan path and the fixation measures. The tasks and supporting questionnaires are listed in section 5.5 Materials below.

5.4.1 Participants

A convenient sample of 39 participants (26 females, age M=23.21, SD = 4.17) were included in this part of the research study. These 39 participants were a subset of the previous study (n=50) who also completed the eye tracking part of the study, however, of these 11 were excluded due to insufficient or poor-quality data capture and could not be included. The method of recruitment has been covered in Chapter 4 Section 4.2. All participants completed the Alcohol Use Questionnaire (AUQ) (Mehrabian & Russell, 1978) to measure alcohol consumption and binge drinking patterns. Two groups, high binge drinker (HBD) (n=20, 10 male, age M=22.9, SD=4.13) and low binge drinker (LBD) (n=19, 3 male, 23.56, SD=4.31) were created using the median binge drinking score, which was 17, and these groups formed the basis for the analysis of this study. This study was approved by the University of West London ethics committee and written consent was obtained from all participants.

5.5 Materials

A more detailed description of the materials used can be found in Chapter 3, Section 3.5, page 87.

5.5.1 Questionnaire Data

5.5.1.1 Alcohol Screening

The FAST Alcohol Screening test was used in the current study to identify if participants were at risk of an alcohol use disorder. The FAST consists of just four questions, which has good sensitivity and specificity across a range of settings (Hodgeson et al., 2002). See Section 3.5.1 for more details.

5.5.1.2 Binge Drinking Score

Binge drinking scores were calculated using the revised Alcohol Use Questionnaire (Mehrabian & Russell, 1978) adapted by Townshend and Duka (2002) which considers the type of alcohol; beer, wine and spirits consumed on a weekly basis. This score was used to classify participants into the low binge scoring group and the high binge scoring group using a median split which was 17 for the current study. See Section 3.5.5 for more details.

5.5.1.3 Alexithymia

Alexithymia is a multifaceted personality construct characterized by difficulty in describing and identifying emotional states and having an externally oriented thinking style (Moriguchi and Komaki, 2013). Alexithymia was measured using the Toronto Alexithymia Scale (TAS-20; Bagby, Parker, and Taylor, 1994). The total score was analysed in the current study. See Section 3.5.2 for more details.

5.5.1.4 Mood

Mood has been shown to have an impact on emotion recognition and experience even amongst healthy participants (Bouhuys, Bloem & Groothuis, 1994). The PANAS questionnaire (Watson, Clark & Tellegen, 1988) was used in the current study. See Section 3.5.3 for more details.

5.5.2 Behavioural Measures

5.5.2.1 Emotion Recognition

The Emotion Recognition Task from the Cambridge Neuropsychological Test Automated Battery (CANTAB ERT) was used to assess the recognition of six basic facial emotional expressions; Happy, Sad, Anger, Disgust, Fear, and Surprise. The images were morphed expressions of real individuals' facial expressions and consisted of 15 levels of each of the 6 emotions shown twice, a total of 180 images presented in two blocks of 90. This was a forced choice task, and each image was presented for 200ms before a grey mask appeared for 500ms followed by the option to choose on a touch screen the emotion most closely represented by the image. There was no time limit to making the selection, but participants were asked to respond as quickly as possible. The task outcome was accuracy (number correct for each emotion), misidentification (number incorrect for each emotion) and latency of response.

5.5.2.2 Visual Scan Path (VSP)

The visual scan path data was collected using the Tobii TX300 eye tracker. The Tobii TX300 Eye-Tracker is an unobtrusive eye tracker for detailed research of natural behavior. It has a large head movement box which allows the participant to move during tracking while maintaining accuracy and precision at a sampling rate of 300 Hz. This means that eye movements such as fixations and saccades can be studied without using a chinrest thus facilitating a more natural experience. A fixation is when the eyes rest on an area momentarily and a saccade is the movement between two fixations. Facial stimuli for this task included 4 basic emotions, Happy, Angry, Fear and Sad as identified by Ekman (1992). Two male and two female images were shown for each emotion making a total of 16 images. The images used were from the Gur database of images (Gur et al., 2002) as these were validated and depicted the intended emotions with clarity. The objective was to identify if there was a difference in the way the high and low binge drinkers gathered information for processing. It also aimed to identify if any differences extended to all emotions or just specific emotions. Areas of Interest (AOI) were set up on the eye tracker for each image around the top half of the face (eye region) and bottom half of the face (mouth region). The images were presented on the screen for 6000 milliseconds and followed by a fixation cross for

2500 milliseconds. The participants passively viewed the images for the first time when the scan path was being recorded. There is conflicting evidence about whether adding a cognitive task, such as recognizing emotions has an impact on the scan pattern by activating top-down attention processes (Hayhoe & Ballard, 2005). Any interference therefore was avoided by passive viewing. Outputs measured in this study included: Total fixation duration (TFD): which measures the sum of the duration of all fixations within an AOI. Fixation count (FC): which measures the number of times a participant fixates on an AOI. Total visit duration (TVD): which measures the duration of all visits within an AOI. Visit count (VC): which measures the number of visits within an AOI. The total length of the visual scan path for each emotion was also calculated. For more detailed explanation of the fixations measured see Chapter 3, Section 3.4.3 Table 2.

Images from the IAPS database of emotional images were also presented to participants. These were chosen to evoke positive, negative or neutral emotions. The images were selected to have high arousal and valence for the positive and negative images and the neutral images chosen for low arousal and valence. The positive and negative images were also more complex than the neutral images which were simpler in content and luminosity (See Section 3.4.2 for more details).

The length of the visual scan path of the following 3 images was calculated and used to compare with the length of the scan path of the emotional faces all of which were presented for the same duration of 6 seconds.

Figure 10. Sample of negative, positive and neutral images used

See Appendix 13 for the full set of images used.

5.6 Procedure

Participants were invited to attend individual sessions at a specialist laboratory at the University of West London at a mutually convenient time. A standard briefing note explaining the aims of the research was read and written consent was obtained.

Participants firstly completed the questionnaires and tasks for Study 1-Part 1. See Chapter 4, Section 4.5 for full details. The Alcohol Use Questionnaire was self-completed followed by the PANAS. The CANTAB ERT task was explained, and a standard briefing note read out. The participants were advised to complete the task as quickly as possible although there was no time limit on the forced choice aspect of the study. Once completed the participants then proceeded to complete the final questionnaire (TAS-20). The tasks for Study 1-Part 2, Eye-tracking of emotional images, were then undertaken. Firstly, participants were asked to passively view the emotional faces with expressions of Anger, Fear, Happy and Sad. Participants were then asked to look at the series of positive, negative and neutral images on screen presented in semi random order for 6 seconds each. The image was followed by the pleasure SAM scale where participants were asked to indicate how they felt, followed by the arousal scale where again participants were asked to indicate their rating. There was no time limit for the ratings and the arousal rating was followed by a grey mask for 5 seconds and a fixation cross for 2 seconds before the next image was presented. There was a trial run initially and once participants were comfortable with the procedure the test progressed without interruption. Each session lasted approximately 50 minutes in total. Participants were debriefed at the end of the session.

5.6.1 Statistical Analysis

All analyses were conducted using SPSS, V24 http://www.spss.com/spss/).

5.6.1.1 T-test

As there were only 2 groups, the High Binge Drinker (HBD) and the Low Binge Drinker (LBD), an independent samples t-test was run to establish if the two sets of data were significantly different from each other on the key demographics and key measures of alexithymia, mood and impulsivity.

5.6.1.2 Correlations

The visual scan data were then examined in relation to both drinking behaviour and the ERT. A Pearson correlation was used except for non-parametric data when a Spearman correlation was used, and this was reported.

5.6.1.3 Unbiased Hit Rate – ERT

The unbiased hit rate for emotion accuracy was also calculated using a confusion matrix based on the number of hits divided by the number of stimuli of the target type and the number of correct responses of the target emotion divided by the total number of uses of that target emotion. See Chapter 4, Section 4.6.4 Table 3, for an example of the confusion matrix.

5.6.1.4 ANOVA - Eye tracking data

A mixed design 4x2x2 analysis of variance was carried out with the independent variables being the emotions presented, face region and drinking patterns. Emotions had 4 levels (Happy, Sad, Fear, Anger), Face region had two levels (eye region and mouth region) whilst drinking patterns had two levels (high binge scoring group and the low binge scoring group). The primary DV variables were the fixations and visits to each emotion presented on screen as measured by the Tobii TX300 eye-tracker.

5.6.1.5 Eye tracking data - Visual Scan Path and Fixations

Comparing the shape of visual scan paths is not a straight forward task as scan paths are more similar within an individual than between individuals (Foulsham et al., 2012). There are many methods used to make comparisons that address specific questions but equally each method has specific weaknesses (See Anderson, Anderson, Kingstone, & Bischof, 2014 for a comparison of methods). The Levenshtein Distance (LD) (Noton & Stark, 1971), is a string edit method. This involves overlaying fixations with a grid of areas or interest (AOI). The scan paths being compared are represented by strings of symbols which indicate the sequence and spatial location of fixations. Two strings are compared by transforming into another by substituting, adding or removing appropriate characters in the string a process known as the editing cost. The Levenshtein Distance is the least number of editing steps required to map the scan paths whilst similarity is expressed as (1–LD). However the use of AOI's means that spatially close fixations can appear in different AOI's and reduce similarity whilst fixations on opposite edges of the AOI will be considered similar increasing similarity scores. A progression of this is the Scan Match (Cristino et al., 2010) which takes into consideration additional factors such as colour or semantic content in the AOI substitution matrix, resulting in less cost associated with visits to the same colour or elements with the same semantic meaning. However, it still has the same issue as LD with respect to AOI's. Proximal fixations falling in different AOI's will distort the scan path score. The problem of AOI distorting the scores for comparison could be overcome using a linear distance method to quantify how close positions of fixations are to each other. The concept of linear distance (Mannan et al., 1995; Mathôt et al., 2012) is used by taking the linear distance between fixations on the first scan path and the nearest fixation in the second scan path and the calculating the linear distances between the fixations in the second scan path and the nearest point in the first scan path. In essence linear distance calculates the distance between fixations and compares the location of fixations whilst ignoring the sequential order of the fixations. The linear distance concept however has difficulty comparing scan paths of differing lengths requiring subjective grouping of fixations to match comparisons. These methods are further complicated if one aims to compare groups of visual scan paths.

The pattern of fixations can be qualitatively described as narrowed, with fixations close together or demonstrate a broader examination of the image with greater distance between the fixation points from longer saccades. In order to address this quantitatively the length of the saccade between each fixation point was calculated. The distance between fixation

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

a and b, b and c, c and d and so on was calculated for each participant for each image using the formula below.

Equation 3. Distance between fixation points

This was summed for each pair to arrive at the total length of the visual scan path for each participant. It is acknowledged that this is a topline measure of the potentially rich data provided by eye tracking and does not take the shape, sequence and direction of the scan path into consideration unlike Levenshtein Distance (Noton & Stark, 1971) or ScanMatch (Cristino et al., 2010) calculations. However, in the current study it provides a straightforward and accurate comparison of scan path length and in conjunction with fixation counts and duration to AOI's results in a good overall comparison of attention focus and has the potential to identify between group differences in viewing strategy.

5.7 Results

5.7.1 Data Cleaning

The visual scan path data was checked for quality of recording and data capture. The individual scan paths for each participant were then reviewed with respect to the fixations and saccades. It is possible for there to be momentary loss of eye tracking data due to the pupil being obscured from the tracker. Where this occurred during otherwise good quality data collection the response for that whole image for that participant was excluded from the data analysis whilst retaining the data from the remaining images. The overall data on the visual scan path length was converted to z-score to check for univariate outliers. One of the cases had a z-score above the threshold of +/- 3.29 (a cut off for 0.1% of scores) indicating a significant outlier. This was a mean score for the male Sad face for one participant. The data for this participant for the male image was reviewed and found to be 100% intact data with all fixations and saccades properly recorded. Further examination of the data using the Shapiro Wilk test indicated the data was normally distributed ($p>0.05$) therefore the data was retained as there was no further impact and the overall scores were all within range without significant outliers. Another participant did have a particularly high score for fixation counts (FC) which significantly impacted the overall scores. This participant data was winzorised and reduced to the next lowest score plus one (Field, 2013). This retained the data in order but meant the FC data was now normally distributed with no problematic skewness or kurtosis (+/- 1.96) (Tabachnick & Fidell, 2014).

In order to ensure the assumptions of normality for parametric testing were not violated, the distribution of scores was initially examined using histograms and the normality curve (SPSS Descriptives/Explore). Normality test Shapiro-Wilks were also examined for significance. A score of 1.96 or less when divided by their error is considered acceptable for a sample of up to 50 participants (Ghashemi & Zahediasl, 2012).

5.7.2 Demographics

A total of 39 participants (26 female), mean age 23.21 (4.17) were included in the full analysis. The sample was split using the median binge score from the AUQ for the whole group in line with other studies (Townshend et al., 2014). In this instance the median score was 17 (HBD ≥ 17, n=20, LBD ≤ 16, n=19). Table 9 shows the descriptive statistics for the total sample and split by the binge drinking groups.

Table 9. Demographics and drinking variables by binge group

	All n=39 Mean/(SD)	**HBD n=20**	**LBD n=19**	***t***
Gender (Female/Male)	26/13	10/10	16/3	
Age	23.21 (4.17)	22.9 (4.13)	23.56 (4.31)	0.48
Age of 1st drink	14.31 (3.49)	14.20 (3.25)	14.42 (3.82)	0.20
Age 1st got drunk	16.83 (3.79)	**15.63 (1.92)**	**18.25 (4.92)**	**2.14***
AUQ Score	37.17 (24.22)	**55.6 (18.53)**	**17.77 (10.08)**	**-9.32*****
Unit Score	15.14 (12.13)	**20.85 (13.53)**	**9.13 (6.56)**	**-4.66*****
Binge Score	21.8 (15.22)	**34.30 (10.08)**	**8.64 (5.03)**	**-10.11*****

*p<0.05, ** p<0.01, *** p<0.001

5.7.3 Mood, Alexithymia, Impulsivity

Reliability for all scales was tested with Cronbach Alpha as in Study 1-Part 1 and all were found to be at acceptable levels.

There were no significant between group differences on the PANAS scores, the TAS-20, or the total BIS-11. There was a difference for the first order subscale of Attention but not for Motor Impulsivity or Non-planning which are more closely associated with Binge Drinking (Herman & Duka, 2019) and Emotion Recognition (Preti et al., 2016), neither was there a correlation with Emotion Recognition, therefore no further analysis was conducted on these measures.

5.7.4 Eye Tracking

The eye-tracking data were checked for overall pattern to ensure that it was consistent with normal expectations for scanning faces. The Mixed ANOVA found that, overall, there was a main effect of emotion with participants having a different pattern of looking depending on the emotions (main effect of emotion for visit count $F(3, 108) = 4.79$, $p<0.01$, $\eta^2 = 0.12$, with Fear receiving the fewest visits). There was also a main effect of region of face for TFD, $F(1,36) = 6.35$, $P<0.05$, $\eta^2 = .15$, where participants spent longer on the eye region overall (Mean=8.56, SEM=0.61) than the mouth region (Mean=6.73, SEM=0.51) which is in line with expectations (Eisenbarth & Alpers, 2011).

5.7.4.1 IAPS Images - Visual Scan Path

A correlation analysis identified a negative relationship between the length of the visual scan path (VSP) for negative images and the Age of first drink $r(38) = -.38$, $p<0.02$, indicating that those who started drinking earlier had a longer VSP. There were no other significant correlations between the VSP of the IAPS images and the drinking measures. An independent samples t-test confirmed there were no significant differences in the VSP of HBD and LBD with regards to the IAPS images.

The VSP of the IAPS images and the facial emotion expressions (FEE) were also checked for any relationship and there were no significant results although the VSP for Anger and the Negative IAPS image was approaching significance $r(38) = 0.32$ $p=0.054$, indicating that those who scored higher on Anger had a trend towards a longer VSP on Negative IAPS images.

5.7.4.2 Emotional faces - Visual scan path

The visual scan path of high binge drinkers (HBD) was longer across all facial emotion expressions (See Figure 11) in comparison to low binge drinkers (LBD), and this difference was significant for the negative emotions of Anger $t(37) = -3.21$, p=0.003, CI= -93.58, -21.28 and Fear $t(37) = -2.93$, p=0.006, CI= -85.01, -15.62. HBD had a mean fixation length of 221.42, SEM=12.27 pixels for the emotion of Anger versus LBD mean = 164, SEM=12.73. For the emotion of Fear the HBD had a mean fixation length of 210.58, SEM =10.64, whilst for LBD the mean length from fixation to fixation was 160.28, SEM 12.95 pixels.

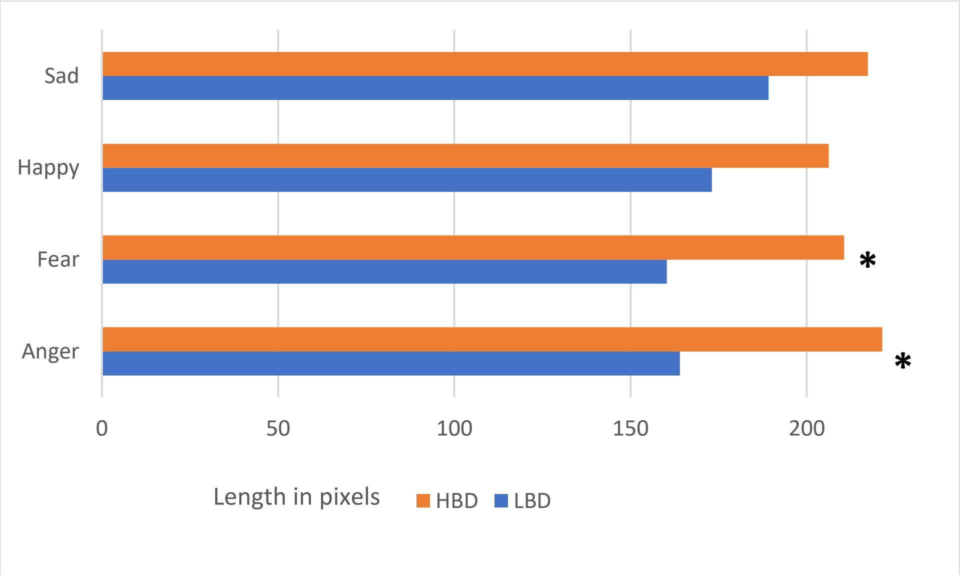


Figure 11. Mean length of visual scan path from fixation to fixation by drinking pattern and emotion

Table 10. Means and SE of length of the visual scan path from fixation to fixation by drinking pattern and emotion

	Anger		**Fear**		Happy		Sad	
	Mean	SE	**Mean**	SE	Mean	SE	Mean	SE
LBD (N=21)	**164***	13	**160***	13	173	18	189	13
HBD (N=18)	**221**	12	**211**	11	206	23	217	9

* *indicates a significant difference with p<0.01*

An example of the scan path is illustrated in Figure 12.

High binge drinker (HBD

Low binge drinker (LBD)

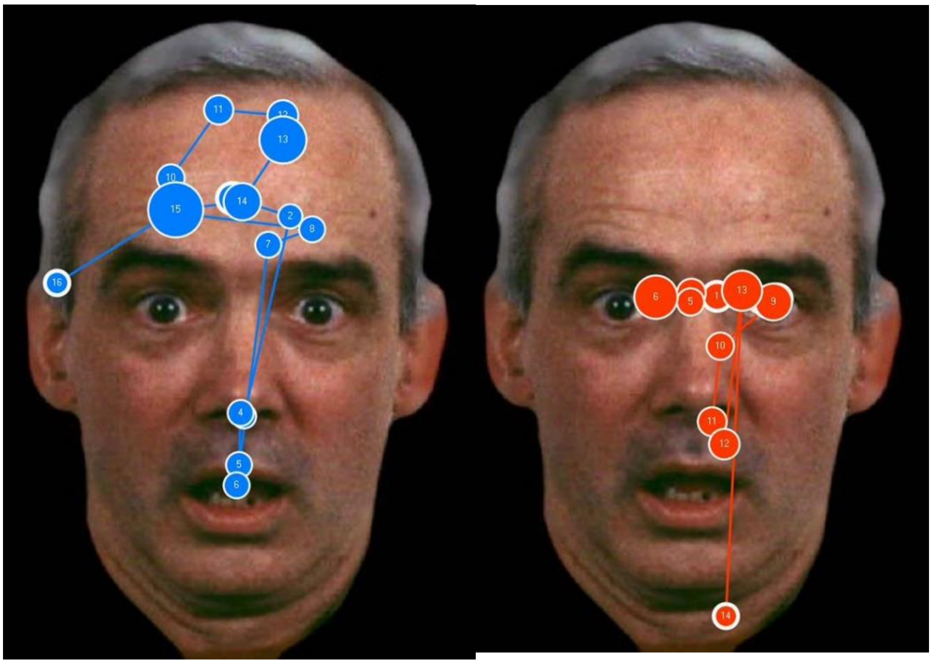


Figure 12. Visual scan path of HBD and LBD for Fear

Figure 12 shows that the fixations of the HBD group are spread wider apart than those of the LBD leading to the longer fixation path. This suggests uncertainty and a scattered approach to collecting information. Whilst HBD do fixate close to the eyes direct contact with the eyes is avoided for the emotion of Fear, suggesting an avoidance strategy. HBD move to the mouth area for fixation 4, 5, and 6, relatively early in the scan path and then back to the eye area. In contrast for the LBD the fixations make contact directly with the eyes and remain there only moving to the mouth area towards the end of the scan path at fixation 11.

5.7.4.3 Eye-tracking fixations

An independent samples t-test was conducted looking for group differences between HBD and LBD on how they looked at each emotion overall. These were measured against the outcome variables first fixation duration (FFD), fixation count (FC), visit duration (VD), total visit duration (TVD) and visit count (VC). See explanation of the measures in Chapter 3, Section 3.4.3, Table 2.

There were some group differences between HBD and LBD in the duration of fixations on the emotion of Sad and to a lesser extent Happy. Specifically, there was a significant difference in the first fixation duration (FFD) to Sad $t(24.98)2.23$, $p<0.05$, CI lower =0.010 upper=0.243. High binge drinkers spent less time fixating for the FFD than LBD (HBD mean = 0.268, SEM=0.02, LBD mean=0.39, SEM=0.53). There was also a significant difference for visit duration to the Sad expression $t(33.26)2.09$, $p<0.05$, CI =0.007, 0.557 with HBD spending less time on each visit to Sad than the LBD (HBD mean=0.264, SEM=0.02, LBD mean=0.348, SEM=0.26).

With respect to the Happy expression there was a significant difference in the FFD for the Happy expression $t(37)2.38$, $p<0.05$, CI lower=0.013, upper=0.015 with HBD spending less time than the LBD (HBD mean=1.03, SEM=0.07, LBD mean=1.32, SEM=0.11).

5.7.4.4 Interaction between emotions, region of face and drinking pattern

Breaking each image down further, a 4x2x2 mixed ANOVA was conducted with emotions as within subjects variable with 4 levels: Anger, Fear, Happy, Sad; the region of the face (ROF) as within group variable, with two levels; eye region (top half) and mouth region (bottom half). Drinking pattern was the between subjects group with two levels: high binge drinker (HBD) and low binge drinker (LBD). Given the unequal gender distribution in the sample, gender was included as a covariate to control for any confounding influence. The outcome measures were the Time to First Fixation (TFF), First Fixation Duration (FFD), Fixation Count (FC), Total Fixation Duration (TFD) and Visit Count (VC) and Total Visit Duration (TVD) as recorded by the eye-tracker.

There were no significant main effects or interaction for TFF or FFD. Results for Total Fixation Duration (TFD), Fixation Count (FC), Visit Count (VC) and Total Visit Duration (TVD) are reported below.

5.7.4.5 Total fixation duration (TFD)

There was a significant three way interaction between BD group, ROF and emotions F(3,108) 3.43, p=0.02, η^2=0.09 (see Figure 13) showing that LBD spent longer time than HBD in the mouth region for the emotion of Fear, whereas for the same emotion of Fear they spent shorter time than HBD on the eyes region. There was an opposite pattern for the emotion of Happy, with LBD spending shorter time than HBD on the mouth region, and longer time than HBD on the eyes region (see Figure 14 and Figure 15 for TFD in LBD and HBD, across emotions for the mouth and eye region).

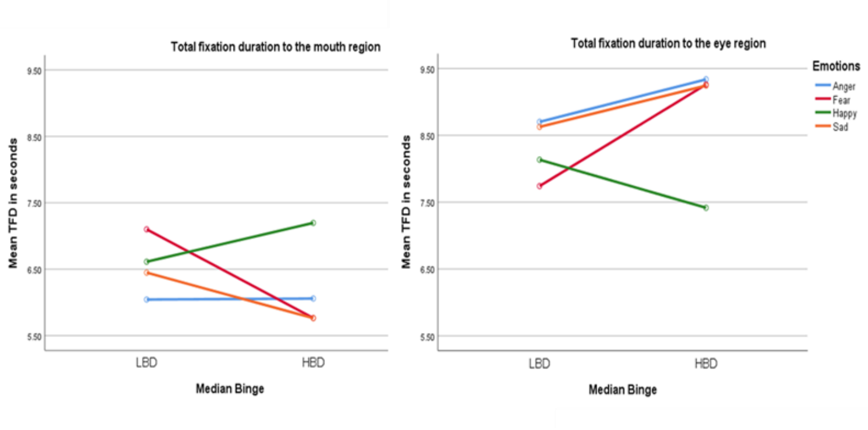


Figure 13. Interaction between Emotions, region of face and drinking pattern for total fixation duration

Figure 14 and Table 11 show the highest total fixation time to the mouth region by low binge drinkers (LBD) is to Fear and for HBD the longest time is spent on Happy. Fear is the lowest fixation duration for HBD closely followed by Anger and Sad.

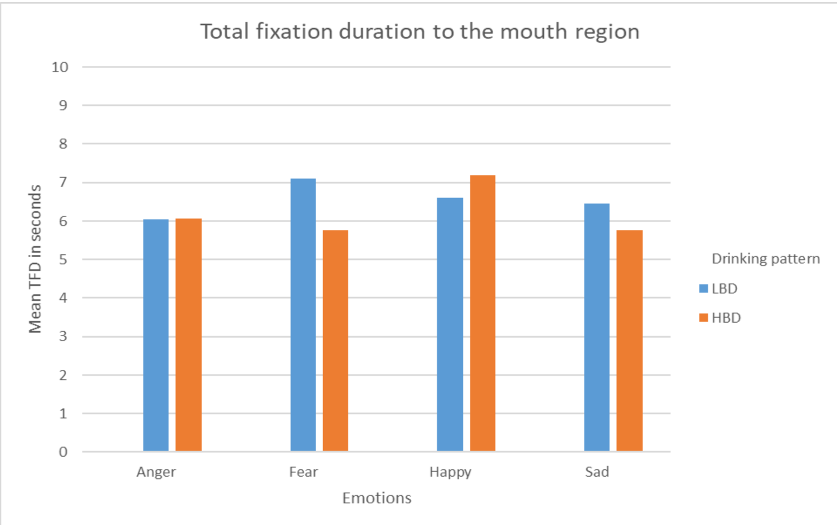


Figure 14. Total fixation duration to the mouth region by emotion and drinking pattern

Table 11. Mean and standard error (SE) of total fixation duration to the mouth region

	Anger		**Fear**		**Happy**		**Sad**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
LBD	6.04	0.71	7.10	0.75	6.61	0.86	6.45	0.72
HBD	6.45	0.72	5.77	0.81	7.20	0.94	5.76	0.79

Figure 15 and Table 12 show details of the TFD to the eye region with HBD tending to spend longer than LBD to the eye region for the emotion Fear.

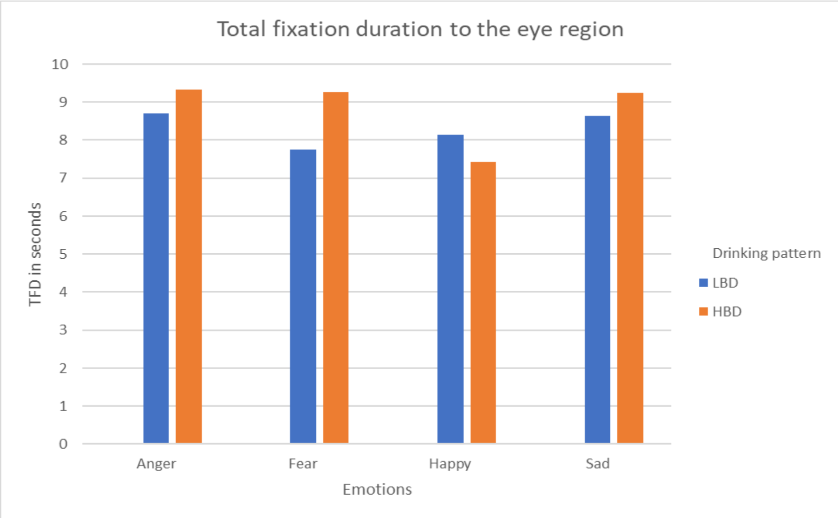


Figure 15. Total fixation duration to the eye region by emotion and drinking pattern

Table 12. Mean and standard error (SE) for total fixation duration to the eye region

	Anger		Fear		Happy		Sad	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
LBD	8.70	0.81	7.74	0.98	8.14	0.96	8.63	0.88
HBD	9.34	0.88	9.26	1.06	7.42	1.04	9.24	0.95

5.7.4.6 Fixation count (FC)

There was a three-way interaction between BD group, ROF and emotion $F(3,108)$ 5.78, p=0.001, η^2 =0.14. As shown in Figure 16, for Anger, Fear and Sad, the HBD had significantly more fixations on the eye region in comparison to LBD. There was an opposite trend for Fear in the mouth region, with HBD having fewer fixations than LBD. See Figure 16 and Figure 17. There was no difference between HBD and LBD fixation count to the mouth for any of the other emotions.

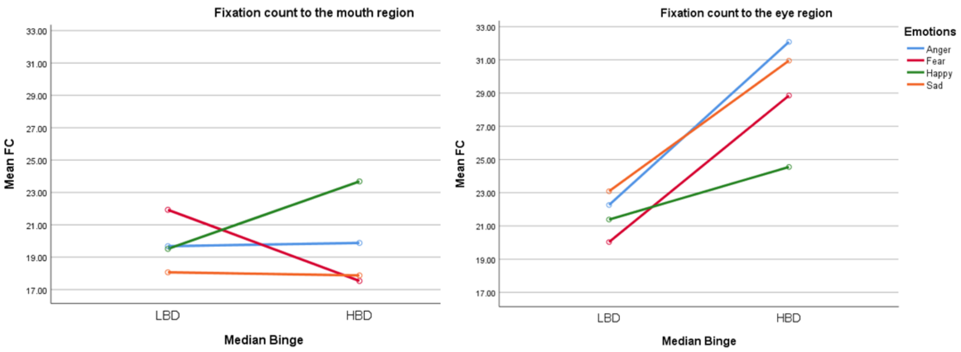


Figure 16. Fixation count and the interaction between emotions, region of face and drinking pattern

Figure 17 and Table 13 show how HBD had more fixations to the mouth region of Happy than the LBD and fewer fixations to the mouth for Fear. LBD had more fixations to the mouth for Fear and fewest for Sad.

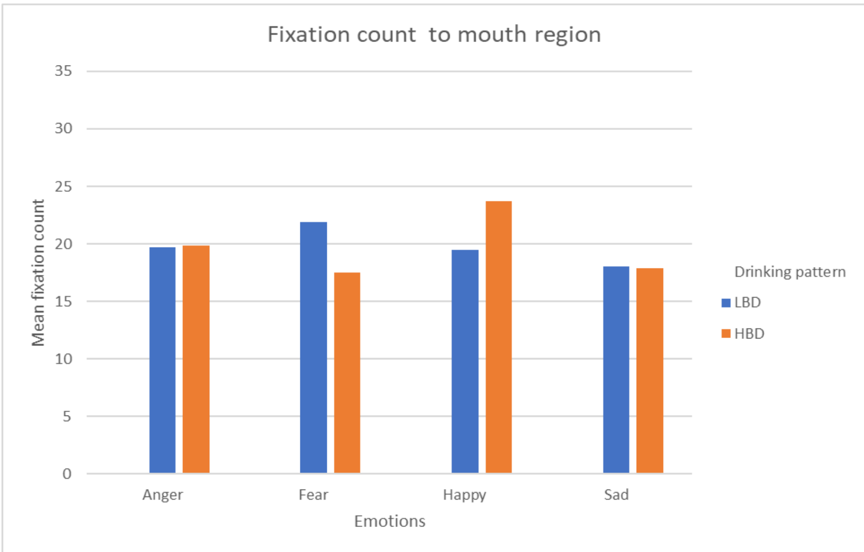
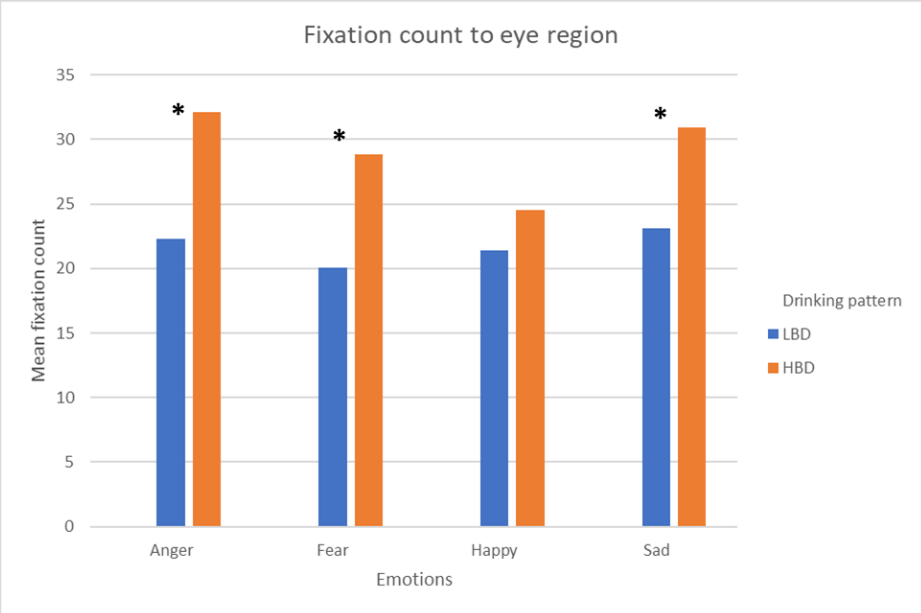


Figure 17. Fixation count to mouth region by emotion and drinking pattern

Table 13. Mean and standard error (SE) for fixation count to the mouth region

	Anger		Fear		Happy		Sad	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
LBD	19.68	2.47	21.93	2.61	19.51	2.50	18.07	1.91
HBD	19.88	2.68	17.53	2.84	23.68	2.71	17.87	2.07

Figure 18 and Table 14 contain details of the fixations to the eye region showing HBD have more fixations to the eyes than the LBD for all emotions but particularly for the negative emotions of Anger p=0.01, Fear p=0.016 and Sad p=0.017.



***** *indicates a significant difference with p<0.05*
Figure 18. Fixation count to eye region by emotion and drinking pattern

Table 14. Mean and standard error (SE) for fixation count to the eye region

	Anger		Fear		Happy		Sad	
	Mean	SE	**Mean**	SE	Mean	SE	**Mean**	SE
LBD	**22.26**	2.67	**20.03**	2.68	21.39	2.67	**23.09**	2.61
HBD	**32.08**	2.89	**28.85**	2.91	24.55	2.90	**30.95**	2.83

Bold indicates a significant difference with p<0.05

5.7.4.7 Visit count (VC)

Considering visit count (VC), which measures the number of visits to an area of interest, as the dependant variable there was a three way interaction between emotions, ROF and drinking pattern *F*(3,108) 3.45, p = 0.019, η^2 =0.09. See Figure 19 for an illustration.

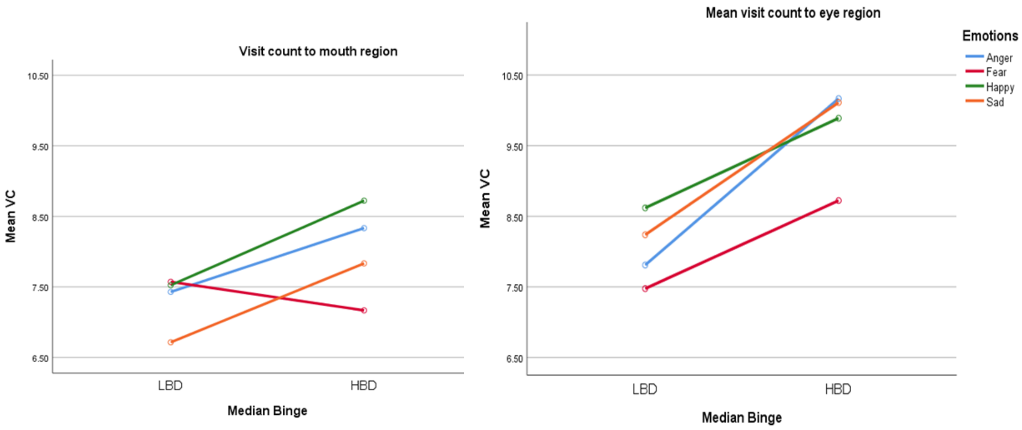


Figure 19. Interaction between emotions, region of face and pattern of drinking for Visit Counts

Figure 20 and Table 15 detail the visits to the mouth region. Differences between HBD and LBD for the visit counts to the mouth were non-significant.

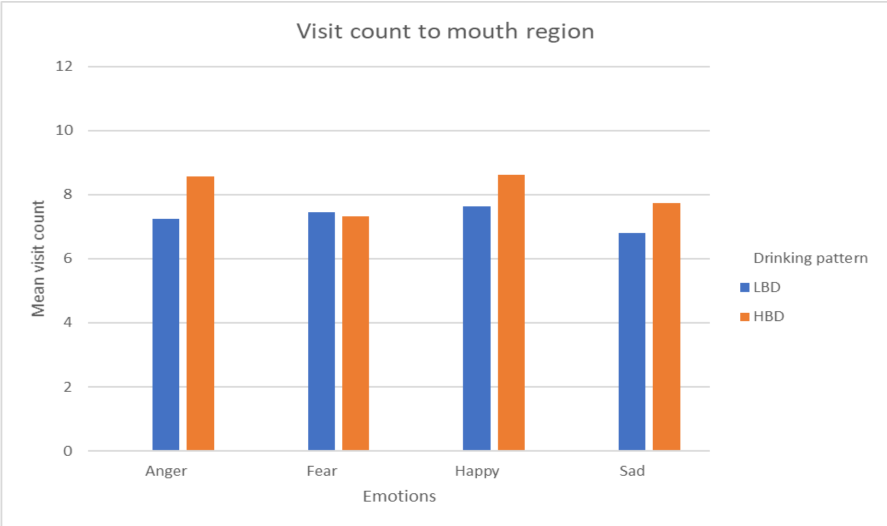
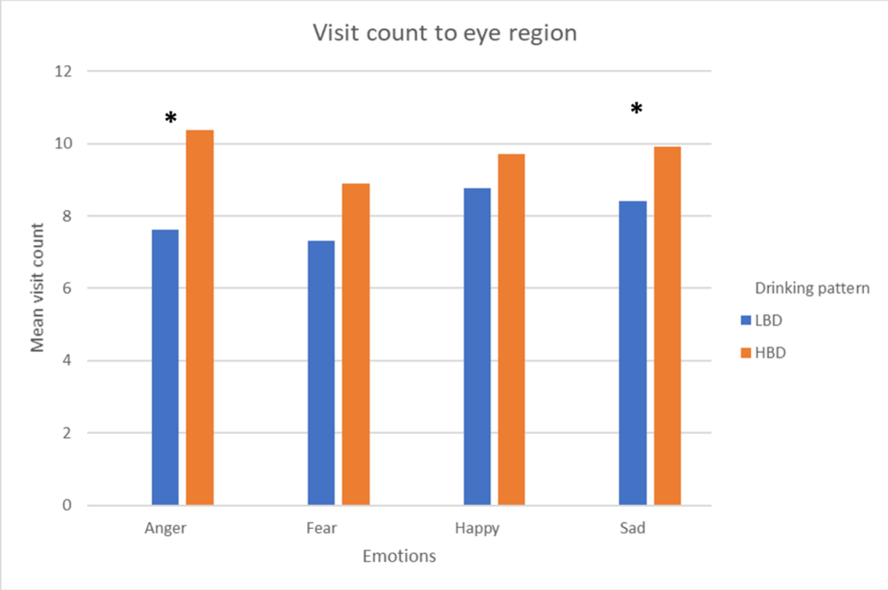


Figure 20. Total visit count (VC) to mouth region by emotion and drinking pattern

Table 15. Means and standard error (SE) of visit counts to the mouth region

	Anger		**Fear**		**Happy**		**Sad**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
LBD	7.23	0.63	7.45	0.70	7.62	0.74	6.80	0.49
HBD	8.56	0.68	7.31	0.75	8.61	0.81	7.73	0.53

With respect to the eye region there were significant differences for the emotions of Anger (p=0.03) and Sad (p=0.04) with HBD making more visits than LBD.



**indicates a significant difference with p<0.05*

Figure 21. Total visit count (VC) to eye region by emotion and drinking pattern

Table 16. Mean and Standard error (SE) of visit counts to the eye region

	Anger		**Fear**		**Happy**		**Sad**	
	Mean	SE	Mean	SE	Mean	SE	**Mean**	SE
LBD	**7.63**	0.71	7.32	0.72	8.78	0.73	**8.41**	0.65
HBD	**10.38**	0.77	8.90	0.79	9.71	0.79	**9.92**	0.71

Bold indicates a significant difference with p<0.05

5.7.4.8 Total visit duration (TVD)

With regards to total visit duration (TVD) there was a an interaction between Emotion, ROF and Drinking Pattern $F(3,108)$ 4.91, p=0.003, η^2=0.12. See Figure 22 for an illustration.

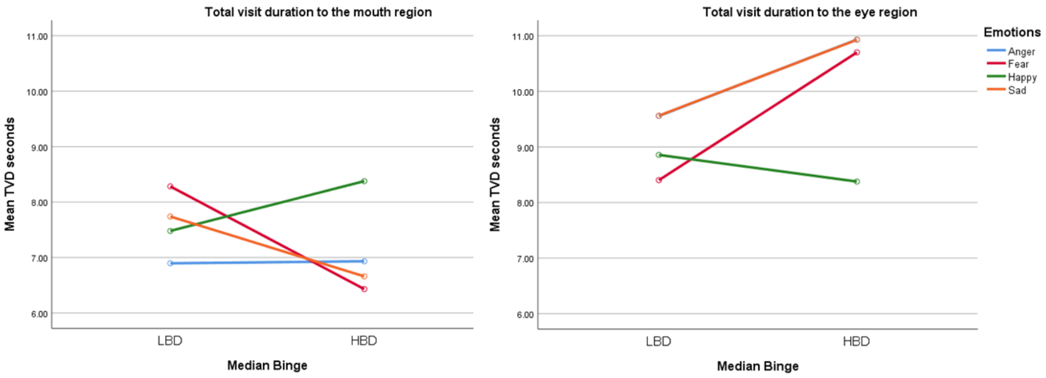


Figure 22. Interaction between emotions, region of face and drinking pattern for the total visit duration

Figure 23 and Table 17 show details of the total visit duration to the mouth region. HBD spend less time on the mouth for Fear than LBD (p=0.06).

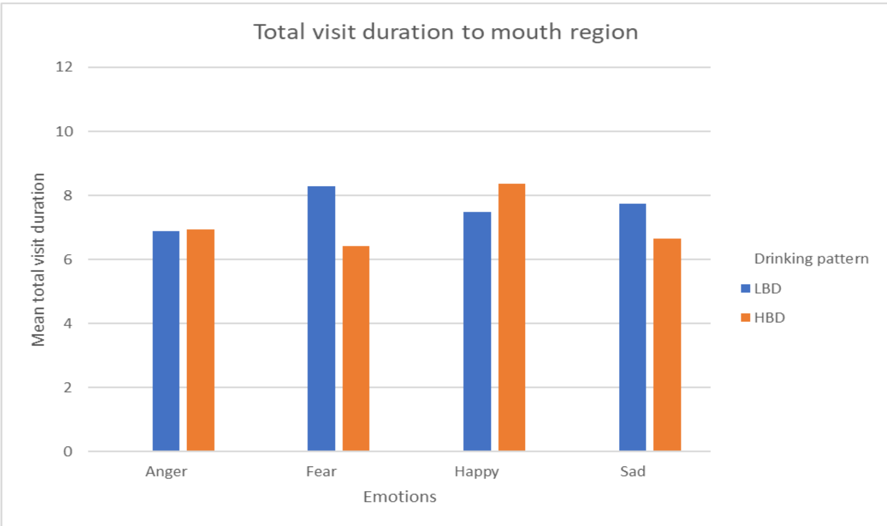


Figure 23. Total visit duration (TVD) to mouth region by emotion and drinking pattern

Table 17. Mean and standard error (SE) for total visit duration to the mouth region

	Anger		**Fear**		**Happy**		**Sad**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
LBD	6.90	0.75	8.28	0.85	7.48	0.95	7.74	0.82
HBD	6.93	0.82	6.43	0.92	8.38	1.03	6.66	0.89

HBD spend longer on the eye region of all of the negative emotions than LBD and this is approaching significance for Fear (p=0.065)

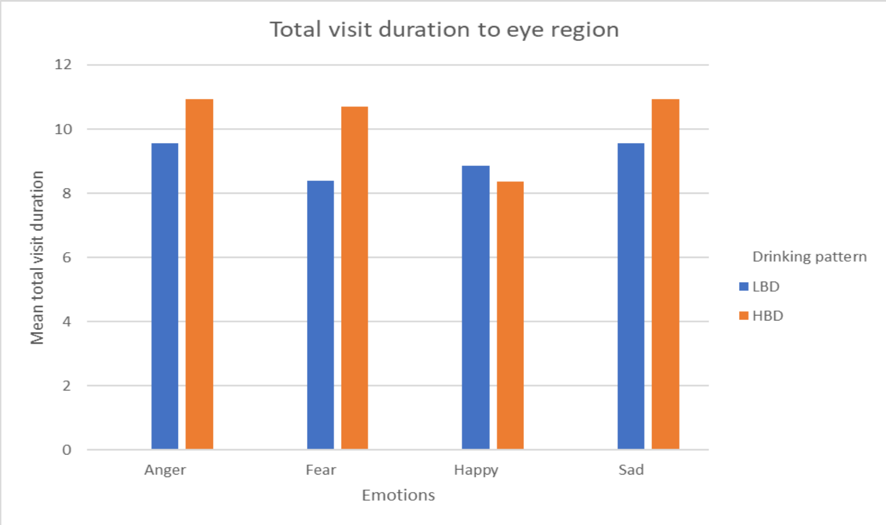


Figure 24. Total visit duration (TVD) to eye region by emotion and drinking pattern

Table 18. Mean and standard error (SE) for total visit duration to the eye region

	Anger		**Fear**		**Happy**		**Sad**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
LBD	9.56	0.88	8.40	1.04	8.86	0.99	9.56	0.95
HBD	10.93	0.95	10.70	1.13	8.38	1.08	10.93	1.03

Table 19 below provides a summary of the main findings of the eye-tracking analysis included in this study.

Table 19. Summary of Significant Eye-tracking results

Measure	**Analysis**	**Expression with Significant effect**	**Result**	**P value and η^2**
Visual Scan Path (VSP) IAPS	Correlation	Negative images and age of first drink	Inverse correlation The younger the age of 1st drink the longer the VSP	r=-.38 p<0.02,
Visual Scan Path (VSP) Faces	t-test	Anger Fear	HBD longer than LBD	Anger p<0.01 CI=-93.58, -21.28 Fear p<0.01 -CI= -85.01, -15.62
First fixation duration (FFD)	t-test	Sad	HBD shorter than LBD	p<0.05 CI 0.01, 0.24
Visit Duration (VD)	t-test	Sad	HBD shorter than LBD	p<0.05 CI 0.007, 0.56
First fixation duration (FFD)	t-test	Happy	HBD shorter than LBD	p<0.05 CI 0.013, 0.015
Total Fixation Duration (TFD)	Mixed ANOVA	ROF x Emotions xBD	LBD tended to spend more time on mouth for Fear, whilst HBD more time on mouth for Happy	p=0.02, η^2 =.09
Fixation Count (FC)	Mixed ANOVA	ROF x Emotions xBD	HBD fewer fixations on mouth for Happy than LBD. HBD more fixations on eyes for Anger, Fear and Sad than LBD	p=0.001, η^2 =.14
Visit Count (VC)	Mixed ANOVA	ROF x Emotions xBD	HBD more visits than LBD to the eyes for Anger and Sad	Em x ROF x BD p=0.019, η^2 =0.09
Total Visit Duration (TVD)	Mixed ANOVA	ROF x BD	HBD tended to have a shorter duration than LBD to the mouth for Fear and longer visit duration to the eyes for Fear	ROF x BD p<0.003, η2 =0.12

5.8 Discussion

This study had a total of 39 participants split into high binge drinker (n=18, 9 male, age M=22.78, SD=4.23) and low binge drinker (LBD) (n=21, 4 male, 23.6, SD=4.20). The hypothesis that HBD and LBD would scan faces differently from each other was upheld, whilst the hypothesis that HBD and LBD would have similar scan paths for facial expressions of emotion and emotionally valenced images was not supported by the results.

5.8.1 Visual Scan Path

The visual scan path of high and low binge drinkers was examined with respect to emotional stimuli presented as emotional valenced images (IAPS) and facial emotion expressions. The hypothesis that there would be different scan patterns between high and low binge drinkers was supported by the data with regards to facial emotion expressions but not for the valenced IAPS images.

In order to reconcile these results, it is useful to recap how both faces and emotional images are processed. Emotionally charged images induce an emotional experience whilst facial emotion expressions elicit recognition or perception of the emotion (Britton et al., 2006), however, similar brain activations (attenuated amygdala response and a corresponding increase in response of the right prefrontal cortex and the anterior cingulate cortex) have been identified in appraising both facial emotion expressions (FEE) and emotionally valenced images (Hariri et al., 2003). Facial emotion expressions elicit physiological responses

(Matsumoto et al, 2008) as do the emotional IAPS images (Lang et al., 1993). In addition, the visual scanning strategy of individuals is thought to be fairly stable over time (Bargary et al., 2017) and has been shown to be consistent in terms of abnormal scanning of both facial expressions and IAPS images (Bestelmeyer et al., 2006). It was hypothesized therefore that any differences in visual scanning of facial emotion expressions would be replicated in emotionally charged images.

A comparative study by Britton et al. (2006), sought to identify common neural correlates of responses to emotional facial stimuli and IAPS pictures. The study used fMRI to explore the neural activations following presentation of Happy, Neutral, Anger, Fear and Sad facial expressions and matched with similarly valenced IAPS images. The common areas of the brain activated included the amygdala, posterior hippocampus, ventromedial prefrontal cortex (vmPFC) and the visual cortex (VC) and these were interpreted as being involved in general emotion processing and not limited to faces or images. However, within this, activations varied by emotion. For example, both negative emotional images and faces activated the amygdala along with Happy faces but not Happy images, whilst Fear did not activate the vmPFC and other negative emotions, both facial and IAPS images, did. Emotional faces activated the superior temporal gyrus (STG), insula and anterior cingulate cortex (ACC) more than the IAPS pictures. The caudal and middle part of the STG influence spatial perception and lower activation led to deficits in spatial perception of line length (Schotten et al., 2010), whilst the role of the STG in visual exploratory behaviour has also been confirmed using intraoperative electrical stimulation, which involves the temporary inactivation of brain areas during brain surgery enabling one to infer the function of these areas (Gharabaghi et al., 2006). The insula, dorsal ACC and amygdala are known as the 'salience network' and as such are responsible for identifying physiologically relevant stimuli from multiple internal and external stimuli (Uddin et al., 2017). That the current study found a difference between HBD and LBD in the scan paths of facial expressions and not for the IAPS images may suggest that the earliest areas affected by the binge drinking pattern are amongst the STG, insula, dACC and amygdala, the areas predominantly involved in facial expressions, and that the deficit is in emotion perception and not emotion experience.

5.8.2 Facial Emotion Expressions

High binge drinkers (HBD) had a significantly longer visual scan path than low binge drinkers (LBD) for the negative emotions of Anger and Fear. This longer scan path is apparent despite there being no significant difference between groups in the overall number of fixations, suggesting a jump of fixations to more distal face regions by HBD rather than more proximal jumps evidenced by the LBD. This is in line with the literature showing extended scanning to the threat emotions of Fear and Anger relative to other emotions evident in healthy participants with a longer distance between fixations and more fixations to the salient features of the face (Green & Davidson, 2003). In the present study, this pattern appears to be more pronounced in HBD compared with LBD. This extended visual scan path is interpreted as denoting 'vigilance' resulting from a heightened autonomic response to threat (Green & Davidson, 2003). It has been proposed that impairments in binge drinkers are similar to those in alcohol dependence (AD) and differ only in degree (Lannoy, Billieux, & Maurage, 2014). This heightened vigilance for threat is consistent with the findings of Townshend and Duka (2003) who explored emotion recognition of mixed emotions amongst those with an AD compared with social drinkers and identified heightened Fear responses along with a differentiated response to Anger and Disgust. Results across other studies are not consistent in this respect however, with some failing to identify any differences in emotion recognition between those with an alcohol dependence and the control group (see Donadon & Osorio, 2014 for a review). These contradictory results have been explained through the level of complexity of the tasks employed with simpler tasks failing to identify deficits in the AD groups (Donadon & Osorio, 2014).

5.8.3 Attention to key areas of facial emotion expressions

Further data examination in the current study identified some significant differences in how high and low binge drinkers looked at faces with the HBD group having significantly more fixation counts to the eyes than LBD group for Anger, Fear and Sad and significantly more visits to the eyes for Anger and Sad.

Eisenbarth and Alpers (2011) examined visual scan paths of healthy participants to identify if there were scan path differences across the different emotions. They identified that the eyes and mouth were both important for decoding all emotions. However, fixation duration was longer on the mouth region for Happy compared with other emotions, whilst the eyes are of key importance for Anger, Fear and Sad. Whilst the current study did not identify any overall difference in correct emotion recognition between groups, in comparison to low binge drinkers, the eye tracking results do indicate greater attention by high binge drinkers to the key areas for specific emotion recognition, that is the mouth region for Happy and eye region for Anger and Sad, whilst eyes and mouth are both important for Fear recognition. In effect, high binge drinkers looked longer and returned more frequently to the mouth area for Happy and the eyes for the emotions of Fear, Anger and Sad. This suggests that whilst HBD directed their attention appropriately for each emotion presented, there was a greater uncertainty on viewing emotional facial expressions which required a longer gaze duration and more frequent visits to the key areas. The identification of a different scan path for the emotion of Sad is interesting and corresponds with the findings of Lannoy et al. (2019) who found diminished recognition of Sad and Fear in binge drinkers. Whilst the current study did not identify an impairment in the recognition of Sad or Fear amongst binge drinkers in the behavioural ERT task, there is a different scan pattern with more fixations to the eye region for the Sad expression by HBD and leading to a longer total visit duration (TVD) than the LBD. This altered scan pattern may represent a prelude to later disruption identified by Lannoy et al. (2019).

In the same study Lannoy and colleagues (2019) identified disrupted Fear recognition. The present study identifies differences in the scan pattern for Fear with significantly more fixations and longer TVD to the eye region by HBD and less time on the mouth for Fear than LBD.

The eye region has been identified as the key diagnostic region for the efficient and accurate identification of Anger and Sad whilst the mouth is the key diagnostic area for Happy and Fear depends on both eyes and mouth (Calder et al., 2003; Calvo et al., 2018; Eisenbarth & Alpers, 2011; Schurgin et al., 2014). The amygdala is pivotal for the recognition of Fear (Davis & Whalen, 2001; Hariri et al., 2003) and has also been identified as playing a major role in directing attention to the eyes (Dadds et al., 2006; Gamer & Büchel, 2009; Kennedy & Adolphs, 2010). Disrupted amygdala function has also been identified in those at risk of a severe AUD (Cservenka et al., 2014; Cservenka & Brumback, 2017) and it may be that early and mild disruption in the amygdala of binge drinkers is also evidenced in these altered visual scan paths.

5.9 Summary

The current study provides some insight into how, notwithstanding the apparent ability to recognise the basic emotions accurately, high binge drinkers are not as efficient as low binge drinkers at accomplishing this task as evidenced by their extended scan patterns. Lannoy et al. (2018) found a greater intensity of emotion was required by BD to accurately identify emotions and as evidenced earlier (Chapter 4, Section 4.7.3), HBD in the current study needed a greater intensity of Fear for correct recognition which suggests less efficient processing of available emotional information.

5.10 Implications

There is a tendency for those who binge drink to progress to alcohol dependence (Gilpin et al., 2014; Jennison, 2004). The link between poor facial emotion recognition and drop out or relapse of those with an alcohol dependence (Rupp et al., 2017) emphasizes the importance of emotion recognition in achieving positive outcomes for the treatment of severe alcohol use disorders. Addressing the negative impact of binge drinking on emotion recognition early in the process could significantly reduce social stress and help to minimize the continued use of alcohol as a coping strategy.

A direct link has also been established between emotional intelligence (EI) and aggression where the higher the EI the less likelihood of an aggressive response in ambiguous situations (see García-Sancho, Salguero, & Fernández-Berrocal, 2014 for a review) and emotion recognition is a fundamental factor contributing to emotional intelligence (Herpertz et al., 2016). Accurate emotion recognition is particularly important in domestic abuse situations and in consent to sexual interaction. Violent offenders, both sexual and non-sexual, have a deficit in emotion recognition (Gillespie et al., 2015) and the lack of empathy and recognition of Fear and Anger facilitates their violent responses. There have been positive results using the Micro-Expression Training Tool (METT) in emotion recognition amongst those with schizophrenia (Russell et al., 2008). Direction of visual gaze to the key diagnostic face areas (eyes and mouth) has been effective in modifying activation in the brain areas recruited for early processing of faces in both a clinical population and healthy controls (Spilka et al., 2019). These types of interventions are promising for demonstrating the effectiveness emotion recognition training and possible adaptation to address emotion recognition in wider populations such as binge drinkers.

5.11 Limitations

This study had some limitations which should be taken into consideration when interpreting the results. The imbalance of male and female participants in the study may have impacted the results in terms of emotion recognition. There is evidence that male and female participants interpret emotions differently with female participants being more accurate (Hall & Matsumoto, 2004; Sullivan, Campbell, Hutton, & Ruffman, 2017). However, in the current study, gender was included as a covariate to take any possible gender imbalance into consideration in the analysis and the differences between the scan paths of HBD and LBD remained significant. In addition, gender difference in emotion recognition is not universally accepted and may be impacted by the intensity of the emotions displayed and the duration of presentation (Hoffmann et al., 2010; Vassallo et al., 2009). Indeed, the low binge drinker group, which was predominantly female in the current study, did focus more accurately on the eyes which would be expected (Vassallo et al., 2009), however, they were slower in their first fixation to the eye region than the HBD which had an even gender split.

The current study used four emotions (Happy, Sad, Anger, Fear) and both male and female images and there was no emotion recognition included with the eye-tracking to enable passive viewing. It would be beneficial in future studies to include Disgust and Surprise along with a Neutral expression for a more comprehensive view on how the emotions are viewed. It would also be beneficial in future studies to include an emotion recognition element that included the eye tracker to make a direct link between visual scan path and emotion recognition.

Finally in real social interactions, facial expressions are dynamic and fleeting. Whilst the different scan patterns for the static emotions explored in this study provide a useful starting point to gain a more in depth understanding into the impact of binge drinking on emotion perception and recognition, dynamic images should be explored in future studies. Dynamic images employ different neural pathways and may help to clarify processing differences between HBD and LBD (Pitcher et al., 2011; Recio et al., 2011; Torro-Alves et al., 2016).

5.12 Conclusions

Given the importance of facial emotion recognition in establishing and maintaining good social interactions, any factors that have a negative impact and hinder that action need to be properly understood. The current study found significant differences in how facial expressions were scanned and suggests an inefficient scanning strategy by the HBD group. No differences were found in the scanning of IAPS images suggesting any deficit relates to facial expressions and cannot be generalized to all emotion processing. Nevertheless, that emotion perception is impacted by binge drinking is a significant finding and understanding the precise influence can facilitate the creation of effective interventions to address the social outcome. This is particularly important given the role of emotion recognition in situations with the risk of aggressive behaviour and violence, both sexual and non-sexual. There is a need to build on the current findings therefore and progress the research to use more complex tasks for the eye tracker data to identify whether the scan path varies in a similar way with greater cognitive load. Dynamic images should be explored to understand the impact in a more ecologically valid way which the next study is exploring.

Chapter 6 Study 2 – The impact of binge drinking on bottom-up emotion recognition, top-down emotion recognition and rating of emotion intensity and scan patterns on static and dynamic emotional faces

The previous studies explored emotion recognition and the visual scanning of emotional faces and images using the eye-tracker to identify differences between high binge drinking and low binge drinking groups. The study reported in this chapter, Study 2, expanded on this and explored a more ecologically valid paradigm by including both static and dynamic images. As expressions encountered in daily life are more likely to be dynamic, often fleeting expressions the inclusion of short 3 second videos were more representative. This study, as an expansion on the previous study, also included the additional emotions of Surprise and Disgust along with Neutral expressions. Study 2 also made the distinction between early (bottom-up) and late (top-down) processing of emotional facial expressions which included the cognitive task of naming the emotion for late processing rather than simply passive viewing as in Study 1-Part 2.

6.1 Introduction

Understanding the social world is elementary to co-operation with others, overall wellbeing and progression through life (Fischer & Manstead, 2008; Stets & Turner, 2008). There are two processes which are fundamental to successful social interactions. Firstly, the identification of a specific individual and the attributions associated with that person. These attributions can be simple, such as gender and age, if the individual is unknown, or more complex if the individual is known such as name, relationship and knowledge of previous interactions. Secondly the perception and interpretation of the facial expression which sets the tone for the interaction (Posamentier & Abdi, 2003). Impaired social interactions are amongst the most significant barriers to social participation for those with an Alcohol Use Disorder (AUD) (Levola et al., 2014). It is perhaps no surprise then that those with an AUD also have difficulty in emotion recognition (Bora & Zorlu, 2017; Freeman et al., 2018; Kopera et al., 2018). As explained in the previous chapters (Chapter 1, Section 1.7 and Chapter 4, Section 4.1) a direct link between difficulties in emotion recognition and poor social functioning has been identified amongst those with schizophrenia (Hooker & Park, 2002). Although this link needs to be established amongst those with an alcohol dependence (AD) both social functioning and emotion recognition are impacted (Levola et al., 2014) and those in treatment with an AD who have poorer facial emotion recognition are more likely to relapse and drop out of treatment (Rupp et al., 2017).

As mentioned in Chapter 1, Section 1.1 and Section 1.4.2, binge drinking involves similar patterns of high levels of alcohol passing into the brain followed by withdrawal, as in alcohol dependence. Binge drinking is also a risk factor for AUD (Bonomo et al., 2004; Gowin et al., 2017; Hermens et al., 2013). Study 1-Part 1 and Study 1-Part 2 have identified that whilst there is no behavioural difference in emotion recognition, greater intensity is required by HBD for the recognition of Fear. Furthermore, there are differences in the visual scan path length for Fear and Anger with HBD having a longer VSP than LBD, along with a longer first fixation duration to Sad. In addition, there is a difference between HBD and LBD with regards to the region of the face fixated and visited for different emotions, with HBD fixating significantly more often on the eyes for Anger, Fear and Sad and visiting the eyes of Anger and Sad significantly more frequently than LBD.

The paradigm of static images of facial expressions has been used in emotion recognition research since the seminal research by Ekman and colleagues on universal emotions dating back to the 1970s. This research inspired the production of a series of Pictures of Facial Affect by Ekman and Friesen (1976) from which the Ekman 60 Faces test was adapted. This test contained images of unambiguous depictions of what are largely considered the universal emotions of Happy, Surprise, Fear, Sad, Disgust and Anger. This type of paradigm using static images formed the basis of most emotion expression research for many decades (Adolphs, 2002; de Paiva-Silva et al., 2016; Phan et al., 2002). Notwithstanding this, the ecologic validity of using static images has been questioned (Chafi et al., 2012). Anecdotally this would appear to make sense when one considers the nature of our everyday social interactions. There have been several studies which aimed to compare the neural pathways involved in encoding both static and dynamic images (Chiller-Glaus, Schwaninger, Hofer, Kleiner, & Knappmeyer, 2011; Johnston, Mayes, Hughes, & Young, 2013; Recio et al., 2011; Trautmann, Fehr, & Herrmann, 2009). If it proved to be the case that static and dynamic images recruit different neural pathways, then it would have implications for future research in so far as static representations of emotions may be affected but not dynamic representations or vice versa.

One such study (Kilts et al., 2003) used positron emission tomography equipment and included 4 tasks amongst healthy participants to identify brain patterns when evaluating the intensity of Happy and Angry expressions in both static and dynamic formats. These were compared with evaluation of orientation of Neutral dynamic expressions. The stimuli were drawn from the Perception of Emotion Test (POET) and had both male and female posers. A non-face geometric shape was also included requiring similar judgements in terms of spatial orientation as the Neutral face. All stimuli were presented for 4 seconds. A difference in activation was identified where static expressions of Anger activated motor and extra-striate cortex (located next to the primary visual cortex) not seen with the dynamic expressions. Kilts et al. (2003) deduce that activation in the somatosensory cortex, seen only for static and not dynamic images, involves a mental simulation of the emotion. This is consistent with a theory put forward by Decety and Grèzes (1999), which contends that when images of actions are perceived the same areas of the brain used to produce the action are activated even when no overt movement occurs, meaning there is an internal practice of the action which is necessary for accurate perception. Whilst Kilts et al. (2003) only examined two emotions and a Neutral expression rather than a full range of emotions, it does confirm a difference in brain activation between static and dynamic expressions regardless of the emotions displayed.

Other studies have also supported the dissociable pathways and activations for static and dynamic facial expressions (Pitcher et al., 2011; Trautmann et al., 2009). The impact of these different activation areas on emotion recognition is ambivalent however, with some studies concluding that dynamic stimuli improve emotion processing (e.g. Trautmann et al., 2009) whilst there is also evidence to the contrary (Kamachi et al., 2013). Trautmann et al. (2009) compared dynamic and static facial expressions of Disgust and Happy with Neutral as the control. They examined the blood oxygen level dependent (BOLD) MRI activation levels in the brain for both Happy and Disgust compared with Neutral expressions using both static and dynamic stimuli. The participants were 16 females in the fMRI study, aged 19 – 27 (21.6 +/-2.3). Trautmann and colleagues (2009) expected to see more widespread activation patterns for dynamic compared with static stimuli. They also anticipated better accuracy in emotion recognition in the dynamic over the static scenarios. The results identified a broad distributed activation, a trend for better recognition rate for dynamic compared to static images (p=.07) which was significant for the emotion of Disgust (p=.05). Kamachi and colleagues (2013) in their paradigms compared data for static and dynamic images for Sad and Angry expressions only, due to what they considered to be a high ceiling effect for the emotions of Happy and Surprise. Kamachi et al. (2013) wanted to see if there was an optimal speed of expression change that facilitated accurate emotion recognition. In their paradigm they used morphed expressions from Neutral to peak levels at 3 different speeds, slow, medium and fast each having different presentation times. Kamachi and colleagues (2013) concluded that it is the speed of the unfolding emotion that influences recognition and intensity rating and not the movement itself such that, in some instances, emotion recognition accuracy was hampered by the motion for example the slow unfolding of expressions were more likely to be confused with Sad and quick unfolding of Sad resulted in only 48% accuracy. This confusion did not occur with static images which had consistent accuracy and intensity ratings over the three time periods. These results suggest a complex system whereby dynamic images do not always enhance emotion recognition accuracy. Nevertheless, a further study examining the role of movement in facial expression recognition (Ambadar et al., 2005) highlighted the role of motion in improving the accuracy of recognition of subtle emotion expressions.

As dynamic expressions activate separate brain areas as highlighted by the fMRI studies and behavioural differences have also been identified, the current study explores facial emotion recognition using both static and dynamic stimuli. A comparison of performance between high and low binge drinkers using both static and dynamic stimuli has not, to our knowledge, been carried out previously. Exploring whether the findings on emotion recognition of static images extend to dynamic images will add to the knowledge base of the impact of binge drinking in a social cognition context.

Specifically, this study predicts:

- HBDs will demonstrate less accuracy than LBDs in the early and rapid ability to recognise complex emotions through facial expressions.
- In later processing HBDs will not be as accurate in emotion recognition and will award lower intensity ratings of emotions than LBDs for both static and dynamic images.
- HBD will use less efficient viewing strategies than LBD to scan faces regardless of image type.

6.2 Method

The method for this study has been explored in detail in Chapter 3 with some amendments which are detailed in the current chapter. In brief, the research was conducted using both cognitive computer tasks and standardised questionnaires. Participant responses were recorded and associations between drinking habits and performance on the computer tasks along with responses on the questionnaires were sought. Differences in high and low binge drinkers were examined for emotion recognition in faces and the perceived intensity of the expressions rated from 1-10.

6.2.1 Design

A cross-sectional quasi-experimental study was carried out. A mixed (7 x 2 x 2) ANOVA was used as the principal analysis. The IVs were emotion type (Anger, Disgust, Fear, Happy, Neutral, Sad, Surprise) and image (static, dynamic) with high binge drinkers and low binge drinkers being the between group measure. These tasks were supported by relevant questionnaires (listed in the Materials section below).

6.2.2 Participants

Participants were a convenient sample of students from the University of West London, recruited through advertisements on Blackboard and via fliers in communal areas and libraries. Psychology students were offered points on the SONA system whilst students in other subjects were offered £10 voucher in appreciation of their time. Participants were informed about the study protocol. Exclusion criteria were abstention from alcohol, a substance or alcohol use disorder or addiction or a mental health disorder. In addition, participants were asked not to consume alcohol within 12 hours prior to participating in the study. A total of 46 participants were recruited with a mean age of 22.67 years (Std= 4.22), 16 males, 30 females. The cohort was split into high (HBD) and low (LBD) binge drinking groups using the median binge score of 26, resulting in 23 participants in each group. The HBD group had a mean age of 21.87 (3.52), male = 12, female = 11. The LBD mean had a mean age 23.48 (4.77), 4 male and 19 females. Although the LBD group has a slightly older mean age this difference is not significant. This study was approved by the University of West London ethics committee and written consent was obtained from all participants.

6.3 Materials

6.3.1 Questionnaires

6.3.1.1 Alcohol Screening

The FAST Alcohol Screening test was used in the current study to identify if participants were drinking at a high-risk level. See Chapter 3, Section 3.5.1 for more information.

6.3.1.2 Binge Drinking Score

Binge drinking scores were calculated using the revised Alcohol Use Questionnaire (Mehrabian & Russell, 1978) adapted by Townshend and Duka (2002). See Chapter 3, Section 3.5.5 for more details. The binge score is calculated on the number of drinks per hour and number of times drunk and the percentage of time becoming drunk. The median split of this score was used to categorise the high (HBD) and low (LBD) groups.

6.3.1.3 Alexithymia

Alexithymia is characterized by difficulty in describing and identifying emotional states and having an externally oriented thinking style (Moriguchi & Komaki, 2013). Alexithymia was measured in the current study using the Toronto Alexithymia Scale (TAS-20; Bagby, Parker, & Taylor, 1994). (see Chapter 3, Section 3.5.2 for details.) The total score was analysed in the current study.

6.3.1.4 Impulsivity measure BIS-11

The BIS-11 is a 30-item self-report questionnaire which provides a total score of general impulsivity, by summing three nonoverlapping second-order subscales which demonstrate good reliability (Spinella, 2007). These comprise, Attentional Impulsivity (cognitive instability and decision making), Motor Impulsivity (acting without thinking), and Nonplanning Impulsivity (inability to plan ahead). (see Chapter 3, Section 3.5.4 for more details.)

6.3.1.5 Interpersonal Reactivity Index (IRI)

It is well established that the construct of empathy contains both cognitive and affective components (Davis, 1983). Emotion researchers broadly define empathy as the ability to sense other people's emotions, coupled with the ability to imagine what someone else might be thinking or feeling (Erol et al., 2017). It would be useful to understand if there was a relationship between the ability to empathise with others and facial emotion recognition by binge drinkers.

The IRI (Davis, 1983) is a multidimensional measure of empathy containing 28 statements measuring four different dimensions of dispositional empathy:

1) Empathic Concern: assesses emotional empathy, or feelings of compassion for others in distress (e.g. "*I often have tender, concerned feelings for people less fortunate than me.*")

2) Perspective Taking: assesses cognitive empathy, or the tendency to see the world from others' viewpoints (e.g. "*I sometimes try to understand my friends better by imagining how things look from their perspective*.")

3) Personal Distress: assesses self-focused responses to others' suffering (e.g. *"When I see someone who badly needs help in an emergency, I go to pieces."*)

4) Fantasy: assesses empathy for fictional characters (e.g. "*I really get involved with the feelings of the characters in a novel.*")

These are related to social functioning, self-esteem, emotionality and sensitivity to others. See Appendix 10 for the full questionnaire.

6.3.1.6 The State-Trait Anxiety Measure

A measure of anxiety was omitted from the data collection for Study 1-Part 1 and Part 2. Anxiety is linked with emotion recognition and alcohol use (Attwood et al., 2017; Cisler & Koster, 2010; Mogg et al., 1997) and therefore it was decided to include a measure of anxiety in the current study to preclude any influence on results.

One of the most commonly employed reliable and sensitive measures of anxiety is The Spielberger State-Trait Anxiety Inventory (STAI) (Endler & Kocovski, 2001). Whilst this has the benefit of enabling comparisons across research the downside of this measure is the length of time it takes to complete consisting as it does of 40 items. The questionnaire consists of 40 items, 20 measuring state anxiety (how you feel right now) and 20 measuring trait anxiety (how you feel generally) to be rated on a scale of: not at all/somewhat/moderately/very much. The state factors include items such as I feel calm, I feel upset, I am worried whilst the trait factors include items such as I worry too much, I have disturbing thoughts, I am a steady person. (see the full questionnaire in Appendix 9)

6.3.2 Computer tasks

6.3.2.1 ERT Task

The Cambridge Cognition (CANTAB) Emotion Recognition Task (ERT) was chosen to measure the ability to identify emotions in facial expressions for the current study. The ERT consists of two blocks of 90 images each. The images are morphed expressions across 15 levels from

Neutral to full expression and as such they measure the ability to recognise six basic emotions along a continuum of strength of expression. Each image is presented on screen for 200ms and each represents different degrees of six emotions; Happy, Anger, Fear, Surprise, Disgust and Sad. Participants are presented with a list of the six possible emotions from which to choose the most likely expression. (see Chapter 3, Section 3.4.1.1 for more details.) There is no time limit on how long they can take to make this decision but are encouraged to do it as quickly as possible.

6.3.2.2 Static vs Dynamic Images

The Tobii TX300 Eyetracker was used to test if there were differences in the way that respondents visually scan faces to gather information regarding the emotions being portrayed. (For more information on the use of eye-tracking see Chapter 1, Section 1.7.) Facial stimuli for the visual scan path experiment included the 6 emotions from the Ekman standardized face set: Anger, Disgust, Fear, Happy, Sad, Surprise, and Neutral (Ekman & Friesen, 1982).

The stimuli were drawn from the STOIC database (Roy et al., 2007). The STOIC database is a validated database that was developed specifically for conducting emotion recognition research using an eye-tracker. This involved having the key features of each expression in the same location on the screen for each participant. In this way the only difference between the images was the emotion expressed enabling direct comparisons to be made. The images were 768 x768 pixels in size and included both male and female faces in equal number. (see Figure 25 below.) A total of 14 static and 14 dynamic images were therefore presented. The stimuli were presented for 3 seconds in line with other research (Pitcher et al., 2011) using both static and dynamic images. The dynamic set showed an expression moving from neutral to emotional. The same faces at the peak of expression were chosen for the static set of emotions. Presentation order of static and dynamic images was counter-balanced and the emotions within each block were semi randomized with two randomized sets presented for each of static and dynamic images.

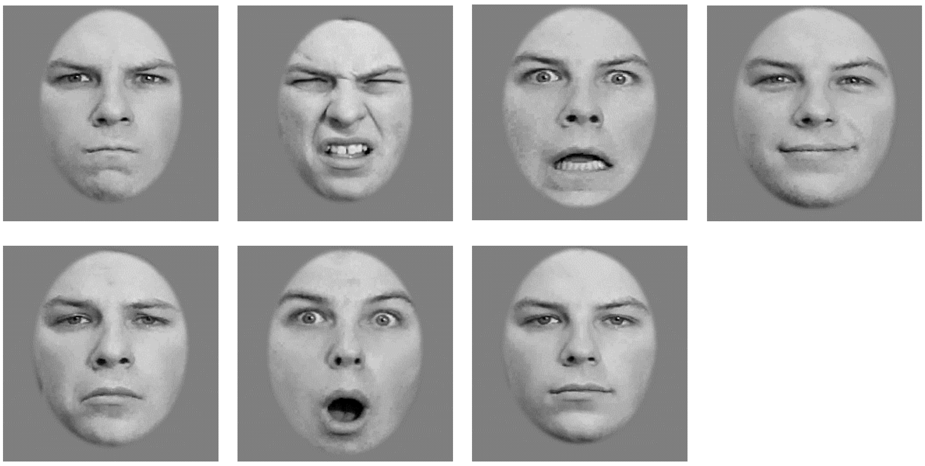


Figure 25. Static male images of peak of emotions presented individually for identification and rating. From top left: Anger, Disgust, Fear, Happy, Sad, Surprise, Neutral

By using both dynamic and static stimuli for scan paths it was possible to identify any difference in data gathering for dynamic versus static images. Participants were asked to identify the emotion expressed and to rate the valency of each emotion on a scale of 1 –10 where 1 was the weakest expression and 10 the highest intensity of the expression.

6.3.3 Procedure

Participants attended individual sessions at a laboratory in the University of West London. A standard briefing note explaining the aims of the research was read and written consent was obtained.

Participants firstly completed a demographics questionnaire (See Appendix 4) which included age, gender, age of first drink, age at first becoming drunk and age they started drinking regularly and the FAST screening questions to identify an alcohol use disorder. The Alcohol Use Questionnaire was self-completed followed by the STAI Anxiety Inventory and the IRI empathy scale. In order to give participants a break from questionnaires, the CANTAB ERT task was initiated next and standard instructions were read to participants. Participants were briefed to complete the task as quickly as possible although there was no time limit on the forced choice aspect of the study. Once the ERT was finished the participants then completed the final BIS-11 and TAS-20 questionnaires. The eye-tracking tasks were then undertaken and these involved emotion recognition and intensity rating. Firstly, participants were provided with onscreen instructions on how to complete the eye-tracking task and what was required of them before a trial run of two images and ratings. At this point participants had the opportunity to ask any questions. Once participants were comfortable with what was required the full test began. The block of static images alternated with the block of dynamic images in presentation order and the images were semi-randomised within each set to eliminate an order effect. The images were presented for 3 seconds and followed with a forced choice identification list with emotions randomised on the list. Following the identification participants were asked to rate the strength of the emotion they had just seen on a scale of 1 – 10. There was no time limit for the identification or ratings. Following the response, a grey screen, 250ms and fixation cross, 500ms, before the next emotional image appeared. Participants were debriefed at the end of the session.

6.3.4 Statistical Analysis

6.3.4.1 Correlations

Correlation analysis was carried out to identify any relationships between the overall drinking habits, such as *age at first drink* and *age first drunk, AUQ, Units* and *Binge score* and the number of emotions correctly identified taken from the CANTAB ERT data. The other measures of interest including the STAI, IRI, TAS-20 and BIS-11 were also checked for associations with emotion recognition.

6.3.4.2 T-test

As there were only 2 groups, the High Binge Drinker (HBD) and the Low Binge Drinker (LBD), an independent samples t-test was run to establish if the two sets of data were significantly different from each other on the key demographics and key measures of alexithymia, anxiety, empathy and impulsivity. The emotions correctly identified and any bias in emotion recognition were also tested between HBD and LBD to see if there were any differences between groups.

6.3.4.3 Unbiased hit rate

The unbiased hit rate for emotion accuracy was also calculated using a confusion matrix based on the number of hits divided by the number of stimuli of the target type and the number of correct responses of the target emotion divided by the total number of uses of that target emotion (see Chapter 4, Section 4.6.4 Table 3, for an example of the matrix). The unbiased hit rate provides a proportion value which needs to be arcsine transformed before being analysed (Wagner, 1993).

6.3.4.4 Mixed ANOVA

ANOVA was used in the current study to identify differences between HBD and LBD and how they responded to the different emotions and whether these differences were group specific. Where the results indicated significant main effects or interactions, these were followed up with post-hoc independent samples t tests.

6.3.4.5 Threshold Correct

The threshold for consistently arriving at a correct response for each emotion was calculated for each participant. This was done taking the intensity level of first recognition of the emotion and the intensity level after which it is perfectly recognised and dividing it by two [(first threshold+perfect threshold)/2] (Lannoy et al., 2018).

6.3.5 Data Cleaning

The data set was screened for accuracy prior to any analysis being carried out, to ensure the underlying assumptions were not violated. All data was checked for input errors on the data file using descriptive statistics in SPSS to identify any out-of-range values. In addition, the scale reliability for each of the questionnaires was tested and found to be at acceptable levels.

6.3.5.1 Normal distribution

Some statistical tests require that the data are parametric or in other words has a normal distribution. This also ensures the linearity and homoscedasticity of the data. The distribution of scores therefore was initially examined using histograms and the normality curve to identify the overall shape of the distribution curve. Normality test Shapiro-Wilks were also examined for significance and where abnormal distribution was indicated data was also tested by dividing values of skewness and kurtosis by their respective standard errors and thus converting them to z-scores. (Tabachnick & Fidell, 2014). A score of 1.96 or less is considered acceptable for a sample of up to 50 participants (Ghasemi & Zahediasl, 2012).

With regards to alcohol consumption measures, where clear outliers were identified the data was Winsorized (scores brought to within the 95th percentile) where appropriate (Field, 2013). The changed scores involved the higher binge drinking group only which contained 1 outlier relative to the rest of the group for the alcohol consumption scores. Adjusting these scores down improves the accuracy of the model and retains the higher binge drinkers in the data. As a-priori tests (G*Power 3.1) indicated a sample size of 22 was sufficient for a cohen's d effect size of 0.8 with error probability of 0.1 and 0.95 power for the main mixed ANOVA analysis, it was important to retain as much data as possible to maximise the power. The current research aimed to identify any differences between the HBD group and the LBD group and therefore any differences would not be impacted by retaining this data in the same relative order.

The key variables are high and low binge drinking, calculated using the median binge score, and the distribution of both groups were checked against independent variables. Age at First Drink, Age First Drunk and Age Drinking Regularly were normally distributed for both HBD and LBD. The Shapiro-Wilks test for normality was significant for the HBD group for AUQ, Unit score and BS, however there were acceptable levels of skewness and kurtosis when dividing the level of skewness and kurtosis by their respective errors (Tabachnick & Fidell, 2014). Parametric tests could therefore be used with these measures and where indicated, if homogeneity of variance was violated, the df were adjusted down to reflect that. The data for the TAS-20 and BIS-11 and STAI were also normally distributed for both the HBD and LBD groups however the IRI Perspective Taking subscale was not normally distributed for either the HBD or LBD group. As this was the only measure in the scale not normally distributed the data was windsorised. This involved one participant in each comparison group, the relative order of the data was maintained, and normality of the data was restored.

The data was also checked for multivariate outliers of the drinking scores, AUQ, Units and BS, using SPSS regression and mahalanobis distance (MD). In all cases MD = $p>0.001$ indicating an acceptable distance from the overall mean or centroid for multivariate data analysis (Tabachnick & Fidell, 2014).

When comparing the scan path length by HBD and LBD any cases with missing data for one element of the study were excluded from the whole analysis. This resulted in a LBD group of 12 and a HBD group of 15 participants for the static images and a LBD group of 10 and HBD group of 12 for the dynamic images. It was important to do this as the length of the path could be distorted due to missing data. Whilst for some other measures concerning fixations to individual emotions more data could be retained where more participant data was available for individual images. To avoid issues of non-normally distributed data and to even out any skew, the data was bootstrapped using 2,000 cases and all confidence intervals reported are Bias Corrected accelerated (BCa) confidence intervals (Efran, 2003) unless otherwise stated.

6.4 Results

A total of 46 participants (30 females), mean age 22.67 (4.22) were included in the full analysis. The sample was split using the median binge score from the alcohol use questionnaire for the whole group in line with other studies (Townshend et al., 2014). In the current study, the median score was 26 (HBD ≥ 27, n=23, LBD ≤ 26, n=23). Table 20 shows the descriptive statistics for the total sample and split by the binge drinking groups. Table 20 also includes the results of independent samples t-test and significant differences between the high and low binge drinking groups are indicated in bold *. Apart from the drinking measures, which were significantly different, HBD were more likely to be using recreational drugs and mixing alcohol and psychoactive substances. Correlation analyses were run to identify if there was a relationship between these measures and the binge drinking measures which was found to be significant for mixing alcohol and psychoactive drugs and AUQ, $r(46) = 0.594$, p=0.001, (CI 0.353, 0.770), Units, *r*(46) = 0.538, p=0.001, (CI 0.203, 0.762) and BS, *r*(46) = 0.565, p=0.001, (CI 0.337, 0.748). The results also identified a relationship between the binge drinking score and use of recreational drugs; AUQ, *r*(44) = 0.367, p=0.01, (CI 0.090, 0.610), Units, *r*(44) = 0.442, p=0.003, (CI 0.157, 0.685) and BS, *r*(44) = 0.316, p=0.037, (CI 0.038, 0.581). There was also a relationship between use of recreational drugs and incorrect attribution of anger *r*(44) = 0.318, p=0.038, (CI -0.005, 0.619), and between mixing alcohol and psychoactive drugs and the incorrect attribution of disgust *r*(44) = -0.362, p=0.017, (CI -0.556, -0.132)

Table 20. Demographics and drinking variables by binge group

	All n=46 Mean/(SD)	**HBD n=23**	**LBD n=23**	***t***
Gender (Female/Male)	30/16	11/12	19/4	
Age	22.67 (4.22)	21.87 (3.52)	23.48 (4.77)	1.30
Age of 1st drink	14.67 (2.30)	14.30 (2.03)	15.04 (2.53)	1.09
Age 1st got drunk	16.13 (2.22)	15.30 (1.72)	16.96 (2.38)	**2.69***
Age drinking regularly	17.74 (2.07)	16.91 (1.51)	18.57 (2.25)	**2.92****
Mix alcohol and psychoactive substances	3.33 (2.24)	4.27 (2.23)	2.36 (1.79)	**-3.13****
Recreational drug use in last 12 months	2.34 (1.85	3.00 (2.05)	1.68 (1.32)	**-2.54***
AUQ Score	40.21 (27.49)	61.65 (22.47)	18.78 (8.97)	**-8.49*****
Unit Score	10.17 (9.00)	14.39 (6.71)	5.96 (4.30)	**-5.07*****
Binge Score	30.09 (22.07)	47.35 (18.15)	12.83 (6.66)	**-8.56*****

*Significant differences at level *p<0.05, ** p<0.01, *** p<0.001*

Table 21 shows the overall and group mean scores for the key psychological measures. It also includes where there are significant between group differences and bootstrapped BCa confidence intervals (CI).

Table 21. Descriptive statistics for key psychological variables

	All n=46 Mean/(SD)	**HBD n=23**	**LBD n=23**	***t***	**Bootstrapped BCa 95% CI**
BIS-11					
Attentional	16.76(3.73)	17.65(4.25)	15.87(2.96)	-1.65 ns	-3.84 / 0.196
Motor	22.60(4.71)	23.61(5.27)	21.61(3.93)	-1.46 ns	-4.59 / 0.476
Non Planning	23.13(4.55)	24.52(3.81)	21.74(4.88)	**-2.15***	**-5.20 / -0.401**
TAS 20	47.73(12.88)	46.27(13.13)	49.35(12.74)	0.77 ns	-4.83 / 10.5
IRI					
Perspective Taking	19.85(4.25)	18.78(4.19)	20.91(4.12)	1.74 ns	-.157 / 4.53
Fantasy Scale	17.41(6.19)	17.13(6.74)	17.69(5.73)	0.31 ns	-3.03 / 4.32
Empathetic Concern	21.15(4.45)	20.83(3.45)	21.48(5.33)	0.49 ns	-1.93 / 3.08
Personal Distress	11.69(4.85)	11.09(4.94)	12.30(4.78)	0.85 ns	-1.54 / 3.99
STAI					
State Anxiety	35.00(9.4)	32.21(7.90)	37.78(10.16)	**2.07***	**.658 / 10.39**
Trait Anxiety	41.91(9.7)	41.00(9.17)	42.83(10.32)	0.63ns	-3.25 / 7.48

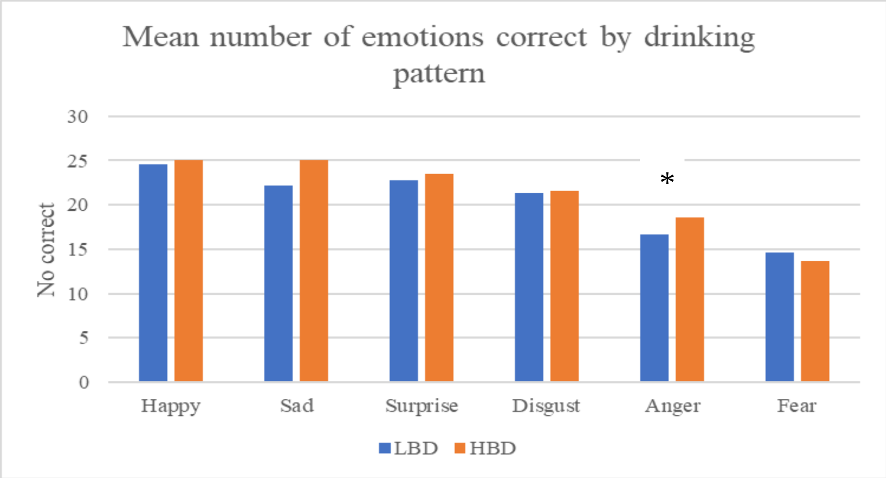
*Significant differences at level *p<0.05, ** p<0.01, *** p<0.001*

An independent samples t-test was also carried out on potential confounding variables. There were no significant differences between groups on the subscales of the empathy scale (fantasy, empathic concern, perspective taking or personal distress), and both groups had similar scores on the alexithymia scale. However, on the BIS-11 impulsivity scale whilst scores on the Attentional and Motor subscales did not differ significantly, there were differences on the Non-planning subscale with the HBD scoring significantly higher than LBD $t(44) = -2.15$, p=0.04, (CI = -5.38, 0.179). There were also significant differences on the state anxiety scale $t(44) = 2.07$, p=0.04, (CI = 0.155, 10.97), where LBD self-rated higher on the state anxiety scale than did HBD. There were no differences on the trait anxiety scale. This was followed up with a correlation analysis to identify if there was a relationship between the non-planning scores or State anxiety scores and the key drinking measures of AUQ, Units and BS or emotion recognition. There was no correlation for the state anxiety but there was a significant positive relationship between non planning and all three drinking measures, AUQ $r(46) = 0.425$, p=0.003, (CI 0.201, 0.614), Units $r(46) = 0.400$, p=0.006, (CI 0.093, 0.645) and BS $r(46) = 0.403$, p=0.005, (CI 0.192, 0.583) indicating that scores on the drinking measures increased so did the non-planning impulsivity score.

6.4.1 Emotion Recognition

6.4.1.1 Bottom-up static emotion recognition, 200ms exposure

The most recognised emotion overall was Happy whilst Anger and Fear were the least well recognised emotions. See Figure 26 for an illustration of the mean while Table 22 details the mean and SE.



* = *p*<.05

Figure 26. The mean number of rapid exposure emotions correctly identified by drinking pattern

Table 22. The mean and standard error of the number of rapid exposure emotions correctly identified

	Happy	**Sad**	**Surprise**	**Disgust**	**Anger***	**Fear**
	mean (SE)	mean (SE)	mean (SE)	mean (SE)	mean (SE)	mean (SE)
LBD	24.56 (0.86)	22.22 (0.85)	22.78 (0.60)	21.35 (0.64)	**16.61 (0.49)**	14.65 (0.93)
HBD	25.05 (0.71)	22.00 (0.68)	23.45 (0.60)	21.55 (0.87)	**18.55 (0.64)**	13.64 (1.27)

Looking specifically at the performance of the HBD and LBD group there was only one significant between group difference in emotion recognition for the raw hit rate of Anger $t(43) = -2.04$, p=0.048 SEM = 0.95, (CI = -3.85 , -0.02) with HBD tending to identify Anger correctly more often than LBD. However, when bias and probability were taken into consideration this difference was no longer significant and there were no other between group differences in the early recognition of the remaining emotions.

Given the disparity between male and female representation in the sample, the number of emotions correctly identified (hit rate) and the arcsine transformed unbiased hit rate and the emotions chosen when incorrect were checked for gender differences. There were no significant between-gender differences although the hit rate for Happy correct was approaching significance $t(43) = 2.01$, p=0.051 SEM = 1.12, (CI = -0.006 , 4.51) such that males tended to get more correct hits for Happy than females (Male Mean = 26.25, SEM = 0.536; Female Mean = 24.0, SEM = 0.773).

6.4.1.2 Between group differences and correlations with measures and emotion recognition accuracy

There were significant between group differences for the Non-planning scale of the BIS-11, with HBD scoring higher than LBD (see Table 21). There were also between group differences for mixing psychoactive substances and alcohol and recreational drug use which were supported by a significant relationship with drinking scores (see Table 20) therefore, a partial correlation was conducted controlling for these measures. The partial correlation was conducted on the arcsine transformed unbiased hit rate score and the drinking measures. The unbiased hit rate took the overall accuracy including chance and bias into consideration. There was a moderate negative correlation between 1st Drink and 1st Drunk and Anger recognition, $r(38) = -.403$, p=0.01, (CI -0.645, -0.079), and $r(38) = -0.455$, p=0.003, (CI -0.679, -0.134) respectively such that the younger participants were when they started drinking or first became drunk the more accurate their recognition of

Anger. Whilst Age First Drunk was moderately negatively associated with Disgust recognition, *r*(38) = -0.405, p=0.01, (CI -0.640, -0.092) indicating that the younger participants were when they first became drunk, the more accurate they were with Disgust recognition. The same partial correlation was carried out to identify any relationship between drinking measures and the number of each emotion *incorrectly* chosen. There was a small positive relationship with Age of First Drink and the incorrect choice of Disgust, *r*(38) = 0.349, p=0.03, (CI -0.018, 0.598) indicating the younger the age of first drink the fewer the incorrect choices of Disgust. There was also a small positive relationship between the Total Percentage Incorrect and Age First Drunk *r*(38) = 0.316, p<0.05, (CI -0.012, 0.540) indicating overall slightly better emotion recognition, the younger participants were when they first became drunk. However, the confidence intervals for the percentage incorrect measures suggest caution should be used in generalising these results which may only be applicable to the current sample as the range crosses zero.

6.4.1.3 Threshold for correct recognition

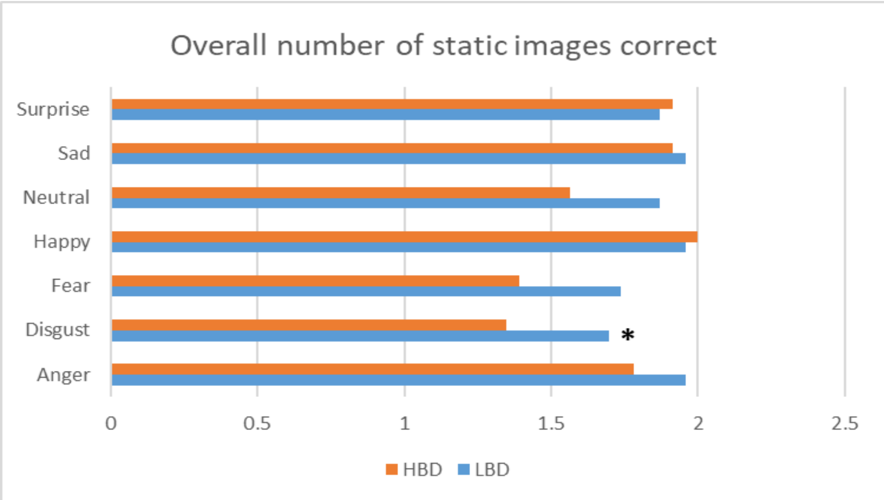
The threshold for correct emotion recognition refers to the level of intensity required before consistent accurate recognition. Age First Drunk and the threshold for correct recognition of Anger r(38) = 0.338, p=0.03 (CI = 6.58, 7.70) and the correct recognition of Happy r(38) = 0.313, p<0.05 (CI = 3.19, 4.22) were positively correlated suggesting that getting drunk at a younger age meant a lower intensity of these expressions was required for accurate recognition. No relationship was identified between the key drinking measures of AUQ, Units and BS and the threshold of emotion recognition for bottom-up processing. An independent t-test did not identify any between-group differences for the threshold for emotion recognition $p>0.05$.

6.4.1.4 Latency of response

The latency of response was calculated for each emotion response and the average response time for each correct emotion was compared between the HBD and LBD. An independent samples t-test found a significant time difference in the recognition of Fear between the HBD and LBD, $t(43) = -2.10$, $p=.042$ SEM = 155.75, (CI = -628.74 , -23.66). The HBD took significantly longer in the correct recognition of Fear (Mean = 1785.6 milliseconds, STD = 635.8, SEM = 135.5) than LBD (Mean = 1462.4 milliseconds, STD = 367.9, SEM = 76.73). There were no between group differences for the remaining emotions.

6.4.1.5 Top-down emotion recognition, 3000ms exposure

The second task involved identifying and rating the 6 emotions and Neutral images presented for 3 seconds. The images were in both static and dynamic format with 2 of each emotion. An independent samples *t*-test showed that there was a significant difference between the HBD and LBD in terms of accuracy of the emotions correct overall with LBD (M=13.04, SEM = 0.22) achieving more accuracy than HBD (M=11.91, SEM = 0.21) for the static images $t(44) = 3.72$, $p=0.002$ (CI =0.511, 1.74). As evident in Figure 27 and confirmed by an independent samples *t*-test, the difference for static images was driven by a more accurate recognition of Disgust amongst the LBD than HBD where $t(44) = 2.46$, p=.02 (CI = 0.044, 0.621). (See Figure 27 for details.)



** P<0.05*

Figure 27. Overall number of static images correctly identified by emotion and drinking pattern

Table 23. Mean and standard error (SE) for number of static images correct

N=46	Anger	**Disgust***	Fear	Happy	Neutral	Sad	Surprise
	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE
LBD	1.96/0.04	**1.70/0.1**	1.74/0.11	1.96/0.04	1.87/0.07	1.96/0.04	1.87/0.07
HBD	1.78/0.11	**1.35/0.1**	1.39/0.16	2.00/0.00	1.57/0.15	1.91/0.06	1.91/0.06

**** P<0.05***

In addition, when looking at the dynamic images, there was no significant difference in terms of the overall recognition of emotions, however, there was a significant difference between the HBD and LBD in the recognition of Anger $t(22) = 2.47$, p=0.03 (CI =0.065, 0.407). (See Figure 28 below.)

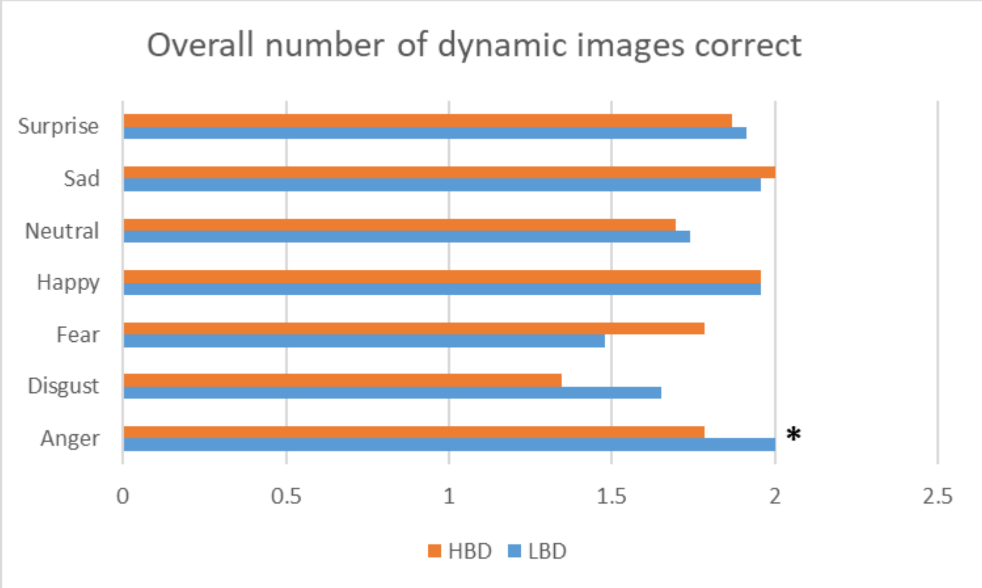


Figure 28. Overall number of dynamic images correctly identified by emotion

Table 24. Mean and standard error (SE) for number of dynamic images correct

N=46	Anger	Disgust	Fear	Happy	Neutral	Sad	Surprise
	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE
LBD	2.00/0.0	1.65/0.12	1.48/0.12	1.960/.04	1.74/0.09	1.96/0.04	1.91/0.06
HBD	1.78/0.09	1.35/0.1	1.78/0.13	1.960/.04	1.70/0.13	2.00/0.0	1.87/0.07

6.4.1.6 Emotion intensity rating for dynamic and static images

Participants were also asked to rate the intensity of each emotion. A repeated measure's ANOVA 6 (emotions) x 2 Image (static, dynamic) x 2 (HBD, LBD) was carried out controlling for use of recreational drugs, mixing alcohol and stimulant drinks and non-planning, using a Bonferroni adjustment for multiple comparisons. The Neutral expression was not included in the intensity ratings. The results were non-significant. See Figure 29 and Figure 31 for rating intensity by HBD and LBD for statice and dynamic images respectively with Table 25 and Table 26 detailing the mean rating and standard error for each.

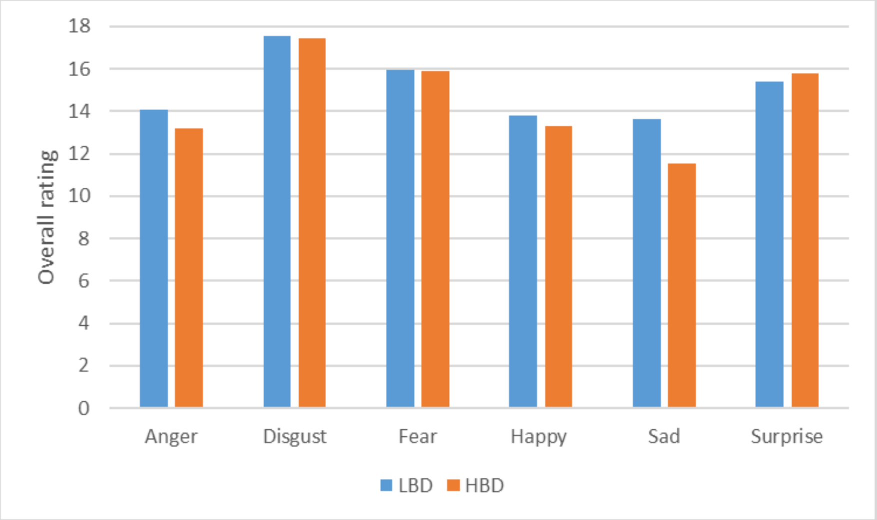


Figure 29. Overall rating of emotion intensity for static images

Table 25. Mean and standard error (SE) of ratings of intensity of static images

N=46	Anger	Disgust	Fear	Happy	Sad	Surprise
	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE
LBD	13.61/0.65	16.74/0.5	15.26/0.51	12.87/0.6	12.57/0.66	15.83/0.56
HBD	12.48/0.79	16.04/0.48	15.74/0.38	13.17/0.58	11.61/0.69	15.78/0.46

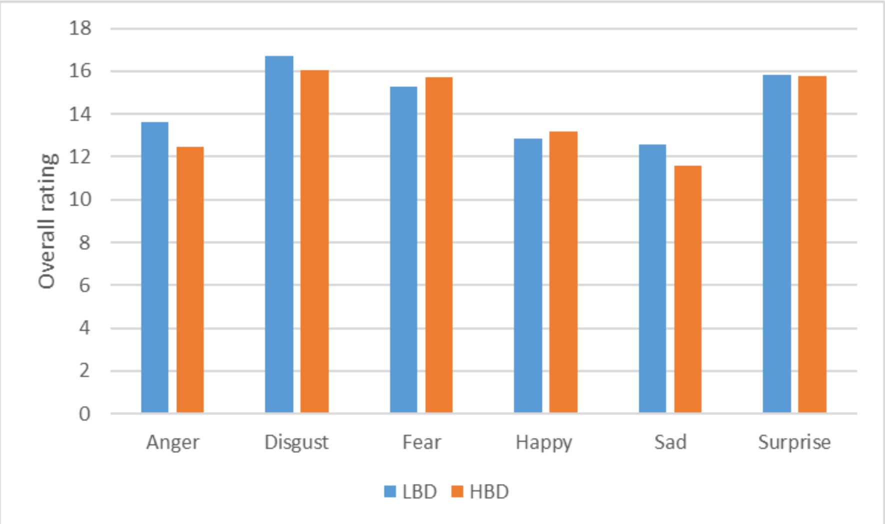


Figure 30. Overall rating for emotion intensity of dynamic images

Table 26. Mean and standard error (SE) for ratings of intensity of dynamic images

N=46	Anger	Disgust	Fear	Happy	Sad	Surprise
	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE	Mean/SE
LBD	14.09/0.56	17.52/0.5	15.96/0.51	13.78/0.61	13.65/0.62	15.39/0.56
HBD	13.17/0.65	17.43/0.4	15.87/0.36	13.30/0.56	11.52/0.81	15.78/0.46

6.4.1.7 Summary for Bottom-up Emotion Recognition

The following table provides a summary of the key findings for emotion recognition and intensity rating.

Table 27. Summary of Significant results for bottom-up emotion recognition

Measure	**Analysis**	**Expression where the Significant effect was found**	**Result**	**P value and η2**
Emotion Recognition-Bottom-up				
Arcsine unbiased hit rate	Partial Correlation	Age 1st drink/Anger/Disgust	Inverse correlation *Indicating that as the age went up the recognition went down*	*r=-0.40 (p*=0.01)/-0.40 (*p*=0.01)
Arcsine unbiased hit rate	Partial Correlation	Age 1st drunk/Anger	Inverse correlation *Indicating that as the age went up the recognition went down*	*r*=-0.46 (*p* =0.05)
% Correct	Partial Correlation	Age 1st drink/Anger	Inverse correlation	*r*=-0.31 (*p* =0.05)
% Correct	Partial Correlation	Age 1st drunk/Anger	Inverse correlation	*r*=-0.31 (*p* =0.003)
% incorrect	Partial Correlation	Age 1st drink/Disgust	Positive correlation *Indicating that the older at first drink the better the recognition*	*r*=0.35 (*p* =0.03)
Threshold for Anger and Happy recognition	Partial Correlation	Age 1st drunk	Positive correlation *Indicating that the older when first drunk the more intensity required for recognition*	*r*=0.34 (*p* =0.03)/ r=0.31(p=0.05)
Latency of response	t-test	Latency of response to Fear	HBD take longer to respond	*p* =0.04 CI = -628.74, -23.66

6.4.2 Eye-movement

6.4.2.1 Visual Scan Path Length

The visual scan paths were calculated in two different measures. The overall total length of the scan paths and the average length of the saccades between fixations by emotion.

The overall trend, although not statistically significant, indicated longer scan paths for the static images than the dynamic images. See Figure 31 below for an illustration whilst Table 28 details the means and SE.

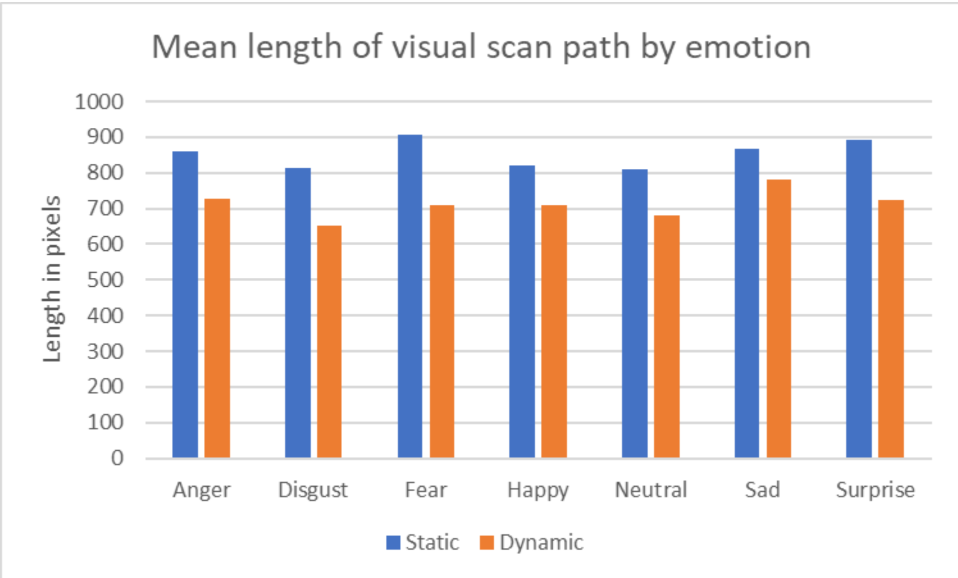


Figure 31. The mean scan path length by emotion and image type

Table 28. Mean length of Visual Scan Path in Pixels by image format and emotion

	Static Mean (SE)	Dynamic Mean (SE)
Anger	862 (56.1)	729 (54.9)
Disgust	812 (55)	652 (39.89)
Fear	905 (59.83)	709 (44.58)
Happy	822 (43.13)	709 (48.86)
Neutral	809 (51.31)	679 (52.44)
Sad	869 (56.32)	779 (48.12)
Surprise	894 (60.52)	725 (50.1)

6.4.2.2 Total length of VSP – Dynamic Images

An independent samples t-test identified there were significant differences in the total length of the VSP between the HBD and the LBD in the dynamic images for Fear, $t(20)$ =2.09, p=0.04 SEM=97.72, (CI = 25.59, 395.68) with LBD having a longer scan path (M=933, SEM=69.49) than the HBD (M=721.70, SEM= 67.33). There was also a significant difference between HBD and LBD for the emotion of Surprise $t(20)$ = 2.9, p=.01 SEM = 107.38, (CI = 97.02 , 525.53) with LBD having a longer scan path (M=924.8, STD =79.34) than the HBD (M=610.57, SEM= 73.71).

6.4.2.3 Average distance between fixations – Dynamic Images

Looking specifically at the average length of the scan path between fixations, the between group difference is significant for the emotion of Anger $t(20)$ = 2.72, p=0.02, SEM = 24.5, (CI = 21.97, 116.19) with LBD having a longer scan path (M=271.86, SEM =14.24) than the HBD (M=202, SEM= 20.22). The difference is also significant for the emotion of

Fear $t(20) = 2.50$, p=0.02 SEM = 25.38, (CI = 17.92, 115.14) with LBD having a longer average scan path (M=283.16, SEM =17.95) than the HBD (M=217.85, SEM= 18.58). The difference for the emotion of Surprise for the average length of the visual scan path is just outside the significant level $t(20) = 2.09$, p=0.057 SEM = 26.37, (CI = 1.82, 108.6) with LBD having a longer scan path (M=267.05, SEM =19.04) than the HBD (M=210.23, SEM= 19.12).

6.4.2.4 Total length of VSP – Static Images

With respect to the static images the independent sample t-test bootstrapped with 2,000 samples did not identify any significant between group differences in the total VSP length for any of the emotions.

6.4.2.5 Average distance between fixations – Static Images

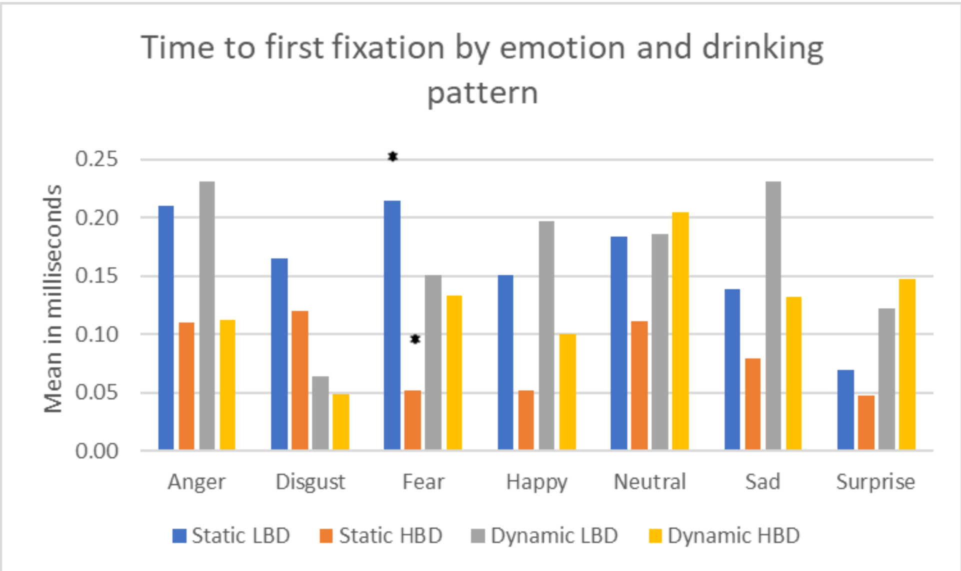
There were no significant differences in the average length of the saccade between fixations.

6.4.2.6 Interaction between visual scan path, image type and drinking pattern (7x2x2 Mixed ANOVA)

A 7 (emotions) x 2 (type of image static/dynamic) x 2 (HBD, LBD) mixed ANOVA with median binge score as the between subjects factor conducted on the total VSP length identified no significant between groups differences. This was conducted using a Bonferroni adjustment for multiple comparisons and controlling for recreational drug taking, mixing alcohol and stimulant drinks and non-planning from the impulsivity scale. There was however, a significant between group difference for the average length of the VSP between emotions by binge drinkers $F(1.67, 20) = 4.09$, $p=0.04$, $\eta^2 = 0.25$, with LBD tending to have longer VSPs than HBD for each emotion regardless of image type although this was only significant for dynamic images as reported above.

6.4.2.7 Time to first fixation (TFF)

Moving on to the detail of the eye tracking data in terms of fixations, an examination of the descriptive statistics revealed that HBD took longer to fixate on dynamic than static images for each emotion except for Disgust. Whilst for dynamic images HBD fixate quicker than LBD for all emotions apart from Neutral and Surprise. See Figure 32 below



***=p<0.05**

Figure 32. TFF for each emotion by drinking pattern and image type.

Table 29. Mean and standard error (SE) for Time to first fixation for dynamic and static images by emotion

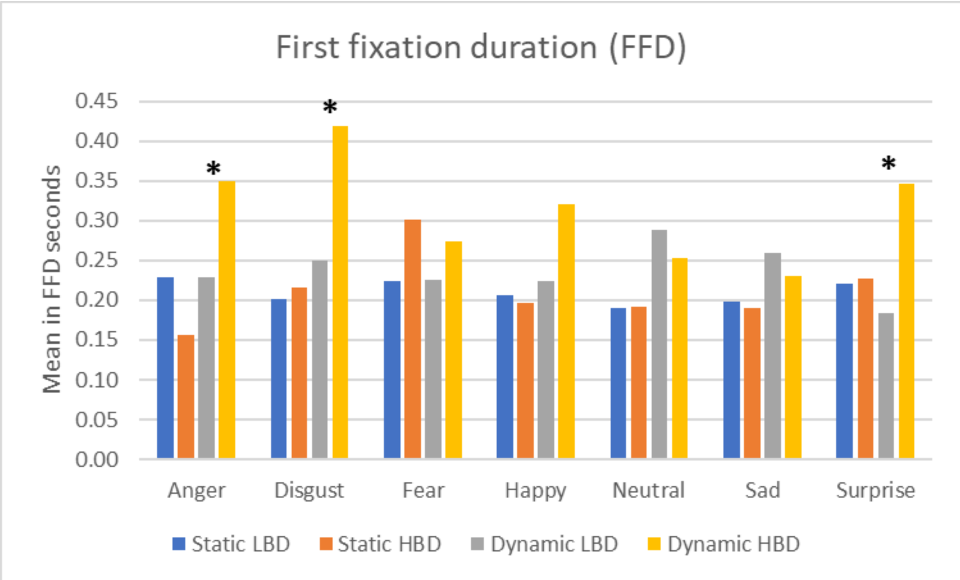
	Dynamic HBD		Dynamic LBD		Static HBD		Static LBD	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Anger	0.116	0.037	0.231	0.085	0.091	0.027	0.210	0.079
Disgust	0.051	0.026	0.064	0.028	0.057	0.030	0.165	0.055
Fear	0.130	0.038	0.151	0.066	**0.052***	**0.024**	**0.215**	**0.075**
Happy	0.094	0.039	0.197	0.064	0.057	0.037	0.151	0.080
Neutral	0.204	0.077	0.186	0.059	0.111	0.033	0.184	0.043
Sad	0.139	0.055	0.231	0.055	0.087	0.031	0.139	0.044
Surprise	0.138	0.046	0.122	0.041	0.052	0.024	0.070	0.038

***=p<0.05**

Further analysis identified a significant between group difference in time to first fixation (TFF) for the emotion of Fear for static images, *t*(25.4) = 2.07 p=0.047, (CI 0.039, 0.327), but not for dynamic images. Examination of the descriptive statistics indicated HBD are quicker to fixate on all static images than LBD and this is significant for the expression of Fear.

6.4.2.8 First fixation duration (FFD)

There is also a difference between groups for the duration of the first fixation (FFD) for the dynamic emotions of Anger *t*(41) = -2.17 BS p=0.036 (CI -0.239, -0.016), Disgust *t*(25.3) = -2.29, BS p=0.031, (CI = -0.327, -0.011), and Surprise *t*(29.5) = -2.69, BS p=0.011, (CI = -0.290, -0.034), with HBD spending longer on the first fixation for each emotion (see Table 30 for Means). In contrast, for the static images, it is only the emotion of Anger that produces a difference which is approaching significance in FFD, *t*(41) = 2.14, p=0.054, (CI = 0.011, 0.144), however, for static images it is the LBD group which spends longer on the first fixation (M= 0.228, SEM = 0.030) than HBD (M = 0.157, SEM= 0.020). See Figure 33 for an illustration and Table 30 for Mean and SE details.



***=p<0.05**

Figure 33. First fixation duration (FFD) by image type and drinking pattern

The mean and SE for FFD are displayed in Table 30.

Table 30. Mean and SE for first fixation duration (FFD) to dynamic and static images by emotion

	Dynamic HBD		Dynamic LBD		Static HBD		Static LBD	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Anger	**0.350**	**0.047**	**0.230**	**0.030**	0.157	0.020	0.228	0.030
Disgust	**0.419**	**0.069**	**0.250**	**0.026**	0.216	0.025	0.201	0.023
Fear	0.274	0.043	0.226	0.025	0.302	0.058	0.223	0.034
Happy	0.321	0.051	0.223	0.025	0.197	0.019	0.206	0.029
Neutral	0.253	0.027	0.288	0.043	0.191	0.021	0.191	0.024
Sad	0.230	0.035	0.259	0.023	0.191	0.020	0.199	0.015
Surprise	**0.346**	**0.054**	**0.184**	**0.027**	0.228	0.044	0.221	0.037

Those in bold indicate a significant difference, p<.05,between HBD and LBD

6.4.2.9 Interaction between fixations to image type, emotions, region of face (ROF) and drinking pattern (Mixed ANOVA)

In order to identify any interactions between image type and the scan pattern depending on the region of the face and drinking pattern a 7x2x2x2 mixed ANOVA was conducted with emotions as an independent within subjects variable with 7 levels (Anger, Disgust, Fear, Happy, Neutral, Sad, Surprise) by image type (static, dynamic), and region of face (top/eye, bottom/mouth) and drinking pattern as the between subjects variable (HBD, LBD). The output measures were time taken to the First Fixation (TFF), Total Fixation Duration (TFD), and Visit Count (VC). The analysis controlled for mixing alcohol and psychoactive drugs, recreational drug use and non-planning, all of which were significantly different between high and low binge drinkers. A Bonferroni correction was applied to take multiple comparisons into consideration.

Time to first fixation (TFF)

Looking at Time to the First Fixation (TFF) there was an interaction between Image and Drinking Pattern $F(1,6) = 12.00$, $p=.01$, $\eta^2 =0.68$. HBD tended to fixate quicker than LBD on all static images regardless of the emotion displayed, although as mentioned above the only significant difference was for static images of Fear.

Total fixation duration (TFD)

There were no main effects of Image type, Emotion or Region of Face (ROF) for Total Fixation Duration, however, there was an interaction for Image x Emotion x ROF x Drinking Pattern $F(6, 36) = 3.12$, $p=.01$, $\eta^2 =0.34$ (see Figure 34 for details).

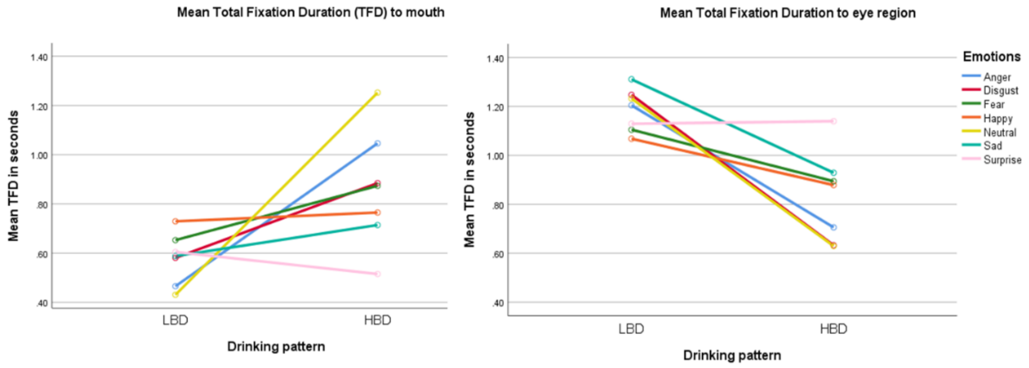


Figure 34. Interaction for total fixation duration for emotions by region of face by drinking pattern

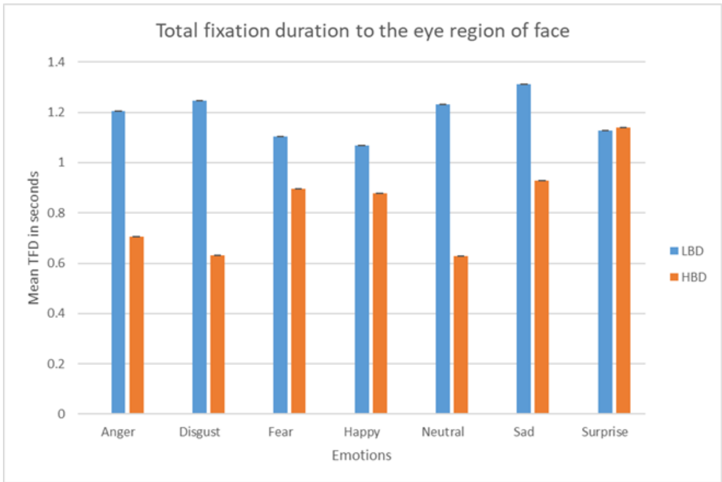


Figure 35. Total fixation duration to the eye region of the face by emotion and binge drinking pattern

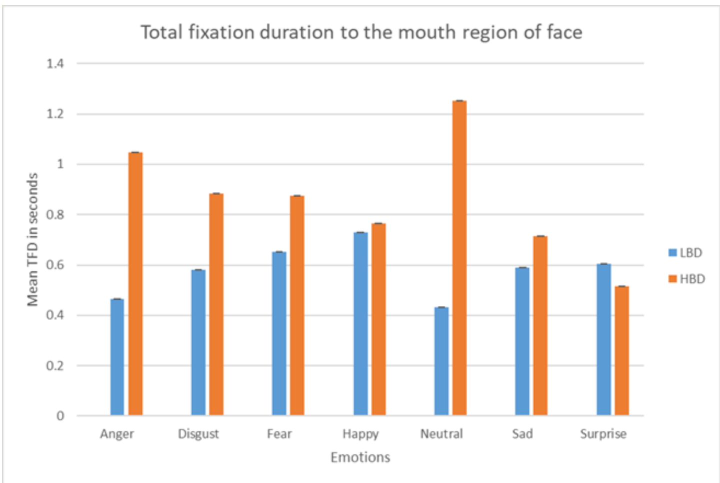


Figure 36. Total fixation duration to the mouth region of the face by emotion and binge drinking pattern

As can be seen from Figure 35 and Figure 36, HBD spend longer on the Mouth region and less time on the Eyes than LBD except for the emotion of Surprise. The mean and standard errors are reported in Table 31.

Table 31. Mean and standard error or the total fixation duration to the eye region and the mouth region by emotion and drinking pattern

	HBD Eye		LBD Eye		HBD Mouth		LBD Mouth	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Anger	0.706	0.283	1.205	0.172	1.046	0.173	0.466	0.106
Disgust	0.633	0.229	1.247	0.14	0.885	0.122	0.581	0.075
Fear	0.894	0.331	1.105	0.202	0.874	0.192	0.653	0.117
Happy	0.879	0.438	1.068	0.267	0.765	0.299	0.729	0.182
Neutral	0.630	0.229	1.232	0.140	1.252	0.208	0.431	0.127
Sad	0.929	0.300	1.311	0.183	0.714	0.290	0.588	0.177
Surprise	1.140	0.479	1.129	0.292	0.515	0.278	0.605	0.170

Visit count (VC)

There was an interaction between ROF and drinking pattern for the visit count, $F(1,6) = 6.00$, $p=.05$, $\eta^2 = 0.50$. There is also an interaction between emotion and the region of face (ROF) visited, $F(6,36) = 2.72$, $p=.03$, $\eta^2 = 0.31$ and a marginal significance for emotions, ROF and drinking pattern, $F(6,36) = 2.22$, $p=.06$, $\eta^2 = 0.27$. See Figure 37 for an illustration.

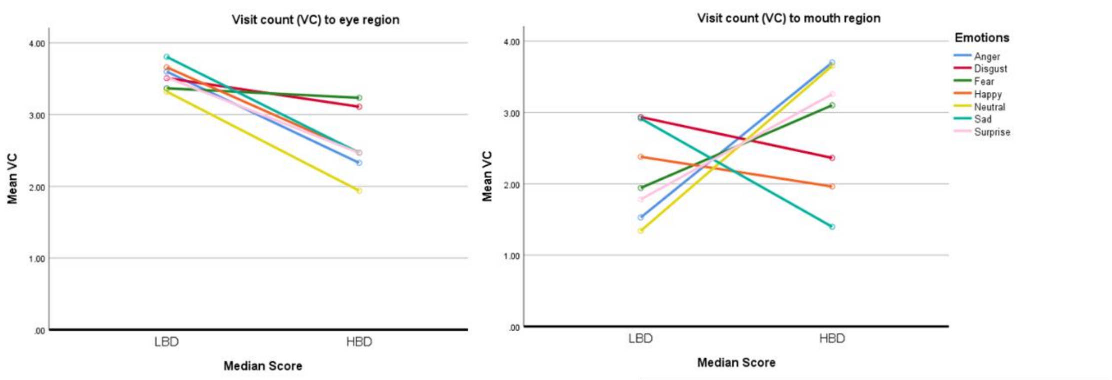


Figure 37. Interaction between visit count and region of face by emotion and drinking pattern

HBD have a tendency to make fewer visits to the eye region than LBD across all emotions and this is significant for the dynamic images for Fear $t(9) = 2.26$, p=.050, (CI = 0.068, 1.777). The means and standard errors of the visit counts are reported in Table 32 for dynamic images and Table 33 for static images. There is a significant difference between the visit counts of HBD to the mouth region for the Neutral expression to the static image in comparison with LBD, $t(9) = -2.30$, p=.047, (CI -2.47, -0.022).

Table 32. Mean and SE number of visits to dynamic images for eye and mouth region by emotion and drinking pattern

Dynamic	HBD Eye		LBD Eye		HBD Mouth		LBD Mouth	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Anger	2.75	0.629	3.29	0.286	2.50	0.289	2.00	0.309
Disgust	3.75	0.250	3.29	0.360	2.75	0.479	2.43	0.297
Fear*	**2.75**	**0.479**	**3.71**	**0.184**	2.75	0.479	2.14	0.143
Happy	2.75	0.479	3.57	0.297	2.50	0.500	2.29	0.286
Neutral	2.50	0.646	3.14	0.261	2.00	0.000	1.86	0.404
Sad	3.25	0.479	3.29	0.286	2.75	0.479	2.14	0.459
Surprise	3.00	0.408	3.43	0.369	2.75	0.629	2.00	0.378

Those in bold indicate a significant difference (p<0.05) between HBD and LBD

Table 33. Mean and SE number of visits to static images for eye and mouth region by emotion and drinking pattern

Static	HBD Eye		LBD Eye		HBD Mouth		LBD Mouth	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Anger	3.50	0.289	3.00	0.436	3.25	0.479	2.00	0.378
Disgust	3.00	0.577	3.43	0.481	3.25	0.629	2.71	0.360
Fear	3.00	0.408	3.43	0.202	2.75	0.629	2.14	0.261
Happy	2.75	0.750	3.43	0.297	2.25	0.629	2.00	0.309
Neutral*	2.25	0.629	3.00	0.218	**3.25**	**0.479**	**2.00**	**0.309**
Sad	3.00	0.577	3.57	0.369	2.25	0.250	2.43	0.297
Surprise	2.75	0.479	3.14	0.261	2.75	0.629	2.14	0.261

Those in bold indicate a significant difference (p<0.05) between HBD and LBD

A summary of the main findings for group differences in visual scan path and fixations is provided in Table 34, whilst Table 35 summarises the significant interactions for the visual scan path and fixations involving the emotions, region of face, image format and drinking pattern.

Table 34. Summary of significant results for differences between HBD and LBD on top-down visual scan path and fixations

Measure	**Analysis**	**Expression where the Significant effect was found**	**Result**	**P value and Confidence Interval (CI)**
Dynamic Total length of VSP	t-test	Fear Surprise	HBD had a longer scan path than LBD for both Fear and Surprise	*P=0.04 CI=25.59, 395.68* *P=0.01 CI=97.02, 525.53*
Dynamic Average distance between fixations	t-test	Anger Fear Surprise	Average distance between fixations is longer for LBD than HBD	P=0.02, CI = 21.97, 116.19 P=0.02, CI =17.92, 115.14 P=0.057, CI =1.82, 108.6
Time to first fixation (TFF)	t-test	Static Fear	HBD quicker to fixate than LBD	P=0.05, CI 0.039, 0.327
First fixation duration (FFD)	t-test	Dynamic Anger, Dynamic Disgust Dynamic Surprise Static Anger	HBD fixate for longer than LBD for dynamic emotions For the static image of Surprise LBD spend longer than HBD on the first fixation.	P=0.04 CI - 0.239, -0.016 P=0.03, CI = - 0.327, -0.011 P=0.01, CI = - 0.290, -0.034 P=.054, CI = 0.011, 0.144

Table 35. Summary of significant interactions between emotions, image format and region of face for top down VSP and fixations

Measure	**Analysis**	**Expression where the Significant effect was found**	**Result**	**P value and η2**
Average distance between fixations	7x2x2 ANOVA	Dynamic images x Drink Pattern	HBD had shorter average distance between fixations than LBD	P=0.04, η^2 =.25
Time to first fixation (TFF)	7x2x2 ANOVA	Interaction between image type and Drink Pattern	HBD fixated quicker on all static images than LBD. Significant for Fear	p=0.01, η^2 =0.68 p=0.04
Total fixation duration (TFD)	7x2x2 ANOVA	Interaction for Image x Emotion x Region of Face (ROF) x Drink Pattern	HBD fixated longer on mouth and less on eyes than LBD with exception of Surprise	p=0.01, η^2 =0.34
Visit count (VC)	7x2x2 ANOVA	Interaction for Image x ROF x Drink Pattern Interaction for ROF x Emotion	HBD visit the mouth more than LBD for Static Neutral HBD fewer visit to eyes than LBD for Dynamic Fear	p=0.05, η^2 =0.50 p=0.03, η^2 = 0.31

6.5 Discussion

The current study tested three central hypotheses. Firstly, it predicted high binge drinkers (HBD) would be less accurate than low binge drinkers (LBD) in their ability to recognise complex emotions (morphed with different levels of intensity) through facial expressions in bottom-up processing. This aspect of the study, a quick presentation (200ms) of the 6 basic emotions (Anger, Disgust, Fear, Happy, Sad and Surprise) at 15 different levels was employed to test for accuracy and latency of response. The second hypothesis predicted HBD would be less accurate than LBD in top-down processing of emotional faces and provide lower ratings for the perceived intensity of static and dynamic emotions presented for 3 seconds. Finally, the third hypothesis predicted there would be a difference in how both groups scanned static and dynamic facial expressions for information with HBD utilising a less efficient strategy. This was measured with an eye-tracker during the three second presentation of the static and dynamic images.

6.5.1 Bottom-up Emotion Recognition

The first hypothesis that HBDs would be less accurate than LBD in emotion recognition was not supported by the data for the behavioural ERT which presented images for 200ms. There was a significant difference between the HBD and LBD groups for the recognition of Anger with the HBD getting more correct answers on the raw hit rate. However, as HBD were also more likely to incorrectly choose Anger, once bias and probability were considered this difference in accuracy disappeared. This trend of bias towards use of Anger is consistent with the findings of

Freeman et al., (2018) who used the same battery of tests amongst those with an alcohol dependence (AD) and found a bias amongst those with an AD to incorrectly identify expressions as angry. Anger is one of the threat related emotions that is frequently identified as disrupted in alcohol research (Donadon, & Osorio, 2014). This is important as the misperception of ambiguous emotions as negative, for example attributing Anger or Disgust to a Neutral expression, have been linked to inappropriate social reactions (Attwood et al., 2009; Attwood & Munafo, 2014; Frigerio et al., 2002; Khouja et al., 2019). These inappropriate reactions can lead to greater difficulty with social interactions and indeed evidence suggests that those who are better at reading non-verbal cues experience more social success whilst those who struggle with non-verbal cues are less socially competent (McKown et al., 2009; Philippot et al., 1999). Difficulties with social interactions can lead to a downward spiral with increased drinking as a coping mechanism to feel more relaxed socially which in turn can eventually lead to a severe AUD (Addolorato et al., 2018).

The perception of negative emotions in ambiguous situations could lead to confusion, particularly in stressful situations, and through inappropriate responses, further complicate social interactions. It is possible that the negative appraisal of a wide variety of situations could lead to suspicion that others are somehow being deceptive or not being open and honest, resulting in defensive behaviour or retaliatory aggression and thereby increasing the risk of violence (Clements & Schumacher, 2010). This could be particularly problematic in domestic violence situations. In research amongst a community sample of partner-violent and non-violent men's abilities to recognize emotions on images of their wives and unfamiliar men and women, a study found that violent husbands interpreted Happy as Disgust and were impaired in their ability to recognize Fear when it was present interpreting it instead as Neutral (Marshall & Holtzworth-Munroe, 2010).

The bias corrected result of no behavioural difference in performance between HBD and LBD is supported in other binge drinking research (Lannoy et al., 2017) whilst yet other research has identified behavioural differences (Lannoy et al., 2019, 2018). This inconsistency in findings is also present in AUD research and is indicative of the heterogeneity of the impact of alcohol abuse amongst alcohol consumers including binge drinkers. The inconsistency could, in part, be explained by the wide range of paradigms and stimuli used targeting slightly different aspects of performance. For example the Townshend and Duka (2003) exploring emotion recognition amongst those with an AUD used single presentation of emotion cards of prototypical emotional expressions morphed according to Sprengelmeyer et al. (1997). This resulted in the 6 basic emotions presented in order (Happy, Surprise, Fear, Sad, Disgust, and Anger) containing 90% of each basic emotion with 10% of the adjoining emotion along with 6 faces that were 50% of each of the two adjoining emotions making 12 emotional expressions in total. There was no time limit on the recognition and rating was indicated on a score card with a five-choice categorical scale ('not at all', 'a little', 'half', 'very much', and 'completely'). This study identified a difference in emotion recognition between those with an AUD and controls but not for rating of emotion intensity. Whilst a study by Salloum et al. (2007) used only 5 emotions (Happy, Fear, Anger Sad and Disgust) made up of 2 intensity levels (low = 30% of the maximum emotional intensity and high = 70% of the maximum intensity), presenting 120 of each intensity level for only 2 seconds on a computer screen with accuracy and latency of response being analysed. The results found no behavioural difference between those with an AUD and healthy controls in their ability to recognize high and low intensity emotions, however ERP measurements indicated lower brain activation amongst AUD participants across all emotions and this difference was greatest for the negative emotions. Another study using electrophysiological measurements (Lannoy, D'Hondt, et al., 2018) compared the behavioural performance and brain activity of binge drinkers, moderate drinkers and non-drinkers who identified two emotions (Happy and Angry) either by face or voice. There was little difference behaviourally however, there were significant cerebral changes in the BD particularly related to the processing of Anger with delayed processing at the frontal site compared with medium drinkers and non-drinkers. The current research also found little behavioural difference in emotion recognition between HBD and LBD, however, there were differences in how they looked at faces for processing indicating possible neurological change governing the direction of attention. The occipital site picking up p3b potentials (these originate from the temporal-parietal activity related to attention and subsequent memory processing and using the neurotransmitter norepinephrine on the parietal pathway. See Polich,

(2007) for more detailed explanation) indicated that BD had a greater amplitude when processing incongruent trials of Anger than medium drinkers but not non-drinkers. The greater electrophysiological activity in BD during the incongruent trials suggests a compensatory strategy that requires more resources for task completion (Lannoy, D'Hondt, et al., 2018). These findings suggest that although there is no behavioural difference, there is nonetheless an impact on the brain and emotion processing.

The current study also examined the latency of response for the different emotions. Previous research has identified that BD's have difficulty in comparison to controls, in processing emotional stimuli (Maurage, Bestelmeyer, et al., 2013). Whilst some research suggests that this is a global difficulty (Lannoy, Dormal, et al., 2018) other research is more specific and has identified Fear and Sad as the emotions which are impacted (Lannoy et al., 2019). It is of note that under conditions of acute alcohol consumption, Fear and Sad are also the emotions impaired whilst participants are unaware of their difficulties (Honan et al., 2018). That this deficit is identified in BD when not under the influence of alcohol is significant. In the current study HBD took longer to respond to the emotion of Fear than LBD but there was no significant difference for the other emotions. This disruption to Fear is consistent with Lannoy et al., (2019) and slower reaction times to emotional stimuli are also found in AD research but at a broader level (Foisy et al., 2007) such that overall response times by those with an AD to emotional questions were slower than controls, whereas there was no difference in reaction times on a non-emotional task. This difference suggests it is indeed the emotional element of the task that gives rise to the slower reaction times, and it is not a more general slower motor reactivity (Foisy et al., 2007).

One possible explanation for the difference in the results of the current study compared to the Lannoy et al., (2019) study, where both Fear and Sad were disrupted, is the exposure duration of the stimuli. The current study presented the complex stimuli for only 200ms which captured bottom-up automatic processing whilst the Lannoy et al. (2019) presented the stimuli for 10s which taps later conscious top-down processing. That latency deficits have been identified at both the early and late stages of processing is a valuable new insight into the impact of BD and again highlights the impact of alcohol on the processing of Fear.

6.5.2 Top-down emotion recognition

In addition to the early and rapid identification of emotions the current study also predicted that HBDs would be less accurate than LBDs when processing both static and dynamic emotional faces presented for 3000ms. This hypothesis was upheld. In this instance there was a significant difference between the HBD and LBD in terms of the overall numbers of emotions correctly identified. This is consistent with Lannoy et al. (2018) which identified a global deficit, however, in the current study whilst there was a trend towards lower recognition amongst the HBD across emotions this was driven by a significant difference in Disgust. Disgust is commonly confused with Anger as both involve a narrowing of the brows forming a ‘v’ and a wrinkling of the forehead (Herman et al., 2020). However, in the current study Disgust was most commonly confused with Sad, not Anger although a bias towards Anger was identified in the rapid exposure of complex emotions. A differentiated response between those with an alcohol dependence and a control group to both Anger and Disgust was also identified by Townshend and Duka (2003). It was suggested that with mixed emotions where there was ambiguity in the dominant emotion, biases prevailed. If this held true in the current study, then early processing produced a bias towards threat related emotions whilst later processing suggests a bias away from threat. This progression through early and late processing may contribute a partial explanation for the heterogeneity of results in BD research identified to date.

That alcohol dependence impacts the recognition of Anger and Disgust was also highlighted in a meta-analytic review (Bora & Zorlu, 2017) which identified Anger and Disgust as experiencing the most frequent disruption across studies. Further Freeman et al., (2018), expanded this clarifying that those with an AUD not only confused the similar expressions of Anger and Disgust but they also attributed hostile intentions to non-threatening expressions such as Sad and Surprise. That this trend is also evident in the HBD in the current study is interesting and suggests that the orbitofrontal cortex (OFC), which is essential for the recognition of Disgust, Anger and Fear (Adolphs, 2002), is impacted by binge drinking.

The OFC is necessary for evaluating a stimulus for an appropriate goal requiring action which in turn produces emotions and behaviours to achieve that goal (Rolls & Grabenhorst, 2008). When not functioning at its best the OFC can produce erroneous and inappropriate responses which negatively impact interpersonal relationships. It is of concern therefore that, amongst those with an AD, there is evidence that impaired Anger and Disgust recognition do not improve following abstinence (Kornreich et al., 2001). Furthermore, those with an AD, even when abstinent, continue to experience interpersonal difficulties and are unaware of their deficits in emotion recognition (Kornreich et al., 2002). This could suggest that BD are at risk of deteriorating emotion recognition impacting their interpersonal relationships potentially leading to more fractious encounters even whilst sober. Awareness of the impact of BD on emotion recognition, even though individual differences vary, would therefore be beneficial and the development of an emotion awareness intervention for young BD could help them avoid detrimental outcomes in their workplace and personal relationships. Emotion perception training has been shown to be effective even amongst a healthy population (Herpertz et al., 2016) and has also been shown to be enduring when tested two and six months post training (Herpertz et al., 2016; Nelis et al., 2009).

Whilst overall static images are rated as more intense than the dynamic images, the second hypothesis of a difference in intensity rating between the HBD and LBD was not upheld. There has been very little research to our knowledge comparing how high and low binge drinkers perceive the intensity of emotional facial expressions. Previous research in AUD has been equivocal with overestimation of Fear and Sad identified, a heightened response to negative emotions in particular Anger, with those with an AUD awarding higher intensity ratings than the control groups (Maurage et al., 2009) whilst other research has not identified any behavioural difference in intensity ratings (Salloum et al., 2007). This suggests that perception of emotion intensity is not impacted at a behavioural level by a binge pattern of alcohol consumption.

6.5.3 Eye-movement results

The third hypothesis, that there would be a difference in how the HBD and LBD scanned images for information was upheld. Overall, the LBD tended to have longer visual scan path (VSP) than the HBD regardless of image type. There was a significant difference in the scan path for the dynamic images of Fear and Surprise with the HBD having a shorter scan path than the LBD for both emotions. Although a shorter scan path for HBD is not consistent with the findings of Study 1-Part 2, Chapter 5, the current study, Study 2, included a recognition and rating task thus increasing the cognitive load which may have impacted the efficiency of HBD. Although the scan path difference was only significant for dynamic images, these have a broad distributed activation area in the brain (Trautmann et al., 2009) which could be more susceptible to change due to binge drinking and may explain the difference in impact in comparison with static images. From a scanning strategy perspective, it has been proposed that increased length between fixations and therefore a longer scan path, is an adaptive strategy which suggests a vigilant style of scanning and this is particularly true for healthy participants in relation to threat related expressions (Green & Davidson, 2003). That the HBD were quicker to fixate on static Fear suggests a vigilance to threat, however, the shorter scan-path for Fear may reflect the dampening of the amygdala response to threat identified in fMRI studies on alcohol consumption (Gorka et al., 2013; Sripada et al., 2011) amongst binge drinkers (Stephens et al., 2005) and amongst those with an AUD (O'Daly et al., 2012).

The difference between HBD and LBD in number of fixations to the static and dynamic images is interesting. HBD have significantly more fixations to the mouth for dynamic Sad and spend significantly longer on the mouth for dynamic Anger than LBD. This is not the key diagnostic recognition area for the expressions of Anger and Sad and suggests an avoidance of the eye area for these negative expressions but only for the dynamic images. As dynamic images are more ecologically valid than static images this may be more representative of real-life reactions. This vigilance avoidance strategy has previously been identified in those with anxiety (Bar-Haim et al., 2007; Koster et al., 2005) and as those in the high binge group had lower state anxiety than the low binge group, it suggests the current result is not related to anxiety.

It could also be a reflection of the impact of BD on the amygdala which is responsible for directing gaze to the eyes as well as threat evaluation (Dadds et al., 2006; Gamer & Büchel, 2009) resulting is a lower threat evaluation and less direction of the gaze to the eyes. LBD had higher fixation count to the eye region across all emotions which is in keeping with normal viewing strategies (Calvo et al., 2018) with the exception of Surprise where HBD have more fixations to the eyes for the static Surprise images. Surprise is most similar in facial expressions to Fear and therefore more difficult to distinguish (Herman et al., 2020) which could have contributed to the need to return to the eye region for this expression. The initial difficulty with threat emotions and those easily confused with threat is supported by the longer initial fixation by HBD to Anger, Disgust and Surprise suggesting the gaze is held momentarily on the dynamic images while the expression unfolds before a saccade to another fixation point. Further research is required to further clarify these points.

The eye tracking study revealed an initial attention to Fear, with HBD being quicker than LBD to fixate on this emotion for static images but not for dynamic images. HBD did however spend longer on the first fixation for dynamic Anger, Disgust and Surprise than LBD. In contrast for the static images both HBD and LBD have similar durations for the first fixation except for Anger where HBD spend a shorter amount of time on this emotion. This could be a vigilance-avoidance strategy on the part of HBD. In addition, HBD spend longer on the non-diagnostic areas of the face than LBD. All these issues point to underlying difficulty in emotion evaluation for HBD in comparison with the LBD.

It is important to have a clear understanding of the impact of BD on this aspect of social cognition given the developmental stage, not just physically but socially for young adults amongst whom binge drinking is most prevalent. For young adults, binge drinking occurs at a time when the foundations for establishing a career path and role in society are laid and both of which are hampered by inadequate or difficult social interactions as evidenced by those with schizophrenia, traumatic brain injury or AUD (Brüne et al., 2009; Godfrey & Shum, 2000; Le Berre, 2019; Rupp et al., 2017). It has been established through a ten-year longitudinal study that binge drinking at high school and college is linked with college drop-out, poorer long-term relationships and poorer occupational advancement, along with a greater risk of alcohol use disorders (Jennison, 2004). Although a causal relationship is yet to be firmly established there is sufficient evidence from animal studies (Stephens et al., 2005) and human studies using fMRI (O'Daly et al., 2012; Sawyer et al., 2019; Sripada et al., 2011) demonstrating the negative impact of alcohol consumption and withdrawal on brain areas related to social cognition. That this negative impact would have long term consequences is not surprising. It does emphasise the importance of spreading awareness of the negative impact of BD on social cognition and developing interventions which include emotion training and awareness of the risk of perceiving negative intentions and responding inappropriately in ambiguous or neutral situations. Hostile interpretation training has been shown to be effective amongst those with an AUD (Cougle et al., 2017) and similar interventions should be considered and trialed amongst heavy binge drinkers.

6.5.3.1 Limitations

This study did have some limitations. The primary limitation was the small number of participants included in the eye tracking analysis. Eye tracking studies are sensitive to blinks and temporary loss of tracking data. In the current analysis where comparisons were made across emotions and image types only those participants with full recordings for all elements were included. A total sample size of 18 would be sufficient for a repeated measures ANOVA with an effect size of 0.3 and power of 0.95. Notwithstanding this, a larger and more balanced sample in terms of gender would be desirable to replicate the results and enable different analyses to identify whether scan path patterns could predict binge drinking patterns.

6.5.4 Conclusions

In conclusion HBD displayed a bias toward Anger in early recognition and by incorrectly attributing Anger when they were uncertain of the emotion. This bias was not present in the later processing stages of emotion recognition. HBD also required more time to respond to Fear than LBD. It is interesting that the LBD tended to be more accurate than HBD for the static images, but HBD performed just as well as LBD for the dynamic images. Notwithstanding the similar emotion recognition abilities of both groups there were differences in terms of visual scanning strategy. The HBD group employed a reduced scanning strategy, but this was limited to the static images, which was less effective than the LBD. There was also a differentiated response to both Anger and Fear. These results reinforce previous research which has identified a negative impact of binge drinking on emotion recognition and highlights the importance of trialing emotion training amongst this group to help improve long term outcomes.

Future research should further explore the impact of early and late processing of emotion recognition. It would also be beneficial to identify whether there were differences between HBD and LBD in how they looked at broader social interactions and linking responses with neural activity.

Chapter 7 Discussion and conclusions

This chapter firstly provides an overview of the research and this is followed by a summary of the findings from the studies presented in Chapters 4, 5 and 6 of this thesis. The significance of these findings for everyday life and the implications of the research in terms of theory and practice is discussed. Finally, an evaluation of the research limitations is presented as well as directions for future research.

7.1 Overview of the research

Whilst binge drinking is perceived as a serious concern for society, in comparison with alcohol use disorders, relatively little research has been conducted which focusses on social cognition. The aim of this thesis was to explore the impact of binge pattern alcohol consumption on social cognition with a particular focus on facial emotion recognition and how information is gathered from faces for processing. Specifically, the research had the following objectives:

- To identify whether there were differences at a behavioural level between high binge drinkers and low binge drinkers bottom-up and top-down facial emotion recognition.
- To identify if there were quantitative differences in how high binge drinkers and low binge drinkers viewed emotional images and faces.
- To identify if there were quantitative differences in how binge drinkers perceived and processed both static and dynamic emotional faces.

To address these objectives a quantitative method was used. The study used standardised questionnaires, along with both established procedures adhering to robust protocols and novel computer tasks, as well as eye-tracking to answer these questions. The initial research explored early emotion recognition using a standardised test with stimuli presented for 200ms (see Section 3.4.1.1 for details). As a standardised test was not available for integration with the eye-tracker, a novel test was created to investigate how participants rated emotional images on a scale of 1 to 10 for valence and arousal. The images were drawn from the IAPS standardised database (see Section 3.4.2 for details). The eye-tracker captured how participants scanned these emotional images, whilst the study also explored how participants passively viewed emotional faces, which were drawn from the GUR database (see Section 3.4.3.1 for details). The output measures for the eye-tracker included the length of the visual scan-path and various measures for fixations and visits.

Building on these results, and in order to achieve more ecologically valid results, the next phase of the research explored early emotion recognition again but added a new element exploring late emotion recognition, emotion intensity rating and eye-tracking of both static and dynamic images. Both static and dynamic images were drawn from the STOIC database, an established facial image database specifically designed to be used with an eye-tracker and were of the same size and presented for 3 seconds each to facilitate direct comparisons (see Section 6.3.2.2 for details). The static images were drawn from the peak of the expression to ensure clarity of expression.

7.2 Summary of the findings

The research presented in this thesis has generated interesting findings some of which support existing research and others, which are novel, contributing to the understanding of the impact of binge drinking on facial emotion recognition. These findings and their implications are discussed in the following sections.

A literature review set out the current knowledge on the impact of binge drinking and emotion recognition. The literature review identified a lack of consistency in conclusions in the previous literature, but it did suggest that whilst there was no behavioural difference between the HBD and LBD in the performance of simple emotion recognition tasks, more complex tasks did identify a difference between binge drinkers and controls and this could be attributed to specific emotions of Fear and Sad (see Chapter 2 for details).

The findings from the review suggested there was a need for further research in this area to clarify the inconsistency in results. The review led to the choice of complex emotion recognition tasks being used in Chapter 4, Study 1-Part 1. The review also highlighted the need for behavioural measures that would be objective yet have the sensitivity to identify differences in attention and recognition of emotional stimuli.

Study 1-Part 1: The impact of binge drinking in bottom-up complex emotion recognition, compared the scores of high and low binge drinkers on the measures of mood, impulsivity and alexithymia and there were no significant between binge drinking group differences. The lack of a difference in mood was unexpected. A previous study by Townshend &

Duka, (2005) found binge drinkers had a lower positive mood than non-binge drinkers. However, Study 1-Part 1 had a lower binge drinking score (HBD score 16+) than the Townshend and Duka study (HBD score of 24+). In addition, the mood measurement in Study 1-Part 1 (PANAS, Watson, Clark & Tellegen, 1988), was less complex than the one used by Townshend and Duka (2005), the POMS (McNair, Lorr & Doppleman, 1971) which measured 8 factors and two composite factors of mood facilitating a more fine-grained evaluation of mood. See Section 3.5.3 for details of questionnaire choice. The POMS questionnaire contained 72 items which would have put more strain on participants and that level of detail on mood was not deemed necessary in the current research as it was the broad strokes of mood, positive or negative, which have been shown to influence emotion recognition (Schmid & Schmid Mast, 2010). Similarly, the lack of difference between HBD and LBD for the impulsivity measure, the BIS-11 and alexithymia TAS-20 could have been due to the lower level of binge drinking in the sample (see Chapter 4, Table 4 for details of drinking and key factor scores). Study 1-Part 1, then tested the ability of high and low binge drinkers to recognise complex emotions presented rapidly (200ms). This captured automatic bottom-up facial emotion recognition abilities. The details of Study 1-Part 1 are set out in Chapter 4. Study 1-Part 1 did not identify any behavioural binge drinking group difference in the accuracy of emotion recognition. However, when bias and probability were considered, there was a bias towards Happy, which approached significance, with Happy being inaccurately attributed to other emotions by the HBD group. This bias may be explained by the social context in which most students drink. Most young people binge drink for social motives (Kuntsche et al., 2005) and this may have influenced the findings. Social information processing, social skills and positive affect have been associated with life satisfaction amongst students (Rezaei & Khosroshahi, 2018). In contrast a negative outlook hinders positive social interactions and has a negative impact on the ability to create wide social networks which are meaningful and supportive (Brissette et al., 2002). By maintaining a positive bias students may increase the possibility of achieving a higher life satisfaction which is one of the motivations of students to binge drink. Study 1-Part 1 also identified that HBD required a greater intensity to recognise the emotion of Fear. This is consistent with other research on binge drinking (Lannoy et al., 2019) and suggests that even at lower levels of binge drinking, such as in Study 1-Part 1, emotion recognition of Fear is impacted.

The next part of the research, *Study 1-Part 2: The impact of binge drinking on the visual scan path across emotional faces and images*, as detailed in Chapter 5, used the eye-tracker to identify how high and low binge drinkers scanned 4 different facial emotion expressions (Anger, Fear, Happy, Sad). This was conducted with passive viewing to reduce any cognitive load and the emotions were presented for 6,000ms. This element of the study found significant differences in the scanning strategy with HBD displaying a longer visual scan path (VSP) than the LBD. The difference in VSPs was significant for the negative emotions of Anger and Fear. This pattern suggests a vigilant strategy on the part of HBD displaying a pattern similar to healthy participants in research by

Loughland, Williams, and Gordon, (2002) although in Study 1-Part 2 the VSP of HBD is more pronounced than the LBD group. This pattern denotes an adaptive strategy consistent with the evolutionary theory of emotions. The longer scanning style is consistent with a vigilant pattern indicating a heightened autonomic response to threat while the fixations to key features of the threat expressions facilitate the evaluation of potential personal danger (Green & Davidson, 2003). That the HBD had an exaggerated pattern suggest some inefficiencies in the processing of the emotional stimuli or a hypervigilance towards threat. It is worth noting that the acute administration of alcohol to heavy social drinkers has the effect of attenuating the amygdala response to fearful and angry faces (Gilman et al., 2008; Sripada et al., 2011) and the amygdala may therefore suffer a long term impact from alcohol making the heavy binge drinker less efficient at identifying the threat emotions.

Testing faces alone makes it difficult to conclude whether any differences identified relate to emotions generally or specifically emotional faces. In order to address this, emotional images were drawn from the IAPS database and grouped as positive, negative and neutral images. Participants were asked to rate these for valence and arousal on a Self-Assessment Manikin (SAM) scale of 1-10 (see Chapter 4, Figure 8). There were no significant differences between the HBD and LBD groups for either ratings (see Chapter 4) or the scan pattern (see Chapter 5). This led to the conclusion that any differences between HBD and LBD for facial emotion recognition could not be generalised to all emotion processing but related to social cognitions and specifically to faces.

To explore this further a follow-up study, *Study 2: The impact of binge drinking on bottom-up emotion recognition, top-down emotion recognition and rating of emotion intensity and scan patterns on static and dynamic emotional faces*, was conducted to identify if heavier binge drinking had a similar or greater impact on bottom-up and top-down emotion recognition. The bottom-up complex emotion recognition task was conducted again. In addition, to provide a comparison with top-down processing, a novel test of simple emotion recognition and rating of intensity of facial emotions along with eye-tracking of facial emotion expressions was included. The eye-tracking data were expanded to include 6 emotions (Anger, Disgust, Fear, Happy, Neutral, Sad, Surprise), furthermore, both dynamic and static images were introduced to move towards more ecologically valid stimuli. Study 2 built on the results of the previous study and brought further insights to the impact of binge drinking at a heavier level whilst exploring the impact of binge drinking on both early and late processing of emotion recognition using more ecologically valid stimuli.

High binge drinkers displayed a bias towards Anger in automatic, bottom-up recognition by incorrectly attributing Anger to a range of other emotions. This is at odds with Study 1-Part 1, reported in Chapter 4, Section 4.7.3, but may be explained by the lower level of binge drinking reported in Part 1 where participants displayed a positive attribution bias towards the emotion of Happy. This may also be explained by the lower level of binge drinking which is associated with a social motive as opposed to high binge drinking which is associated with coping motivations (see

Kuntsche et al., 2005 for a review). The bias towards Anger reported in Study 1-Part 2, Chapter 5, Section 5.7.4.2, was not present in the later, top-down processing. This could be due to differences in the impact between early and late processing stages or the fact the images used for later processing were less complex and ambiguous as they only represented the peak of the expression whilst early processing employed complex emotions and had 15 levels of each expressed emotion. Although not fine grained enough to identify specific emotion deficits, consistent with other research (Lannoy et al., 2018), later processing did reveal HBD were generally less accurate than LBD for recognition of static facial expressions, even when presented at the height of the expression. In addition, whilst there was a similar trend for dynamic images, that is HBD were less accurate than LBD, this difference was not significant in the more ecologically valid context. This is consistent with research which indicates that dynamic facial expressions are more recognisable than static images (Ambadar et al., 2005; Chiller-Glaus et al., 2011; Trautmann et al., 2009). There are different systems or pathways used in deciphering static and dynamic images and perhaps binge drinking impacts the static pathway more than the dynamic.

The eye-tracking results of the emotional images in Study 2 revealed a shorter VSP for the HBD than the LBD generally and this was significant for dynamic Fear and Anger images but not static images. Although this was not consistent with the findings of Study 1-Part 2, reported in Chapter 5, Section 5.7.4.2, which involved passive viewing of emotional faces, it contributes to our understanding as Study 2 (Chapter 6) included two tasks, emotion recognition reported in Section 6.4.1.5 and intensity rating reported in Section 6.4.1.6, thereby increasing the complexity and cognitive load on participants. In addition, the peak of emotion was presented for a shorter period for dynamic images which unfolded over 3 seconds from Neutral to peak, whereas for the static images the peak of the emotion was presented for the full 3 seconds.

Taken together the results indicate that whilst HBD display similar emotion recognition abilities to LBD at a behavioural level, at a neurocognitive level and at higher levels of binge drinking, participants display more difficulty than LBD in processing the emotions when the cognitive tasks of naming the emotion and evaluating the intensity were introduced instead of passive viewing.

There were differences in how HBD and LBD scanned emotions, and this also varied depending on whether they were static or dynamic images. HBD were quicker to fixate on Fear for static images than LBD but not dynamic images which would have started with a Neutral expression. Furthermore, HBD spent longer on the first fixation to Anger, Disgust and Surprise for dynamic images in comparison to LBD. There would have been some ambiguity in the dynamic images as these images started as neutral and unfolded to the full expression over 3 seconds which may explain the longer duration for the first fixation while the emotion unfolded, and the ambiguity was resolved. Indeed overall, HBD had a different viewing strategy compared to LBD, with fewer visit counts to the eyes and more visit counts to the mouth which may have hampered their rapid and accurate recognition of emotions. In addition, HBD also had a longer visit duration to Anger dynamic images and this tended to be to the mouth region indicating an avoidance of the key diagnostic area of the eyes.

These longer fixations to the non-diagnostic face area differed from the first study that had passive viewing of the facial expressions and resulted in the binge drinkers devoting more attention to the key diagnostic areas. This finding supports the proposal that increased cognitive demands hampers efficient emotion recognition in HBD whereby increasing the complexity of the task brings to the surface more difficulties in binge drinkers than controls (Lannoy, Dormal, Brion, et al., 2018). In addition, when the emotion of Anger was displayed in static format the HBD spent significantly less time on the first fixation compared to LBD supporting the concept of an avoidance strategy with regards to this threat emotion (Cooper & Langton, 2006; Green, Williams, & Davidson, 2006).

7.3 Theoretical implications

Evolutionary theory of emotions as put forward by Darwin (1872) cited in Ekman (1982) p. 239, proposes an adaptive role for emotion recognition enabling survival in the environment and consequently even minor disruption of emotion recognition could have far reaching consequences. From the evolutionary perspective, the basic reactions that emotions facilitate are an adaptive response to primary survival issues such as avoiding danger, protecting the self and family and establishing societal roles (Keltner et al., 2019) which emphasise the impact even a minor disruption can have long term. Byron, (2008) states that inner feelings are rarely private, and they subconsciously leak from the body and are reflected on the face, the voice, body posture as well as the choice of words. Reading the emotions of others provides pointers and information about others views, intentions and the environment which in turn informs how best to react and respond (Fiske, 1992). A more accurate interpretation of emotional expressions leads to a more satisfying and mutually beneficial social interaction which widens and strengthens social networks and this is valid in both social and work life (Byron, 2008; Van Kleef, 2010). Whilst binge drinking in the short-term may enhance social interactions, the current research suggests there are negative consequences long-term by hindering the adaptive response and leading to negative and erroneous interpretations of others' emotions, which in turn impacts perceptions of others' intentions.

In addition, understanding the emotions of others and viewing how others react to certain situations informs our own perceptions of group norms and moral judgements (Heerdink et al., 2019). This links with Social Identity Theory and social comparisons (Ellemers et al., 2002; Tajfel & Turner, 1979) where inappropriate responses may result in rejection by the group whilst being perceived as part of the group results in more acceptance and generous treatment by the group (Jenkins, 2014; Turner et al., 1979). Social competence therefore is essential to social progression and feelings of wellbeing (Brackett et al., 2006; Denham et al., 2003; McKown et al., 2009). These links with evolutionary and social theory emphasise the detrimental impact even relatively minor difficulties can create for young people at a key developmental and transitionary period in their lives. The current research is an important step in identifying how binge drinking can hinder social competence and social acceptance.

7.4 Contribution to knowledge

This is the first study, to our knowledge, that has tested the impact of binge drinking on the recognition of both static and dynamic emotion images. It is also the first study to use eye-tracking to compare how both HBD and LBD view emotional stimuli and whether there are any differences in viewing strategy. The most important finding and contribution to knowledge that this research has made is to provide the first evidence of distinct visuo-cognitive processing strategies for facial emotion expressions in HBD relative to LBD. This research suggests that binge drinking may have an impact on the processing of facial emotion expressions, and this could be due to the influence of alcohol on the amygdala reducing the ability to direct attention to the eyes. Research in the area of binge drinking and emotion recognition is limited and at the early stages as yet, but there is some evidence of an impaired ability to recognise the threat emotions of Fear and Sad (Lannoy et al., 2019; Leganes-Fonteneau, Pi-Ruano, & Tejero, 2020). The current research has extended this finding and has potentially identified the mechanism through which this impairment has occurred by identifying the different patterns, displayed by binge drinkers, of foveal attention to key facial areas of interest. The research suggested that at lower levels of binge drinking and with simple viewing tasks there is little impact on recognition and normal viewing strategies, with attention directed appropriately to the eyes and mouth for accurate emotion recognition, and these strategies are heightened, particularly for the threat emotions of Anger and Fear. However, the impact of binge drinking changes with higher levels of binge drinking and more complex tasks. The vigilance for Anger was supported by evidence from the bottom-up, rapid exposure to complex emotions. The addition of a cognitive task to the longer exposure of emotions identified an overall deficit in emotion recognition that was driven by a significant disruption in the recognition of Disgust. The mechanism for disruption to recognition appears to be in the visuo-cognitive pathway and directing attention to the appropriate face areas to facilitate rapid and accurate emotion recognition. Whilst acknowledging that there is a complex distributional network involved in emotion recognition which is not fully understood, in simplified terms, direction of gaze to the eye region is co-ordinated in the amygdala (Gamer & Büchel, 2009; Kennedy & Adolphs, 2010), which is a brain area impacted by binge drinking (Stephens et al., 2005). The focus on the appropriate face area is crucial to emotion recognition (Calvo et al., 2018; Dadds et al., 2006; Kennedy & Adolphs, 2010) and the current research suggests that this has been negatively impacted amongst high binge drinkers. As identified in Study 2 reported in Chapter 6, HBD focus less attention to the key diagnostic area of the eyes which could be driven by the impact of binge drinking on the amygdala.

7.5 Practical implications

The practical implications of the current research suggest that people who binge drink can have trouble in everyday social interactions particularly when under greater cognitive load resulting in suboptimal performance in emotion recognition. At the extreme, the incorrect interpretation of ambiguous emotions as negative or threatening can lead to aggression and a hostile response (Taylor & Jose, 2014). This is particularly harmful and dangerous in domestic abuse situations where misattribution of negative emotions leads to heightened aggression and physical violence (Clements & Schumacher, 2010; Marshall & Holtzworth-Munroe, 2010). In addition the reduced sensitivity to the recognition of fear, which may serve as a cue to inhibit aggression, means this signal is not received and the aggression escalates (Marshall & Holtzworth-Munroe, 2010). Although specific research is scarce on date rape and emotion recognition in perpetrators, it is plausible that a similar deficit in the recognition of the social cue of fear would also fail to inhibit the escalation to aggression in this scenario. The UN have a day, 25th November, to highlight the elimination of violence against women and since the murder of Sarah Everard in March 2021 a further 81 women had reportedly been murdered in the UK by October 2021 (Ingala-Smith, 2021) so violence and aggression is widespread. The latest figures from the Crime Survey for England and Wales (2021) record 53% of violence against the person for female victims was domestic abuse related compared with 26% for male victims. There are multiple psychosocial factors and events that can lead to such violence and whilst acknowledging the disproportionate level of relationship violence against women and girls, boys and men are also the victims of partner violence (Crime Survey for England and Wales, 2021). It is important therefore to understand the contribution that binge drinking can make to a relationship and situation, even when individuals are not directly under the influence of alcohol.

These situations are at the extreme and not all difficulties in emotion recognition lead to aggression or violence. It may be that those experiencing emotion recognition difficulties feel confused or uncomfortable in their interpretations of the facial expressions of others which can lead them to seek to avoid or withdraw from uncomfortable social situations. To mitigate those feelings binge drinkers may look to other means such as alcohol or drugs to cope with awkward situations thereby perpetuating alcohol consumption and aggravating the impact on social cognition.

In support of this hypothesis, a cohort study of 17 year olds conducted in the UK (Stapinski et al., 2016) found that 26% of young adults consumed alcohol at least once a week if not more often with only 8% who had not consumed any alcohol in the previous 12 months. Nearly two thirds of young people who consume alcohol have some social motivation, be that to enhance positive effect or avoid negative affect (Kuntsche et al., 2005; Lammers et al., 2013). Motivations for regular alcohol consumption therefore are expressed in terms of a desire to be more confident in social situations and/or to cope with low mood. Poor or inaccurate emotion recognition can ultimately add to feelings of lack of confidence, alienation and low mood. As most young people consume alcohol before they are legally supposed to, any intervention aimed at delaying the onset of alcohol consumption targeted at university students is already too late and therefore understanding the motivations the drive secondary school children to drink is a more effective strategy (Coffman et al., 2007).

It has been suggested that understanding the motivations and group breakdown by class, inherited predisposition and environment is important for addressing risky alcohol consumption amongst young people (Coffman et al., 2007; Mackie et al., 2011; Stapinski et al., 2016). Whilst it is important to tailor any intervention to target specific motivations and groups, it is also important to address the possible impact of binge drinking on normal functioning in order to improve the outcome for all individuals. Any intervention which could help individuals who binge drink, understand and redress potential cognitive deficits is valuable.

The current research contributes to this endeavour by adding knowledge about the possible impact of binge drinking on emotion recognition. The role of emotion recognition in guiding and facilitating how people interact with the environment is critical for individual development and progress (Frith, 2008, 2012). Difficulties with social interactions, along with problems understanding the intentions of others and forming good social networks and support groups can lead to a lack of confidence, poor career progression, even isolation and maladaptive coping strategies which in turn can result in the maintenance of risky drinking behaviours and an alcohol use disorder (Addolorato et al., 2018; Rupp et al., 2017). Any intervention should not only adopt a targeted approach to motivations but also aim to address emotion recognition to improve outcomes and help in the prevention of this potential downward spiral. The Micro-expression training tool (METT) has proved to be effective in improving emotion recognition in people diagnosed with schizophrenia by directing more eye movements to the appropriate face areas of eye, nose and mouth (Russell et al., 2008) and would be one targeted type of intervention which could also be helpful for binge drinkers.

Individual training for emotion recognition could be effective, but the practicalities of targeting individuals for whom this is an issue, whether binge drinkers or not, would be time-consuming and costly. The Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT) was employed by Herpertz, Schütz, and Nezlek, (2016) amongst a healthy population, half of whom received group training on emotional intelligence to perceive the emotions of others, with the other half receiving business training. The study found an improved performance on the MSCEIT amongst the group who received the emotional training over those in the business training group, with positive results being maintained at the 6-month evaluation stage. This type of broader emotional intelligence training, which can benefit all recipients whether binge drinkers or not, may be an effective approach rather than trying to identify and treat individual binge drinkers (Herpertz et al., 2016). Emotional intelligence is associated with better student performance, less risky behaviour and better career success especially in roles involving interactions with others compared with those with lower emotional intelligence, whilst group training, which is more cost effective than individual training, has demonstrated improved emotion recognition and regulation abilities over baseline measures even at a 6 month follow-up (Herpertz et al., 2016; Nelis et al., 2009). For example, a programme such as the one deployed by Nelis et al. (2009), which also used group training, was based on guidelines produced after decades of research (Elias, 1997). The programme included: perception, appraisal, and expression of emotion; emotional facilitation of thinking; understanding and analysing emotions; reflective regulation of emotion, all of which would be beneficial for students regardless of whether they were binge drinkers or not. This type of training would address deficits in emotion recognition, that could exacerbate binge drinking, without the added difficulty of specifically identifying and targeting those individuals. Greater awareness of emotions in others and improved social skills could make the difference between problematic drinking and help in emotion regulation and control. This could, therefore, be one useful approach to explore in future research.

7.6 Limitations of the current research

As with all research the current study has several limitations. A causal relationship cannot be established between binge drinking and emotion recognition in these cross-sectional studies, as the deficits in emotion recognition and differences in scanning patterns identified may have already existed in the HBD and may have influenced their drinking pattern. Nonetheless research has shown that it is plausible to conclude that BD can lead to deficits in emotion recognition due to the cerebral changes brought about by alcohol (O’Daly et al., 2012; Sawyer et al., 2019; Stephens et al., 2005).

The sample size was small which limited the type of analysis that could be conducted and some of the ability to generalise the results. Notwithstanding this the sample was adequate for the mixed ANOVA and the results were largely consistent with other research and expectations. Nonetheless further research should be conducted to confirm these findings.

Participants were incentivised with either a payment or SONA points to facilitate their own future research. Due to the small numbers of those receiving payment it was not possible to check whether these groups behaved differently due to their different motivations.

A median split of the AUQ measure was used to group the high and the low binge drinkers. This meant that the first study had a low median binge score relative to other studies e.g. Townshend et al. (2014) which had a median BS of 28. Whilst this approach hampers the ability to compare the results with other studies the decision was taken to proceed with this approach as it had previously been used in binge drinking research (Townshend & Duka, 2005; Townshend et al., 2014) and helped to identify whether any impairments occurred at lower levels of the binge score. Using this grouping method has also contributed to the support for the continuum hypothesis of binge drinking, by finding that higher levels of binge score, and therefore greater intoxication levels, resulted in greater impairment than lower binge scores.

Other factors can also influence emotion recognition and it would be useful to exclude as many as possible from the outset. The quality of sleep has been shown to influence perception of faces with those suffering from insomnia displaying an attentional bias towards tired faces in particular the eye region (Akram et al., 2018). The current study recorded satisfaction with sleep which was not related to emotion recognition however a more precise question might be more revealing in this context. Whilst the current research did ask for use of medication, and other drug use a more precise record of which substances would enable more detailed analysis as it may be the combination of specific drugs and alcohol that has a particular impact on perception and emotion recognition (Fernández-Serrano et al., 2010). There are also developmental issues, psychological health and personality traits which are either genetic or the result of adverse childhood experiences which can impact emotion perception (Buckner et al., 2021; Tognin et al., 2020) and future research should assess as many as possible to improve the precision of the research. Whilst participants were asked to abstain from consuming alcohol for a minimum of 12 hours before the study an objective measure of blood alcohol levels would be beneficial to include in future research.

The sex imbalance, with more females in comparison to males in the research population is not ideal as there is some evidence that women have a small advantage over men in recognising negative emotions (Thompson, & Voyer, 2018), however, there is also evidence that there is no advantage for females in young adulthood for emotion recognition or scanning strategy (Abbruzzese et al., 2019). Nonetheless, it was possible to include statistical tests to control for any differences. Notwithstanding this, given the contradictory findings in gender research and emotion recognition, future studies should aim for a balance as much as possible.

The current research used recognised paradigms and tests to explore emotion recognition. However, for the eye-tracking element a new test was created in Tobii studio to run on the eye-tracker to monitor the eye gaze. The eye tracking tests were constructed using established standardised stimuli to ensure that the images were accurate representations of the emotions and appropriate for the task objective. The current study used both static and dynamic images in order to move towards more ecologically valid stimuli with a better representation of real-world impact. Whilst there may be a question over the validity of novel tests, in this instance the use of standardised stimuli means that the tests are replicable and do measure what they are intended to measure and are therefore reliable. The introduction of novel tests, such as eye-tracking the emotion recognition tasks, is a positive step to progress research on the impact of binge drinking on social cognition. It helps to elucidate the temporal shift of attention over the face and identify potential mechanisms leading to a deficit in emotion recognition which could not be identified by other means.

The test for emotion recognition accuracy for the static and dynamic images used just two images for each emotion by stimulus type. This resulted in a near ceiling effect for emotion recognition and whilst differences were identified it would be more robust for future studies to include more images and thereby uncover more variability in the data where that exists.

In the original format this research also included a measurement of physiological responses to the emotional images. Research has identified physiological responses to emotional images, and these are more pronounced for more emotionally valenced images (Fernández et al., 2012; Ohira et al., 2006). Physiological responses such as heart rate and skin conductance levels thus provide objective measures that can be triangulated with the behavioural responses and the eye-tracking data. Unfortunately, due to a catastrophic problem with the software outside of the researcher's control, collection of this data had to be discontinued. Future research could reinstate this measurement which would add insight to the output of the eye-tracker and behavioural measures.

As has already been acknowledged, social interaction in the real world is much more complex than mere facial expressions and employs context, tone, words, gestures as well as facial expressions to communicate intent and needs. This is an area that is difficult to explore and to our knowledge has not been researched amongst the binge drinking population. Exploring social interactions is therefore the next step in understanding the wider impact of binge drinking on social cognition and is outlined in the Further Research section of this report.

7.7 Further Research

The current research has indicated no behavioural difference between low and high binge drinkers in emotion recognition when it comes to accuracy for bottom-up processing. However, higher levels of binge drinking did identify a bias towards Anger in this bottom-up emotion recognition task. This could have a significant impact on social interactions with ambiguous emotions being perceived as negative leading to the possibility of an inappropriate response. Viewing emotions with the addition of a task to identify and judge the intensity of the displayed emotion, therefore measuring top-down processing, led to less accuracy for the static images but this was not significant for the dynamic images which were more ecologically valid. The eye tracking results differed between the HBD and the LBD with the greater difference being for dynamic images of Anger and Fear. This is interesting as it would be expected that a more ecologically valid situation would result in less of a difference between HBD and LBD as recognition was similar for dynamic images but not static images. This anomaly needs to be further explored and clarified.

A causal relationship cannot be established between binge drinking and emotion recognition. It would be useful therefore to conduct a similar study with baseline measurements of emotion recognition at the start of university prior to the onset of binge drinking, with follow-up measures at 6 months and 12 months. This research would help to clarify the relationship between emotion recognition and binge drinking.

Another area for further research would be to understand the extent to which context and other cues to emotional status and intent mitigate deficits in emotion recognition. Electroencephalogram (EEG) research has been used to identify the strength of brain wave activity when looking at positive and negative emotions and can contribute to understanding brain activity when looking at different emotions as expressed in movie clips (Costa, Rognoni, & Galati, 2006; Nie, Wang, Shi, & Lu, 2011; Vernooij et al., 2007). In order to progress research of binge drinkers to include responses and interpretation of real-world social interaction, EEG could be combined with eye-tracking to monitor both the brain response, the eye-movement and behavioural response to various everyday scenarios played out in video clips providing words, gestures, expression and context. Such a study would provide an insight not just on emotion recognition but include comprehension of intentions and responses to everyday emotional situations. The Awareness of Social Inference Test (TASIT) (McDonald et al., 2006) is used to assess social perception and has been validated in the UK amongst young adults (Burdon et al., 2016). The TASIT could be used in this further research. It includes a series of video clips expressing specified emotions and a series of closed questions to identify correct interpretation of the interaction. This study would clarify a more nuanced response identifying the focus of attention, eye-gaze and brain activation to complex interactions similar to everyday encounters.

7.8 Concluding remarks

The current research makes a positive contribution to the existing literature by confirming there is little behavioural difference in bottom-up emotion recognition between high binge drinkers and low binge drinkers however there does appear to be an impact at a neuro-cognitive level. This study identified a positive bias in bottom-up emotion recognition at lower levels of binge drinking whilst at higher levels of binge drinking a negative bias emerged. Impaired emotion recognition amongst HBD was identified with greater cognitive load and top-down processing and this is consistent with other research. This research also identified differences in how high and low binge drinkers scan static and dynamic images as well as viewing strategies used for emotion recognition. Taken together these findings suggest a less efficient viewing strategy which becomes more pronounced resulting in impaired recognition with greater cognitive load and higher levels of binge drinking. The mechanism implicated in this is the amygdala which is instrumental in directing gaze to the eyes and is also impacted by alcohol. A longitudinal study on emotion recognition should be carried out with a cohort of students in their first semester at university, with a follow up after 6 and 12 months which would help to clarify the impact of binge drinking behaviour on emotion recognition over time and any pre-existing deficits.

The current study has raised the question of whether deficits in emotion recognition of facial expressions translate into broader deficits and misinterpretation when more clues are available like most interactions in everyday life. Further research therefore should monitor brain activity and eye-tracking whilst looking at images like those in the current study but also includes elements of movie clips with everyday emotional interactions and questions to measure accurate interpretation of the interactions.

Abrasive social interactions due to an erroneous and negative interpretation of expressions can have a serious detrimental effect on individuals and lead to the desire to avoid similar situations. Efforts to cope with these types of situations can also lead to increased drinking and result in alcohol use disorders although this trajectory is not inevitable. More seriously, the erroneous interpretation of ambiguous emotions as negative, the misinterpretation of Fear, or not recognising Fear at lower intensities could exacerbate situations where there is a risk of domestic violence or even date rape. As binge drinkers are unlikely to be aware of an impact of their drinking on emotion recognition a short course on emotional intelligence training, as part of first or second year college or sixth form curriculum, building skills for life would be beneficial. These have been shown to be effective amongst healthy participants and a broad target audience would benefit both HBD and LBD as well as non-drinkers. This would also be a beneficial area for future longitudinal research.

REFERENCES

Abbruzzese, L., Magnani, N., Robertson, I. H., & Mancuso, M. (2019). Age and gender differences in emotion recognition. *Frontiers in Psychology*, *10*(OCT). https://doi.org/10.3389/fpsyg.2019.02371

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

Addolorato, G., Vassallo, G. A., Antonelli, G., Antonelli, M., Tarli, C., Mirijello, A., Agyei-Nkansah, A., Mentella, M. C., Ferrarese, D., Mora, V., Barbàra, M., Maida, M. F., Cammà, C., Gasbarrini, A., Bruno, G., D'Angelo, G., Del Zompo, F., Di Rienzo, T., Feliciani, D., … Sestito, L. (2018). Binge Drinking among adolescents is related to the development of Alcohol Use Disorders: results from a Cross-Sectional Study. *Scientific Reports*, *8*(1), 1–9. https://doi.org/10.1038/s41598-018-29311-y

Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology*, *11*(2), 231–239. https://doi.org/10.1016/S0959-4388(00)00202-6

Adolphs, R. (2002a). Neural systems for recognizing emotion. *Current Opinion in Neurobiology*, *12*(2), 169–177. https://doi.org/10.1016/S0959-4388(02)00301-X

Adolphs, R. (2002b). Recognizing emotion from facial expressions: psychological and neurological mechanisms. *Behavioral and Cognitive Neuroscience Reviews*, *1*(1), 21–62. https://doi.org/10.1177/1534582302001001003

Adolphs, R., & Anderson, D. (2013). Social and emotional neuroscience. *Current Opinion in Neurobiology*, *23*(3), 291–293. https://doi.org/10.1016/j.conb.2013.04.011

Adolphs, R., Gosselin, F., Buchanan, T., Tranel, D., Schyns, P., & Damasio, A. (2005). A mechanism for impaired fear recognition after amygdala damage. *Nature*, *433*(7021), 68–72. https://doi.org/10.1038/nature03051

Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. (1994). Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala. *Nature*, *372*(6507), 669–672. https://doi.org/10.1038/372669a0

Akram, U., Robson, A., & Ypsilanti, A. (2018). Sleep-related attentional bias for faces depicting tiredness in insomnia: Evidence from an eye-tracking study. *Journal of Clinical Sleep Medicine*, *14*(6), 959–965. https://doi.org/10.5664/jcsm.7160

Al-Shawaf, L., Conroy-Beam, D., Asao, K., & Buss, D. M. (2014). Human emotions: An evolutionary psychological perspective. *Emotion Review*, *8*(2), 173–186. https://doi.org/10.1177/1754073914565518

Aloi, J., Blair, K. S., Crum, K. I., Meffert, H., White, S. F., Tyler, P. M., Thornton, L. C., Mobley, A. M., Killanin, A. D., Adams, K. O., Filbey, F., Pope, K., & Blair, R. J. R. (2018). Adolescents show differential dysfunctions related to Alcohol and Cannabis Use Disorder severity in emotion and executive attention neuro-circuitries. *NeuroImage Clinical*, *19*, 782–792. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=medl&AN=29988822

Ambadar, Z., Schooler, J. W., & Cohn, J. F. (2005). *Deciphering the Enigmatic Face The Importance of Facial Dynamics in Interpreting Subtle Facial Expressions*. http://www.pitt.edu/$ambadar/stimuli.htm.

Anderson, N. C., Anderson, F., Kingstone, A., & Bischof, W. F. (2014). A comparison of scanpath comparison methods. *Behavior Research Methods*, *47*(4), 1377–1392. https://doi.org/10.3758/s13428-014-0550-3

Armstrong, T., & Olatunji, B. O. (2012). Eye tracking of attention in the affective disorders: A meta-analytic review and synthesis. In *Clinical Psychology Review* (Vol. 32, Issue 8, pp. 704–723). https://doi.org/10.1016/j.cpr.2012.09.004

Asthana, H. S., Mandal, M. K., Khurana, H., & Haque-Nizamie, S. (1998). Visuospatial and affect recognition deficit in depression. *Journal of Affective Disorders*, *48*(1), 57–62. https://doi.org/10.1016/S0165-0327(97)00140-7

Attwood, A. S., Ataya, A. F., Benton, C. P., Penton-Voak, I. S., Munafo, M. R., Munaf, M. R., & Munafò, M. R. (2009). Effects of alcohol consumption and alcohol expectancy on the categorisation of perceptual cues of emotional expression. *Psychopharmacology*, *204*(2), 327–334. https://doi.org/10.1007/s00213-009-1463-1

Attwood, A. S., Easey, K. E., Dalili, M. N., Skinner, A. L., Woods, A., Crick, L., Ilett, E., Penton-Voak, I. S., Munafò, M. R., & Munaf, M. R. (2017). State anxiety and emotional face recognition in healthy volunteers. *Royal Society Open Science*, *4*(5), 160855. https://doi.org/10.1098/rsos.160855

Attwood, A. S., & Munafo, M. R. (2014). Effects of acute alcohol consumption and processing of emotion in faces: Implications for understanding alcohol-related aggression. *Journal of Psychopharmacology*, *28*(8), 719–732. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med10&AN=24920135

Attwood, A. S., Ohlson, C., Benton, C. P., Penton-Voak, I. S., & Munafo, M. R. (2009). Effects of acute alcohol consumption on processing of perceptual cues of emotional expression. *Journal of Psychopharmacology*, *23*(1), 23–30.

Babbage, D. R., Yim, J., Zupan, B., Neumann, D., Tomita, M. R., & Willer, B. (2011). Meta-Analysis of Facial Affect Recognition Difficulties After Traumatic Brain Injury. *Neuropsychology*, *25*(3), 277–285. https://doi.org/10.1037/a0021908

Bagby, R. M., Parker, J. D. A., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale—I. Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research*, *38*(1), 23–32.

Bagby, R. M., Taylor, G. J., & Parker, J. D. A. (1994). The twenty-item Toronto Alexithymia Scale—II. Convergent, discriminant, and concurrent validity. *Journal of Psychosomatic Research*, *38*(1), 33–40.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & Van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*(1), 1–24. https://doi.org/10.1037/0033-2909.133.1.1

Bargary, G., Bosten, J. M., Goodbourn, P. T., Lawrance-Owen, A. J., Hogg, R. E., & Mollon, J. D. (2017). Individual differences in human eye movements: An oculomotor signature? *Vision Research*. https://doi.org/10.1016/j.visres.2017.03.001

Baron-Cohen, S., Wheelwright, S., & Jolliffe, T. (1997). Is there a “language of the eyes”? Evidence from normal adults, and adults with autism or Asperger Syndrome. *Visual Cognition*, *4*(3), 311–331. https://doi.org/10.1080/713756761

Barrett, L. F., & Wager, T. D. (2006). The Structure of Emotion. *Current Directions in Psychological Science*, *15*(2), 79–83. https://doi.org/10.1111/j.0963-7214.2006.00411.x

Baudouin, J. Y., Martin, F., Tiberghien, G., Verlut, I., & Franck, N. (2002). Selective attention to facial emotion and identity in schizophrenia. *Neuropsychologia*, *40*(5), 503–511. https://doi.org/10.1016/S0028-3932(01)00114-2

Baumeister, R. F., & Leary, M. R. (1995). The Need to Belong: Desire for Interpersonal Attachments as a Fundamental Human Motivation. *Psychological Bulletin*, *117*(3), 497–529. https://doi.org/10.1037/0033-2909.117.3.497

Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. F. (1996). Comparison of Beck depression inventories -IA and -II in psychiatric outpatients. *Journal of Personality Assessment*, *67*(3), 588–597. https://doi.org/10.1207/s15327752jpa6703_13

Bernardin, F., Maheut-Bosser, A., & Paille, F. (2014). Cognitive impairments in alcohol-dependent subjects. *Frontiers in Psychiatry*, *5*.

Bestelmeyer, P. E. G., Tatler, B. W., Phillips, L. H., Fraser, G., Benson, P. J., & St.Clair, D. (2006). Global visual scanning abnormalities in schizophrenia and bipolar disorder. *Schizophrenia Research*, *87*(1–3), 212–222. https://doi.org/10.1016/j.schres.2006.06.015

Black, C. (2016). *Employment-Outcomes-of-Drug-or-Alcohol-Addiction-and-Obesity-Print* (Issue December). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/573892/employment-outcomes-of-drug-or-alcohol-addiction-and-obesity-print.PDF

Blair, M. R., Watson, M. R., Walshe, R. C., & Maj, F. (2009). Extremely Selective Attention: Eye-Tracking Studies of the Dynamic Allocation of Attention to Stimulus Features in Categorization. *Journal of Experimental Psychology: Learning Memory and Cognition*, *35*(5), 1196–1206. https://doi.org/10.1037/a0016272

Blaney, P. H. (1986). Affect and memory: a review. *Psychological Bulletin*, *99*(2), 229–246.

Bonomo, Y. A., Bowes, G., Coffey, C., Carlin, J. B., & Patton, G. C. (2004). Teenage drinking and the onset of alcohol dependence: A cohort study over seven years. *Addiction*, *99*(12), 1520–1528. https://doi.org/10.1111/j.1360-0443.2004.00846.x

Bora, E., & Zorlu, N. (2017). Social cognition in alcohol use disorder: a meta-analysis. *Addiction*, *112*(1), 40–48. https://doi.org/10.1111/add.13486

Bouhuys, A. L., Bloem, G. M., & Groothuis, T. G. G. (1995). Induction of depressed and elated mood by music influences the perception of facial emotional expressions in healthy subjects. *Journal of Affective Disorders*, *33*(4), 215–226. https://doi.org/10.1016/0165-0327(94)00092-N

Bower, G. H. (1981). Mood and memory. *American Psychologist*, *36*(2), 129–148. https://doi.org/10.1016/0005-7967(87)90052-0

Bower, G. H., Gilligan, S. G., & Monteiro, K. P. (1981). Selectivity of learning caused by affective states. *Journal of Experimental Psychology: General*, *110*(4), 451–473. https://doi.org/10.1037/0096-3445.110.4.451

Brackett, M. A., Rivers, S. E., Shiffman, S., Lerner, N., & Salovey, P. (2006). Relating emotional abilities to social functioning: A comparison of self-report and performance measures of emotional intelligence. *Journal of Personality and Social Psychology*, *91*(4), 780–795. https://doi.org/10.1037/0022-3514.91.4.780

Bradley, M., & Lang, P. J. (1994). Self-Assessment Manikin (SAM). *J.Behav.Ther. & Exp. Psychiat.*, *25*(1), 49–59.

Bradley, M. M., & Lang, P. J. (2007). *Bradley, M. M. & Lang, P. J. (2007). The International Affective Picture System (IAPS) in the study of emotion and attention. In J. A. Coan and J. J. B. Allen (Eds.),*. 29–46.

Brissette, I., Scheier, M. F., & Carver, C. S. (2002). The role of optimism in social network development, coping, and psychological adjustment during a life transition. *Journal of Personality and Social Psychology*, *82*(1), 102–111. https://doi.org/10.1037/0022-3514.82.1.102

Britton, J. C., Taylor, S. F., Sudheimer, K. D., & Liberzon, I. (2006). Facial expressions and complex IAPS pictures: Common and differential networks. *NeuroImage*, *31*(2), 906–919. https://doi.org/10.1016/j.neuroimage.2005.12.050

Brooks, S. J., Savov, V., Allzén, E., Benedict, C., Fredriksson, R., & Schiöth, H. B. (2012). Exposure to subliminal arousing stimuli induces robust activation in the amygdala, hippocampus, anterior cingulate, insular cortex and primary visual cortex: A systematic meta-analysis of fMRI studies. *NeuroImage*, *59*(3), 2962–2973. https://doi.org/10.1016/j.neuroimage.2011.09.077

Bruce, V. (1982). Changing faces: Visual and non-visual coding processes in face recognition. *British Journal of Psychology*, *73*, 105–116. https://doi.org/10.1111/j.2044-8295.1982.tb01795.x

Brumback, T., Cao, D., & King, A. (2007). Effects of alcohol on psychomotor performance and perceived impairment in heavy binge social drinkers. *Drug and Alcohol Dependence*, *91*(1), 10–17. https://doi.org/10.1016/j.drugalcdep.2007.04.013

Brüne, M., Abdel-Hamid, M., Sonntag, C., Lehmkämper, C., & Langdon, R. (2009). Linking social cognition with social interaction: Non-verbal expressivity, social competence and “mentalising” in patients with schizophrenia spectrum disorders. *Behavioral and Brain Functions*, *5*, 1–10. https://doi.org/10.1186/1744-9081-5-6

Bublatzky, F., Gerdes, A. B. M., White, A. J., Riemer, M., & Alpers, G. W. (2014). Social and emotional relevance in face processing: Happy faces of future interaction partners enhance the late positive potential. *Frontiers in Human Neuroscience*, *8*(JULY), 1–10. https://doi.org/10.3389/fnhum.2014.00493

Bublatzky, F., Pittig, A., Schupp, H. T., & Alpers, G. W. (2017). Face-to-face: Perceived personal relevance amplifies face processing. *Social Cognitive and Affective Neuroscience*, *12*(5), 811–822. https://doi.org/10.1093/scan/nsx001

Buckner, J. D., Morris, P. E., Abarno, C. N., Glover, N. I., & Lewis, E. M. (2021). Biopsychosocial Model Social Anxiety and Substance Use Revised. *Current Psychiatry Reports*, *23*(6), pp35.

Burdon, P., Dipper, L., & Cocks, N. (2016). Exploration of older and younger British adults’ performance on The Awareness of Social Inference Test (TASIT). *International Journal of Language and Communication Disorders*, *51*(5), 589–593. https://doi.org/10.1111/1460-6984.12233

Burton, R., & Marsden, J. (2016). *The Public Health Burden of Alcohol and the Effectiveness and Cost-Effectiveness of Alcohol Control Policies An evidence review*. 241. http://www.gov.uk/phe%5Cnwww.facebook.com/PublicHealthEngland%5Cnalcoholenquiries@phe.gov.uk%5Cnwww.gov.uk/phe%5Cnwww.facebook.com/PublicHealthEngland%5Cnalcoholenquiries@phe.gov.uk

Bush, G., Luu, P., & Posner, M. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences*, *4*(6), 215–222.

Bushman, B. J., & Cooper, H. M. (1990). *Psychological Bulletin Effects of Alcohol on Human Aggression: An Integrative Research Review* (Vol. 107, Issue 3).

Byron, K. (2008). Carrying too heavy a load ? The communication and miscommunication of emotion by email. *Academy of Management Review*, *33*(2), 309–327.

Calder, A. J., Keane, J., Manly, T., Sprengelmeyer, R., Scott, S., Nimmo-Smith, I., & Young, A. W. (2003). Facial expression recognition across the adult life span. *Neuropsychologia*, *41*(2), 195–202.

Calvo, M. G., Fernández-Martín, A., Gutiérrez-García, A., & Lundqvist, D. (2018). Selective eye fixations on diagnostic face regions of dynamic emotional expressions: KDEF-dyn database. *Scientific Reports*, *8*(1), 1–10. https://doi.org/10.1038/s41598-018-35259-w

Campanella, S., Peigneux, P., Petit, G., Lallemand, F., Saeremans, M., Noël, X., Metens, T., Nouali, M., De Tiège, X., De Witte, P., Ward, R., & Verbanck, P. (2013). Increased Cortical Activity in Binge Drinkers during Working Memory Task: A Preliminary Assessment through a Functional Magnetic Resonance Imaging Study. *PLoS ONE*, *8*(4), 1–10. https://doi.org/10.1371/journal.pone.0062260

Canham, S. L., Mauro, P. M., Kaufmann, C. N., & Sixsmith, A. (2016). Association of Alcohol Use and Loneliness Frequency among Middle-Aged and Older Adult Drinkers. *Journal of Aging and Health*, *28*(2), 267–284. https://doi.org/10.1177/0898264315589579

Cannon, W. B. (1927). The James-Lange theory of emotions: A critical examination and an alternative theory. *The American Journal of Psychology*, *39*(1/4), 106–124.

Capito, E. S., Lautenbacher, S., & Horn-Hofmann, C. (2017). *Acute alcohol effects on facial expressions of emotions in social drinkers: a systematic review*. https://doi.org/10.2147/PRBM.S146918

Carmona-Perera, M., Clark, L., Young, L., Pérez-García, M., & Verdejo-García, A. (2014). Impaired Decoding of Fear and Disgust Predicts Utilitarian Moral Judgment in Alcohol-Dependent Individuals. *Alcoholism: Clinical and Experimental Research*, *38*(1), 179–185. https://doi.org/10.1111/acer.12245

Carofiglio, V., & De Rosis, F. (2005). In Favour of Cognitive Models of Emotions Valeria. *Virtual Social Agents*, 171–176.

Carton, J. S., Kessler, E. A., & Pape, C. L. (1999). Nonverbal decoding skills and relationship well-being in adults. *Journal of Nonverbal Behavior*, *23*(1), 91–100.

Chafi, A., Schiaratura, L., & Rusinek, S. (2012). Three Patterns of Motion Which Change the Perception of Emotional Faces. *Psychology*, *03*(01), 82–89. https://doi.org/10.4236/psych.2012.31014

Chambers, C. D., & Heinen, K. (2010). TMS and the functional neuroanatomy of attention. *Cortex*, *46*(1), 114–117. https://doi.org/10.1016/j.cortex.2009.03.002

Chan, R. C. K., Li, H., Cheung, E. F. C., & Gong, Q. yong. (2010). Impaired facial emotion perception in schizophrenia: A meta-analysis. *Psychiatry Research*, *178*(2), 381–390. https://doi.org/10.1016/j.psychres.2009.03.035

Chen, Y. C., & Spence, C. (2011). The Crossmodal Facilitation of Visual Object Representations By Sound: Evidence From the Backward Masking Paradigm. *Journal of Experimental Psychology: Human Perception and Performance*, *37*(6), 1784–1802. https://doi.org/10.1037/a0025638

Chiller-Glaus, S. D., Schwaninger, A., Hofer, F., Kleiner, M., & Knappmeyer, B. (2011). Recognition of emotion in moving and static composite faces. *Swiss Journal of Psychology*, *70*(4), 233–240. https://doi.org/10.1024/1421-0185/a000061

Cisler, J. M., Bacon, A. K., & Williams, N. L. (2009). Phenomenological Characteristics of Attentional Biases Towards Threat: A Critical Review. *Cognitive Therapy and Research*, *33*(2), 221–234. https://doi.org/10.1007/s10608-007-9161-y.Phenomenological

Cisler, J. M., & Koster, E. H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review*, *30*(2), 203–216. https://doi.org/10.1016/j.cpr.2009.11.003

Clements, K., & Schumacher, J. A. (2010). Perceptual biases in social cognition as potential moderators of the relationship between alcohol and intimate partner violence: A review. *Aggression and Violent Behavior*, *15*(5), 357–368. https://doi.org/10.1016/j.avb.2010.06.004

Cochrane, C. E., Brewerton, T. D., Wilson, D. B., & Hodges, E. L. (1993). Alexithymia in the eating disorders. *International Journal of Eating Disorders*, *14*(2), 219–222.

Coffman, D. L., Patrick, M. E., Palen, L. A., Rhoades, B. L., & Ventura, A. K. (2007). Why do high school seniors drink? Implications for a targeted approach to intervention. *Prevention Science*, *8*(4), 241–248. https://doi.org/10.1007/s11121-007-0078-1

Cohen, S., Doyle, W. J., Turner, R., Alper, C. M., & Skoner, D. P. (2003). Sociability and suscesptibility to the common cold. *Transgenic Research*, *12*(6), 761–763. https://doi.org/10.1023/B:TRAG.0000005082.29212.cf

Compton, R. J., Banich, M. T., Mohanty, A., Milham, M. P., Herrington, J., Miller, G. A., Scalf, P. E., Webb, A., & Heller, W. (2003). Paying attention to emotion: An fMRI investigation of cognitive and emotional Stroop tasks. *Cognitive, Affective and Behavioral Neuroscience*, *3*(2), 81–96. https://doi.org/10.3758/CABN.3.2.81

Connell, A. M., Patton, E., & McKillop, H. (2015). Binge drinking, depression, and electrocortical responses to emotional images. *Psychology of Addictive Behaviors*, *29*(3), 673–682. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med11&AN=25915691

Cooper, L., Frone, M., Russell, M., & Mudar, P. (1995). Drinking to Regulate Positive and Negative Emotions: A Motivational Model of Alcohol Use. *Journal of Personality and Social Psychology*, *69*(5), 990–1005.

Cooper, R. M., & Langton, S. R. H. (2006). Attentional bias to angry faces using the dot-probe task? It depends when you look for it. *Behaviour Research and Therapy*, *44*(9), 1321–1329. https://doi.org/10.1016/j.brat.2005.10.004

Cortes, C. R., Grodin, E. N., Mann, C. L., Mathur, K., Kerich, M., Zhu, X., Schwandt, M., Diazgranados, N., George, D. T., Momenan, R., & Heilig, M. (2018). Insula Sensitivity to Unfairness in Alcohol Use Disorder. *Alcohol & Alcoholism*, *53*(3), 201–208. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med13&AN=29309499

Costa, A. P., Steffgen, G., & Samson, A. C. (2017). Expressive Incoherence and Alexithymia in Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *47*(6), 1659–1672.

Costa, T., Rognoni, E., & Galati, D. (2006). EEG phase synchronization during emotional response to positive and negative film stimuli. *Neuroscience Letters*, *406*(3), 159–164. https://doi.org/10.1016/j.neulet.2006.06.039

Courtney, K. E., & Polich, J. (2009). Binge Drinking in Young Adults: Data, Definitions, and Determinants. *Psychological Bulletin*, *135*(1), 142–156. https://doi.org/10.1037/a0014414

Crabbe, J. C., Harris, R. A., & Koob, G. F. (2011). Preclinical studies of alcohol binge drinking. *Annals of the New York Academy of Sciences*, *1216*(1), 24–40.

Crane, N. A., Gorka, S. M., Phan, K. L., & Childs, E. (2018). Amygdala-orbitofrontal functional connectivity mediates the relationship between sensation seeking and alcohol use among binge-drinking adults. *Drug & Alcohol Dependence*, *192*, 208–214. https://doi.org/10.1016/j.drugalcdep.2018.07.044

Crawford, J. R., & Henry, J. D. (2003). The Depression Anxiety Stress Scales (DASS): Normative data and latent structure in a large non-clinical sample. *British Journal of Clinical Psychology*, *42*(2), 111–131.

Crawford, J. R., & Henry, J. D. (2004). The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. In *British Journal of Clinical Psychology* (Vol. 43). www.bps.org.uk

Crego, A., Holguín, S. R., Parada, M., Mota, N., Corral, M., & Cadaveira, F. (2009). Binge drinking affects attentional and visual working memory processing in young university students. *Alcoholism: Clinical and Experimental Research*, *33*(11), 1870–1879. https://doi.org/10.1111/j.1530-0277.2009.01025.x

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. Sage Publications.

Crime Survey for England and Wales. (2021, April). *Domestic abuse victim characteristics, England and Wales: year ending March 2021*. Office for National Statistics (ONS). https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/articles/domesticabusevictimcharacteristicsenglandandwales/yearendingmarch2021

Cristino, F., Mathôt, S., Theeuwes, J., & Gilchrist, I. D. (2010). ScanMatch: A novel method for comparing fixation sequences. *Behavior Research Methods*, *42*(3), 692–700. https://doi.org/10.3758/BRM.42.3.692

Crivelli, C., Jarillo, S., Russell, J. A., & Fernández-Dols, J. M. (2016). Reading emotions from faces in two indigenous societies. *Journal of Experimental Psychology: General*, *145*(7), 830–843. https://doi.org/10.1037/xge0000172

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.

Cservenka, A., & Brumback, T. (2017). The burden of binge and heavy drinking on the brain: Effects on adolescent and young adult neural structure and function. *Frontiers in Psychology*, *8*(JUN). https://doi.org/10.3389/fpsyg.2017.01111

Cservenka, A., Fair, D. A., & Nagel, B. J. (2014). Emotional processing and brain activity in youth at high risk for alcoholism. *Alcoholism: Clinical & Experimental Research*, *38*(7), 1912–1923. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med10&AN=24890898

Curran, S. L., Andrykowski, M. A., & Studts, J. L. (1995). Short form of the Profile of Mood States (POMS-SF): Psychometric information. *Psychological Assessment*, *7*(1), 80.

Cyders, M. A., & Smith, G. T. (2007). Mood-based rash action and its components: Positive and negative urgency. *Personality and Individual Differences*, *43*(4), 839–850.

D'Hondt, F., Campanella, S., Kornreich, C., Philippot, P., Maurage, P., D'Hondt, F., Campanella, S., Kornreich, C., Philippot, P., & Maurage, P. (2014). Below and beyond the recognition of emotional facial expressions in alcohol dependence: from basic perception to social cognition. *Neuropsychiatric Disease and Treatment*, *10*, 2177–2182. http://ezproxy.uwl.ac.uk/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,shib&db=psyh&AN=2014-51139-001&site=ehost-live

D'Hondt, F., de Timary, P., Bruneau, Y., & Maurage, P. (2015). Categorical perception of emotional facial expressions in alcohol-dependence. *Drug and Alcohol Dependence*, *156*, 267–274. https://doi.org/10.1016/j.drugalcdep.2015.09.017

D'Hondt, F., Lepore, F., & Maurage, P. (2014). Are visual impairments responsible for emotion decoding deficits in alcohol-dependence? *Frontiers in Human Neuroscience*, *8*(MAR), 1–7. https://doi.org/10.3389/fnhum.2014.00128

Dadds, M., Perry, Y., Hawes, D., Merz, S., Riddell, A., Haines, D., Solak, E., & Abeygunawardane, A. (2006). Attention to the eyes and fear-recognition deficits in child psychopathy. In *British Journal of Psychiatry* (Issue 189). https://doi.org/1 0 . 11 9 2 / b j p . bp . 1 0 5 . 0 1 8 1 5 0

Davis, M. H. (1983). Measuring Individual Differences in Empathy: Evidence for a Multidimensional Approach. *Journal of Personality and Social Psychology*, *44*(1), 113–126. https://doi.org/10.1145/234611.234613

Davis, M., & Whalen, P. J. (2001). The amygdala: Vigilance and emotion. *Molecular Psychiatry*, *6*(1), 13–34. https://doi.org/10.1038/sj.mp.4000812

Dawe, S., Loxton, N. J., Gullo, M. J., Staiger, P. K., Kambouropoulos, N., Perdon, L., & Wood, A. (2007). The role of impulsive personality traits in the initiation, development, and treatment of substance misuse problems. In *Translation of Addictions Science Into Practice* (pp. 321–339). Pergamon. https://doi.org/10.1016/B978-008044927-2/50064-X

Dawkins, L., & Powell, J. (2011). Effects of nicotine and alcohol on affective responses to emotionally toned film clips. *Psychopharmacology*, *216*(2), 197–205. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med7&AN=21327759

Dawkins, L., Turner, J., Hasna, S., & Soar, K. (2012). The electronic-cigarette: Effects on desire to smoke, withdrawal symptoms and cognition. *Addictive Behaviors*, *37*(8), 970–973. https://doi.org/10.1016/j.addbeh.2012.03.004

Dawkins, L., Turner, J., Roberts, A., & Soar, K. (2013). “Vaping” profiles and preferences: An online survey of electronic cigarette users. *Addiction*, *108*(6), 1115–1125. https://doi.org/10.1111/add.12150

de Arcos, F. A., Verdejo-Garcia, A., Peralta-Ramirez, M. I., Sanchez-Barrera, M., & Perez-Garcia, M. (2005). Experience of emotions in substance abusers exposed to images containing neutral, positive, and negative affective stimuli. *Drug & Alcohol Dependence*, *78*(2), 159–167. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med5&AN=15845319

de Paiva-Silva, A. I., Pontes, M. K., Aguiar, J. S. R., & de Souza, W. C. (2016). How do we evaluate facial emotion recognition? *Psychology and Neuroscience*, *9*(2), 153–175. https://doi.org/10.1037/pne0000047

Dębiec, J. (2014). The Matter of Emotions: Toward the Brain-Based Theory of Emotions. In J. LeDoux, M. Heller, B. Brozek, & J. Debiec (Eds.), *The Emotional Brain Revisited* (pp. 145–161). Copernicus Center Press.

Decety, J., & Grèzes, J. (1999). Neural mechanisms subserving the perception of human actions. *Trends in Cognitive Sciences*, *3*(5), 172–178. https://doi.org/10.1016/S1364-6613(99)01312-1

Denham, S. A., Blair, K. A., Demulder, E., Levitas, J., Sawyer, K., Auerbach-Major, S., & Queenan, P. (2003). Preschool Emotional Competence: Pathway to Social Competence? *Child Development*, *74*(1), 238–256. https://doi.org/10.1111/1467-8624.00533

deVries, M., Holland, R., & Witteman, C. (2018). In the winning mood: Affect in the Iowa gambling task. *Judgment and Decision Making*, *3*(1), 42–50.

DeWit, D. J., Adlaf, E. M., Offord, D. R., & Ogborne, A. C. (2000). Age at first alcohol use: a risk factor for the development of alcohol disorders. *American Journal of Psychiatry*, *157*(5), 745–750.

Dick, D. M., Smith, G., Olausson, P., Mitchell, S. H., Leeman, R. F., O’Malley, S. S., & Sher, K. (2010). Review: understanding the construct of impulsivity and its relationship to alcohol use disorders. *Addiction Biology*, *15*(2), 217–226.

Domínguez-Salas, S., Díaz-Batanero, C., Lozano-Rojas, O. M., & Verdejo-García, A. (2016). Impact of general cognition and executive function deficits on addiction treatment outcomes: Systematic review and discussion of neurocognitive pathways. *Neuroscience and Biobehavioral Reviews*, *71*, 772–801. https://doi.org/10.1016/j.neubiorev.2016.09.030

Donadon, M. F., de Lima Osório, F., De, L. O., Fde, L. O., & de Lima Osorio, F. (2014). *Recognition of facial expressions by alcoholic patients: a systematic literature review*. *10*, 1655–1663. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=prem1&AN=25228806

Drummer, O. H. (2014). Alcohol: Pharmacology and Disposition. *Academic Forensic Pathology*, *4*(2), 128–137. https://doi.org/10.23907/2014.022

Duchowski, A. T. (2002). A breadth-first survey of eye-tracking applications. *Behavior Research Methods, Instruments, & Computers*, *34*(4), 455–470.

Eich, E. (1995). Searching for mood dependent memory. *Psychological Science*, *6*(2), 67–75.

Eich, E., & Metcalfe, J. (1989). Mood dependent memory for internal versus external events. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*(3), 443–455.

Eisenbarth, H., & Alpers, G. W. (2011). *Happy Mouth and Sad Eyes: Scanning Emotional Facial Expressions*. https://doi.org/10.1037/a0022758

Ekman, P., & Friesen, W. V. (1976). Pictures of facial affect. Palo Alto. *Consulting Psychologists' Press*. http://www.scirp.org/reference/ReferencesPapers.aspx?ReferenceID=672323

Ekman, P. (1992). An Argument for Basic Emotions. *Cognition and Emotion*, *6*(3/4), 169–200. https://doi.org/10.1080/02699939208411068

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*, *17*(2), 124–129. http://psycnet.apa.org/record/1971-07999-001

Elias, M. J. (1997). *Promoting social and emotional learning: Guidelines for educators*. http://books.google.com/books?hl=en&lr=&id=AOlqSwQPo9cC&oi=fnd&pg=PR5&dq=Rachael+Kessler&ots=GpKEJ_q5Vc&sig=7SDEQMpnURiu9cwkcJpf8J9CSD4

Ellemers, N., Spears, R., & Doosje, B. (2002). S Elf and S Ocial I Dentity ∗. *Annual Review of Psychology*, *53*, 161–186.

Emmons, R. A., & Diener, E. (1985). Personality correlates of subjective well-being. *Personality and Social Psychology Bulletin*, *11*(1), 89–97.

Endler, N. S., & Kocovski, N. L. (2001). State and trait anxiety revisited. *Journal of Anxiety Disorders*, *15*(3), 231–245. https://doi.org/10.1016/S0887-6185(01)00060-3

Endo, N., Endo, M., Kirita, T., & Maruyama, K. (1992). The effects of expression on face recognition. *Tohoku Psychologicia Folia*, *52*, 37–44.

Enoch, M. A. (2008). The role of GABAA receptors in the development of alcoholism. *Pharmacology Biochemistry and Behavior*, *90*(1), 95–104. https://doi.org/10.1016/j.pbb.2008.03.007

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behavior Research Methods*, *28*(1), 1–11.

Erol, A., Kirdok, A. A., Zorlu, N., Polat, S., & Mete, L. (2017). Empathy, and its relationship with cognitive and emotional functions in alcohol dependency. *Nordic Journal of Psychiatry*, *71*(3), 205–209. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med13&AN=27924662

Evert, D. L., & Oscar-Berman, M. (2001). Selective attentional processing and the right hemisphere: Effects of aging and alcoholism. *Neuropsychology*, *15*(4), 452.

Evren, C., Kose, S., Sayar, K., Ozcelik, B., Borckardt, J. P., Elhai, J. D., & Cloninger, C. R. (2008). Alexithymia and temperament and character model of personality in alcohol-dependent Turkish men. *Psychiatry and Clinical Neurosciences*, *62*(4), 371–378. https://doi.org/10.1111/j.1440-1819.2008.01829.x

Fairhall, S. L., & Ishai, A. (2007). Effective connectivity within the distributed cortical network for face perception. *Cerebral Cortex*, *17*(10), 2400–2406. https://doi.org/10.1093/cercor/bhl148

Fama, R., Pfefferbaum, A., & Sullivan, E. V. (2004). Perceptual learning in detoxified alcoholic men: contributions from explicit memory, executive function, and age. *Alcoholism: Clinical and Experimental Research*, *28*(11), 1657–1665.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191.

Fein, G., Landman, B., Tran, H., Mcgillivray, S., Finn, P., & Moon, K. (2007). Demonstrate Impairment on a Simulated Gambling Task. *Moon*, *32*(3), 1465–1471. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1868686/pdf/nihms20941.pdf

Fernández-Serrano, M. J., Lozano, Ó., Pérez-García, M., & Verdejo-García, A. (2010). Impact of severity of drug use on discrete emotions recognition in polysubstance abusers. *Drug and Alcohol Dependence*, *109*(1–3), 57–64. https://doi.org/10.1016/j.drugalcdep.2009.12.007

Fernández, C., Pascual, J. C., Soler, J., Elices, M., Portella, M. J., & Fernández-Abascal, E. (2012). Physiological responses induced by emotion-eliciting films. *Applied Psychophysiology Biofeedback*, *37*(2), 73–79. https://doi.org/10.1007/s10484-012-9180-7

Field, A. (2014). Discovering Statistics using SPSS, nineth ed.

Field, M., Schoenmakers, T., & Wiers, R. W. (2008). Cognitive Processes in Alcohol Binges: A Review and Research Agenda. *Current Drug Abuse Reviews*, *1*(3), 263–279. http://www.ncbi.nlm.nih.gov/pubmed/19630725

Findlay, J. M. (1997). Saccade target selection during visual search. *Vision Research*, *37*(5), 617–631. https://doi.org/10.1016/S0042-6989(96)00218-0

Fischer, A., & Manstead, A. (2008). Social function of emotion. In M. Lewis, J. Haviland-Jones, & L. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 456–471). The Guildford Press.

Fiske, S. T. (1992). Thinking Is for Doing: Portraits of Social Cognition From Daguerreotype to Laserphoto. *Journal of Personality and Social Psychology*, *63*(6), 877–889. https://doi.org/10.1037/0022-3514.63.6.877

Foisy, M.-L. L., Kornreich, C., Fobe, A. A., D'Hondt, L., Pelc, I., Hanak, C., Verbanck, P., & Philippot, P. (2007). *Impaired emotional facial expression recognition in alcohol dependence: Do these deficits persist with midterm abstinence? 31*(3), 404–410. https://doi.org/10.1111/j.1530-0277.2006.00321.x

Forgas, J. P., & Locke, J. (2005). Affective influences on causal inferences: The effects of mood on attributions for positive and negative interpersonal episodes. *Cognition and Emotion*, *19*(7), 1071–1081. https://doi.org/10.1080/02699930541000093

Foulsham, T., Dewhurst, R., Nyström, M., Jarodzka, H., Johansson, R., Underwood, G., & Holmqvist, K. (2012). Comparing scanpaths during scene encoding and recognition: A multi-dimensional approach. *Journal of Eye Movement Research*, *5*(4), 3. https://doi.org/10.16910/jemr.5.4.3

Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed disengagement from emotional faces. *Cognition and Emotion*, *16*(3), 355–379. https://doi.org/10.1080/02699930143000527

Fox, H. C., Bergquist, K. L., Peihua, G., & Rajita, S. (2010). Interactive effects of cumulative stress and impulsivity on alcohol consumption. *Alcoholism, Clinical and Experimental Research*, *34*(8), 1376–1385. https://doi.org/10.1111/j.1530-0277.2010.01221.x [doi]

Foxcroft, D. R., Smith, L. A., Thomas, H., & Howcutt, S. (2015). Accuracy of Alcohol Use Disorders Identification Test for detecting problem drinking in 18–35 year-olds in England: method comparison study. *Alcohol and Alcoholism*, *50*(2), 244–250.

Frank, M. C., Vul, E., & Johnson, S. P. (2009). Development of infants' attention to faces during the first year. *Cognition*, *110*(2), 160–170. https://doi.org/10.1016/j.cognition.2008.11.010.Development

Freeman, C. R., Wiers, C. E., Sloan, M. E., Zehra, A., Ramirez, V., Wang, G. J., & Volkow, N. D. (2018). Emotion Recognition Biases in Alcohol Use Disorder. *Alcoholism: Clinical and Experimental Research*, *42*(8), 1541–1547. https://doi.org/10.1111/acer.13802

Frigerio, E., Burt, D. M., Montagne, B., Murray, L. K., & Perrett, D. I. (2002). Facial affect perception in alcoholics. *Psychiatry Research*, *113*(1), 161–171.

Frith, C. D. (2008). Review. Social cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1499), 2033–2039. https://doi.org/10.1098/rstb.2008.0005

Frith, C. D. (2012). The role of metacognition in human social interactions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2213–2223. https://doi.org/10.1098/rstb.2012.0123

Fusar-Poli, P., Placentino, A., Carletti, F., Allen, P., Landi, P., Abbamonte, M., Barale, F., Perez, J., McGuire, P., & Politi, P. L. (2009). Laterality effect on emotional faces processing: ALE meta-analysis of evidence. *Neuroscience Letters*, *452*(3), 262–267. https://doi.org/10.1016/j.neulet.2009.01.065

Galanti, K., Gluck, M. E., & Geliebter, A. (2007). Test meal intake in obese binge eaters in relation to impulsivity and compulsivity. *International Journal of Eating Disorders*, *40*(8), 727–732.

Gamer, M., & Büchel, C. (2009). Amygdala activation predicts gaze toward fearful eyes. *Journal of Neuroscience*, *29*(28), 9123–9126. https://doi.org/10.1523/JNEUROSCI.1883-09.2009

García-Sancho, E., Salguero, J. M., & Fernández-Berrocal, P. (2014). Relationship between emotional intelligence and aggression: A systematic review. *Aggression and Violent Behavior*, *19*(5), 584–591. https://doi.org/10.1016/j.avb.2014.07.007

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological Science*, *13*(1), 34–40. https://doi.org/10.1111/1467-9280.00406

Gaudelus, B., Virgile, J., Peyroux, E., Leleu, A., Baudouin, J. Y., & Franck, N. (2015). Mesure du déficit de reconnaissance des émotions faciales dans la schizophrénie. Étude préliminaire du test de reconnaissance des émotions faciales (TREF). *Encephale*, *41*(3), 251–259. https://doi.org/10.1016/j.encep.2014.08.013

Gerdes, A. B. M., Alpers, G. W., & Pauli, P. (2008). When spiders appear suddenly: Spider-phobic patients are distracted by task-irrelevant spiders. *Behaviour Research and Therapy*, *46*(2), 174–187. https://doi.org/10.1016/j.brat.2007.10.010

Gharabaghi, A., Fruhmann, M., Tatagiba, M., & Karnath, H. (2006). *The role of the right superior temporal gyrus in visual search — Insights from intraoperative electrical stimulation*. *44*, 2578–2581. https://doi.org/10.1016/j.neuropsychologia.2006.04.006

Ghasemi, A., & Zahediasl, S. (2012). Normality tests for statistical analysis: A guide for non-statisticians. *International Journal of Endocrinology and Metabolism*, *10*(2), 486–489. https://doi.org/10.5812/ijem.3505

Ghashghaei, H. T., & Barbas, H. (2002). Pathways for emotion: Interactions of prefrontal and anterior temporal pathways in the amygdala of the rhesus monkey. *Neuroscience*, *115*(4), 1261–1279. https://doi.org/10.1016/S0306-4522(02)00446-3

Gil-Hernandez, S., Mateos, P., Porras, C., Garcia-Gomez, R., Navarro, E., & Garcia-Moreno, L. M. (2017). Alcohol binge drinking and executive functioning during adolescent brain development. *Frontiers in Psychology*, *8*(OCT), 1–12. https://doi.org/10.3389/fpsyg.2017.01638

Gillespie, S. M., Rotshtein, P., Satherley, R. M., Beech, A. R., & Mitchell, I. J. (2015). Emotional expression recognition and attribution bias among sexual and violent offenders: A signal detection analysis. *Frontiers in Psychology*, *6*(MAY), 1–12. https://doi.org/10.3389/fpsyg.2015.00595

Gilman, J. M., Ramchandani, V. A., Davis, M. B., Bjork, J. M., & Hommer, D. W. (2008). Why we like to drink: A functional magnetic resonance imaging study of the rewarding and anxiolytic effects of alcohol. *Journal of Neuroscience*, *28*(18), 4583–4591. https://doi.org/10.1523/JNEUROSCI.0086-08.2008

Gilpin, N. W., Ph, D., Koob, G. F., & Ph, D. (2014). Neurobiology of Alcohol Dependence. *Neurobiology of Alcohol Dependence*, i. https://doi.org/10.1016/b978-0-12-405941-2.00027-4

Glahn, D. C., Lovallo, W. R., & Fox, P. T. (2007). Reduced amygdala activation in young adults at high risk of alcoholism: studies from the Oklahoma family health patterns project. *Biological Psychiatry*, *61*(11), 1306–1309. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med5&AN=17306772

Godfrey, H. P. D., & Shum, D. (2000). Executive functioning and the application of social skills following traumatic brain injury. *Aphasiology*, *14*(4), 433–444. https://doi.org/10.1080/026870300401441

Goldman, A. I., & Sripada, C. S. (2005). Simulationist models of face-based emotion recognition. *Cognition*, *94*(3), 193–213. https://doi.org/10.1016/j.cognition.2004.01.005

Goodwin, H., Eagleson, C., Mathews, A., Yiend, J., & Hirsch, C. (2017). Automaticity of Attentional Bias to Threat in High and Low Worriers. *Cognitive Therapy and Research*, *41*(3), 479–488. https://doi.org/10.1007/s10608-016-9818-5

Gorka, S. M., Fitzgerald, D. A., King, A. C., & Phan, K. L. (2013). Alcohol Attenuates Amygdala-Frontal Connectivity During Processing Social Signals in Heavy Social Drinkers: A Preliminary Pharmaco-fMRI Study. *Psychopharmacology*, *229*(1), 141–154. https://doi.org/10.1007/s00213-013-3090-0

Gosselin, F., Spezio, M. L., Tranel, D., & Adolphs, R. (2011). Asymmetrical use of eye information from faces following unilateral amygdala damage. *Social Cognitive and Affective Neuroscience*, *6*(3), 330–337. https://doi.org/10.1093/scan/nsq040

Gowin, J. L., Sloan, M. E., Stangl, B. L., Vatsalya, V., & Ramchandani, V. A. (2017). Vulnerability for alcohol use disorder and rate of alcohol consumption. *American Journal of Psychiatry*, *174*(11), 1094–1101. https://doi.org/10.1176/appi.ajp.2017.16101180

Green, M. J., & Davidson, D. (2003). *In the face of danger : Specific viewing strategies for facial expressions of threat ? 17*(5), 779–787. https://doi.org/10.1080/02699930244000228

Green, M. J., Williams, L. M., & Davidson, D. (2006). *Visual scanpaths to threat-related faces in deluded schizophrenia*. *119*(03), 271–285. https://doi.org/10.1016/S0165-1781(03)00129-X

Gross, C., & Sergent, J. (1992). Face recognition. *Current Opinion in Neurobiology*, *2*, 156–161.

Grynberg, D., Chang, B., Corneille, O., Maurage, P., Vermeulen, N., Berthoz, S., & Luminet, O. (2012). Alexithymia and the processing of emotional facial expressions (EFEs): Systematic review, unanswered questions and further perspectives. *PLoS ONE*, *7*(8). https://doi.org/10.1371/journal.pone.0042429

Gur, R. C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., Turner, T., Bajcsy, R., Posner, A., & Gur, R. E. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods*, *115*(2), 137–143. https://doi.org/10.1016/S0165-0270(02)00006-7

Hall, J. A., & Matsumoto, D. (2004). Gender differences in judgments of multiple emotions from facial expressions. *Emotion*, *4*(2), 201–206. https://doi.org/10.1037/1528-3542.4.2.201

Hall, J., Harris, J. M., Sprengelmeyer, R., Sprengelmeyer, A., Young, A. W., Santos, I. M., Johnstone, E. C., & Lawrie, S. M. (2004). Social cognition and face processing in schizophrenia. *British Journal of Psychiatry*, *185*(AUG.), 169–170. https://doi.org/10.1192/bjp.185.2.169

Haller, S. P. W., Doherty, B. R., Duta, M., Kadosh, K. C., Lau, J. Y. F., & Scerif, G. (2017). Attention allocation and social worries predict interpretations of peer-related social cues in adolescents. *Developmental Cognitive Neuroscience*, *25*, 105–112. https://doi.org/10.1016/j.dcn.2017.03.004

Hamilton, M. A. X. (1959). The assessment of anxiety states by rating. *British Journal of Medical Psychology*, *32*(1), 50–55.

Hari, R., & Kujala, M. V. (2009). Brain Basis of Human Social Interaction: From Concepts to Brain Imaging. *Physiological Reviews, 89*(2), 453–479. https://doi.org/10.1152/physrev.00041.2007

Hariri, A. R., Mattay, V. S., Tessitore, A., Fera, F., & Weinberger, D. R. (2003). Neocortical modulation of the amygdala response to fearful stimuli. *Biological Psychiatry*, *53*(6), 494–501. https://doi.org/10.1016/S0006-3223(02)01786-9

Harper, C. (2009). The neuropathology of alcohol-related brain damage. *Alcohol and Alcoholism*, *44*(2), 136–140. https://doi.org/10.1093/alcalc/agn102

Haxby, J. V, Hoffman, E. A., & Gobbini, M. I. (2002). Human neural systems for face recognition and social communication. *Biological Psychiatry*, *51*(1), 59–67. http://www.ncbi.nlm.nih.gov/pubmed/11801231

Hayhoe, M., & Ballard, D. (2005). Eye movements in natural behavior. *Trends in Cognitive Sciences*, *9*(4), 188–194. https://doi.org/10.1016/j.tics.2005.02.009

Heerdink, M. W., Koning, L. F., van Doorn, E. A., & van Kleef, G. A. (2019). Emotions as guardians of group norms: expressions of anger and disgust drive inferences about autonomy and purity violations. *Cognition and Emotion*, *33*(3), 563–578. https://doi.org/10.1080/02699931.2018.1476324

Heffernan, T., & O'Neill, T. (2012). Time based prospective memory deficits associated with binge drinking: Evidence from the Cambridge Prospective Memory Test (CAMPROMPT). *Drug and Alcohol Dependence*, *123*(1–3), 207–212. https://doi.org/10.1016/j.drugalcdep.2011.11.014

Helzer, J. E., Bucholz, K. K., Bierut, L. J., Regier, D. A., Schuckit, M. A., & Guth, S. E. (2006). Should DSM-V include dimensional diagnostic criteria for alcohol use disorders? *Alcoholism: Clinical and Experimental Research*, *30*(2), 303–310. https://doi.org/10.1111/j.1530-0277.2006.00028.x

Henges, A. L., & Marczinski, C. A. (2012). Impulsivity and alcohol consumption in young social drinkers. *Addictive Behaviors*, *37*(2), 217–220. https://doi.org/10.1016/j.addbeh.2011.09.013

Herman, A. M., & Duka, T. (2019). Facets of impulsivity and alcohol use: What role do emotions play? *Neuroscience and Biobehavioral Reviews*, *106*, 202–216. https://doi.org/10.1016/j.neubiorev.2018.08.011

Herman, A. M., Pilcher, N., & Duka, T. (2020). Deter the emotions: Alexithymia, Impulsivity and Their Relationship to Binge Drinking. *Addictive Behaviors Reports*, *12*(October), 100308. https://doi.org/10.1016/j.abrep.2020.100308

Hermens, D. F., Lagopoulos, J., Tobias-Webb, J., De Regt, T., Dore, G., Juckes, L., Latt, N., Hickie, I. B., Maurage, P., Petit, G., Campanella, S., Hermens, D. F., Lagopoulos, J., Tobias-Webb, J., Regt, T. De, Dore, G., Juckes, L., Latt, N., & Hickie, I. B. (2013). Pathways to alcohol-induced brain impairment in young people: A review. *Cortex: A Journal Devoted to the Study of the Nervous System & Behavior*, *49*. https://doi.org/10.1016/j.cortex.2012.05.021

Hernandez, N., Metzger, A., Magné, R., Bonnet-Brilhault, F., Roux, S., Barthelemy, C., & Martineau, J. (2009). Exploration of core features of a human face by healthy and autistic adults analyzed by visual scanning. *Neuropsychologia*, *47*(4), 1004–1012. https://doi.org/10.1016/j.neuropsychologia.2008.10.023

Herpertz, S., Schütz, A., & Nezlek, J. (2016). Enhancing emotion perception, a fundamental component of emotional intelligence: Using multiple-group SEM to evaluate a training program. *Personality and Individual Differences*, *95*, 11–19. https://doi.org/10.1016/j.paid.2016.02.015

Hinton, D., Hinton, P. R., McMurray, I., & Brownlow, C. (2004). *SPSS explained*. Routledge.

Hodgson, R., Alwyn, T., John, B., Thom, B., & Smith, A. (2002). The fast alcohol screening test. *Alcohol and Alcoholism*, *37*(1), 61–66.

Hodgson, R. J., John, B., Abbasi, T., Hodgson, R. C., Waller, S., Thom, B., & Newcombe, R. G. (2003). Fast screening for alcohol misuse. *Addictive Behaviors*, *28*(8), 1453–1463.

Hoffmann, H., Kessler, H., Eppel, T., Rukavina, S., & Traue, H. C. (2010). Expression intensity, gender and facial emotion recognition: Women recognize only subtle facial emotions better than men. *Acta Psychologica*, *135*(3), 278–283. https://doi.org/10.1016/j.actpsy.2010.07.012

Holmes, L. (2021). *Joint Briefing on the Domestic Abuse Bill 2019-21* (Issue January). https://www.ias.org.uk/wp-content/uploads/2021/01/sb30012021.pdf

Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and Social Isolation as Risk Factors for Mortality: A Meta-Analytic Review. *Perspectives on Psychological Science*, *10*(2), 227–237. https://doi.org/10.1177/1745691614568352

Honan, C. A., Skromanis, S., Johnson, E. G., & Palmer, M. A. (2018). Alcohol intoxication impairs recognition of fear and sadness in others and metacognitive awareness of emotion recognition ability. *Emotion*, *18*(6), 842–854. https://doi.org/10.1037/emo0000404

Hooker, C., & Park, S. (2002). *Emotion processing and its relationship to social functioning in schizophrenia patients*. *112*(1), 41–50. https://doi.org/10.1016/S0165-1781(02)00177-4

Hospers, J. (1997). *An introduction to philosophical analysis*. Psychology Press.

Humphreys, G. W., Donnelly, N., & Riddoch, M. J. (1993). Expression is computed separately from facial identity, and it is computed separately for moving and static faces: Neuropsychological evidence. *Neuropsychologia*, *31*(2), 173–181. https://doi.org/10.1016/0028-3932(93)90045-2

Hur, J., Kaplan, C. M., Smith, J. F., Bradford, D. E., Fox, A. S., Curtin, J. J., & Shackman, A. J. (2018). Acute alcohol administration dampens central extended amygdala reactivity. *Scientific Reports*, *8*(1). https://doi.org/10.1038/s41598-018-34987-3

Ingala-Smith, K. (2021, October 2). The 81 women killed in 28 weeks. *The Guardian*. https://www.theguardian.com/society/2021/oct/02/the-81-women-killed-in-28-weeks

Institute of Alcohol Studies. (n.d.). *Alcohol consumption factsheet*. IAS. Retrieved November 9, 2011, from https://www.ias.org.uk/factsheet/consumption/

International Classification of Diseases - 10. (2019). WHO. Retrieved April 21, 2020, from https://icd.who.int/browse10/2019/en#

Irwin, C., Leveritt, M., Shum, D., & Desbrow, B. (2013). The effects of dehydration, moderate alcohol consumption, and rehydration on cognitive functions. *Alcohol*, *47*(3), 203–213. https://doi.org/10.1016/j.alcohol.2012.12.016

Itier, R. J., & Batty, M. (2009). Neural bases of eye and gaze processing: The core of social cognition. *Neuroscience and Biobehavioral Reviews*, *33*(6), 843–863. https://doi.org/10.1016/j.neubiorev.2009.02.004

Izard, C. E. (1992). *Basic emotions, relations among emotions, and emotion-cognition relations*. *99*(3), 561–565. https://doi.org/10.1037/0033-295X.99.3.561

Izard, C. E. (1993). Four systems for emotion activation: Cognitive and noncognitive processes. *Psychological Review*, *100*(1), 68–90. https://doi.org/10.1037/0033-295X.100.1.68

Jenkins, R. (2014). Social identity. In *Social Identity*. https://doi.org/10.4324/9781315887104

Jennison, K. M. (2004). The short-term effects and unintended long-term consequences of binge drinking in college: A 10-year follow-up study. *American Journal of Drug and Alcohol Abuse*, *30*(3), 659–684. https://doi.org/10.1081/ADA-200032331

Johansson, B. B. (2011). Current trends in stroke rehabilitation. A review with focus on brain plasticity. *Acta Neurologica Scandinavica*, *123*(3), 147–159. https://doi.org/10.1111/j.1600-0404.2010.01417.x

Johnston, P., Mayes, A., Hughes, M., & Young, A. W. (2013). Brain networks subserving the evaluation of static and dynamic facial expressions. *Cortex*, *49*(9), 2462–2472. https://doi.org/10.1016/j.cortex.2013.01.002

Johnston, R. A., & Barry, C. (2001). Best face forward: Similarity effects in repetition priming of face recognition. *Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, *54*(2), 383–396.

https://doi.org/10.1080/713755976

Kamachi, M., Bruce, V., Mukaida, S., Gyoba, J., Yoshikawa, S., & Akamatsu, S. (2013). Dynamic properties influence the perception of facial expressions. *Perception*, *42*(11), 1266–1278. https://doi.org/10.1068/p3131n

Kellough, J., Beevers, C., Ellis, A., & Wells, T. (2008). Time Course of Selective Attention in Clinically Depressed Young Adults: An Eye Tracking Study. *Behav. Res. Ther*, *46*(11), 1238–1243. https://doi.org/10.1016/j.brat.2008.07.004.

Kelly, T. M., Donovan, J. E., Chung, T., Bukstein, O. G., & Cornelius, J. R. (2009). Brief screens for detecting alcohol use disorder among 18-20 year old young adults in emergency departments: Comparing AUDIT-C, CRAFFT, RAPS4-QF, FAST, RUFT-Cut, and DSM-IV 2-Item Scale. *Addictive Behaviors*, *34*(8), 668–674.

Keltner, D., Sauter, D., Tracy, J. L., & Cowen, A. (2019). Emotional Expression: Advances in Basic Emotion Theory. *Journal Nonverval Behav*, *43*(2), 133–160. https://doi.org/10.1007/s10919-019-00293-3

Kennedy, D. P., & Adolphs, R. (2010). Impaired fixation to eyes following amygdala damage arises from abnormal bottom-up attention. *Neuropsychologia*, *48*(12), 3392–3398. https://doi.org/10.1016/j.neuropsychologia.2010.06.025

Kessler, H., Schwarze, M., Filipic, S., Traue, H. C., & von Wietersheim, J. (2006). Alexithymia and facial emotion recognition in patients with eating disorders. *International Journal of Eating Disorders*, *39*(3), 245–251.

Khouja, J. N., Attwood, A. S., Penton-Voak, I. S., & Munafò, M. R. (2019b). Effects of acute alcohol consumption on emotion recognition in social alcohol drinkers. *Journal of Psychopharmacology*, *33*(3), 326–334. https://doi.org/10.1177/0269881118822169

Kilts, C. D., Egan, G., Gideon, D. A., Ely, T. D., & Hoffman, J. M. (2003). Dissociable neural pathways are involved in the recognition of emotion in static and dynamic facial expressions. *NeuroImage*, *18*(1), 156–168. https://doi.org/1053-8119/02

Kim, J. H., Lee, S. J., Rim, H. D., Kim, H. W., Bae, G. Y., & Chang, S. M. (2008). The relationship between alexithymia and general symptoms of patients with depressive disorders. *Psychiatry Investigation*, *5*(3), 179–185. https://doi.org//doi.org/10.4306/pi.2008.5.3.179

Kohler, C. G., Bilker, W., Hagendoorn, M., Gur, R. E., & Gur, R. C. (2000). Emotion recognition deficit in schizophrenia: Association with symptomatology and cognition. *Biological Psychiatry*, *48*(2), 127–136. https://doi.org/10.1016/S0006-3223(00)00847-7

Kohler, C. G., Turner, T. H., Bilker, W. B., Brensinger, C. M., Siegel, S. J., Kanes, S. J., Gur, R. E., & Gur, R. C. (2003). Facial emotion recognition in schizophrenia: Intensity effects and error pattern. *American Journal of Psychiatry*, *160*(10), 1768–1774. https://doi.org/10.1176/appi.ajp.160.10.1768

Kohler, C. G., Walker, J. B., Martin, E. A., Healey, K. M., & Moberg, P. J. (2010). Facial emotion perception in schizophrenia: A meta-analytic review. In *Schizophrenia Bulletin* (Vol. 36, Issue 5, pp. 1009–1019). https://doi.org/10.1093/schbul/sbn192

Koob, G. F. (2003). Alcoholism: allostasis and beyond. *Alcoholism: Clinical and Experimental Research*, *27*(2), 232–243.

Kooiman, C. G., Spinhoven, P., & Trijsburg, R. W. (2002). The assessment of alexithymia: A critical review of the literature and a psychometric study of the Toronto Alexithymia Scale-20. *Journal of Psychosomatic Research*, *53*(6), 1083–1090. https://doi.org/10.1016/S0022-3999(02)00348-3

Kopera, M., Trucco, E. M., Jakubczyk, A., Suszek, H., Michalska, A., Majewska, A., Szejko, N., Loczewska, A., Krasowska, A., Klimkiewicz, A., Brower, K. J., Zucker, R. A., & Wojnar, M. (2018). Interpersonal and Intrapersonal Emotional Processes in Individuals Treated for Alcohol Use Disorder and Non-Addicted Healthy Individuals. *Addictive Behaviors*, *79*(1), 8–13. https://doi.org/10.1016/j.addbeh.2017.12.006

Kornreich, C., Blairy, S., Philippot, P., Dan, B., Foisy, M.-L., Hess, U., Bon, O. Le, Pelc, I., & Verbanck, P. (2001). Impaired emotional facial expression recognition in alcoholism compared with obsessive-compulsive disorder and normal controls. *Psychiatry Research*, *102*(3), 235–248. https://doi.org/10.1016/S0165-1781(01)00261-X

Kornreich, C., Brevers, D., Canivet, D., Ermer, E., Naranjo, C., Constant, E., Verbanck, P., Campanella, S., Noel, X., Noël, X., Nol, X., & Noël, X. (2013). Impaired processing of emotion in music, faces and voices supports a generalized emotional decoding deficit in alcoholism. *Addiction*, *108*(1), 80–88. https://doi.org/10.1111/j.1360-0443.2012.03995.x

Kornreich, C., Philippot, P., Foisy, M.-L., Blairy, S., Raynaud, E., Dan, B., Hess, U., Noël, X., Pelc, I., & Verbanck, P. (2002). Impaired emotional facial expression recognition is associated with interpersonal problems in alcoholism. *Alcohol and Alcoholism*, *37*(4), 394–400. https://doi.org/10.1093/alcalc/37.4.394

Kosmidis, M. H., Bozikas, V. P., Giannakou, M., Anezoulaki, D., Fantie, B. D., & Karavatos, A. (2007). Impaired emotion perception in schizophrenia: A differential deficit. *Psychiatry Research*, *149*(1–3), 279–284. https://doi.org/10.1016/j.psychres.2004.09.011

Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective attention to threat in the dot probe paradigm: Differentiating vigilance and difficulty to disengage. *Behaviour Research and Therapy*, *42*(10), 1183–1192. https://doi.org/10.1016/j.brat.2003.08.001

Koster, E. H. W., Verschuere, B., Crombez, G., & Van Damme, S. (2005). Time-course of attention for threatening pictures in high and low trait anxiety. *Behaviour Research and Therapy*, *43*(8), 1087–1098. https://doi.org/10.1016/j.brat.2004.08.004

Kuntsche, E., Knibbe, R., Gmel, G., & Engels, R. (2005). Why do young people drink? A review of drinking motives. *Clinical Psychology Review*, *25*(7), 841–861.

Kuntsche, E., Rehm, J., & Gmel, G. (2004). Characteristics of binge drinkers in Europe. *Social Science and Medicine*, *59*(1), 113–127. https://doi.org/10.1016/j.socscimed.2003.10.009

Lammers, J., Kuntsche, E., Engels, R. C. M. E., Wiers, R. W., & Kleinjan, M. (2013). Mediational relations of substance use risk profiles, alcohol-related outcomes, and drinking motives among young adolescents in the Netherlands. *Drug and Alcohol Dependence*, *133*(2), 571–579. https://doi.org/10.1016/j.drugalcdep.2013.07.030

Lane, R. D., Sechrest, L., Reidel, R., Weldon, V., Kaszniak, A., & Schwartz, G. E. (1996). Impaired verbal and nonverbal emotion recognition in alexithymia. *Psychosomatic Medicine*, *58*(3), 203–210. https://doi.org/10.1097/00006842-199605000-00002

Lane, S. D., Moeller, F. G., Steinberg, J. L., Buzby, M., & Kosten, T. R. (2007). Performance of cocaine dependent individuals and controls on a response inhibition task with varying levels of difficulty. *The American Journal of Drug and Alcohol Abuse*, *33*(5), 717–726.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. University of Florida, Gainesville, FL.* 2008.

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology*, *30*(3), 261–273. https://doi.org/10.1111/j.1469-8986.1993.tb03352.x

Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D. H. J., Hawk, S. T., & van Knippenberg, A. (2010). Presentation and validation of the radboud faces database. *Cognition and Emotion*, *24*(8), 1377–1388. https://doi.org/10.1080/02699930903485076

Lannoy, S., Benzerouk, F., Maurage, P., Barrière, S., Billieux, J., Naassila, M., Kaladjian, A., & Gierski, F. (2019). Disrupted Fear and Sadness Recognition in Binge Drinking: A Combined Group and Individual Analysis. *Alcoholism: Clinical and Experimental Research*, *43*(9), 1978–1985.

https://doi.org/10.1111/acer.14151

Lannoy, S., Billieux, J., & Maurage, P. (2014). Beyond Inhibition: A Dual-Process Perspective to Renew the Exploration of Binge Drinking. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00405

Lannoy, S., D'Hondt, F., Dormal, V., Blanco, M., Brion, M., Billieux, J., Campanella, S., & Maurage, P. (2018). Electrophysiological correlates of emotional crossmodal processing in binge drinking. *Cognitive, Affective and Behavioral Neuroscience*, *18*(6), 1076–1088. https://doi.org/10.3758/s13415-018-0623-3

Lannoy, S., Dormal, V., Billieux, J., & Maurage, P. (2018). A joint exploration of executive subcomponents in binge drinking. *Addiction Research and Theory*. https://doi.org/10.1080/16066359.2018.1549233

Lannoy, S., Dormal, V., Brion, M., Billieux, J., & Maurage, P. (2017). Preserved Crossmodal Integration of Emotional Signals in Binge Drinking. *Frontiers in Psychology*, *8*, 984. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=prem2&AN=28663732

Lannoy, S., Dormal, V., Brion, M., Gaudelus, B., Billieux, J., & Maurage, P. (2018). *Affective impairments in binge drinking: Investigation through emotional facial expression decoding*. *83*, 59–63. https://doi.org/10.1016/j.comppsych.2018.03.004

Lannoy, S., Duka, T., Carbia, C., Billieux, J., Sullivan, F., Dormal, V., Gierski, F., Lopez-Caneda, E., Sullivan, E. V, & Maurage, P. (2021). Emotional processes in binge drinking: A systematic review and perspective Séverine. *Clinical Psychology Review*, 105398. https://doi.org/10.1016/j.cpr.2021.101971

Lannoy, S., Heeren, A., Moyaerts, N., Bruneau, N., Evrard, S., Billieux, J., & Maurage, P. (2017). Differential impairments across attentional networks in binge drinking. *Psychopharmacology*, *234*(7), 1059–1068. https://doi.org/10.1007/s00213-017-4538-4

Larsen, I. U., Vinther-Jensen, T., Gade, A., Nielsen, J. E., & Vogel, A. (2016). Do i misconstrue? Sarcasm detection, emotion recognition, and theory of mind in huntington disease. *Neuropsychology*, *30*(2), 181–189. https://doi.org/10.1037/neu0000224

Le Berre, A. P. (2019). Emotional processing and social cognition in alcohol use disorder. *Neuropsychology*, *33*(6), 808–821. https://doi.org/10.1037/neu0000572

LeDoux, J. (1997). Emotion, Memory and the Brain: Mysteries of the Mind. *Scientific American*, *270*(6), 68–75. http://www.ncbi.nlm.nih.gov/pubmed/8023118

Leganes-Fonteneau, M., Pi-Ruano, M., & Tejero, P. (2020). Early Signs of Emotional Recognition Deficits in Adolescent High-Binge Drinkers. *Substance Use and Misuse*, *55*(2), 218–229. https://doi.org/10.1080/10826084.2019.1662810

Lemmens, P., Knibbe, R. A., & Tan, F. (1988). Weekly recall and diary estimates of alcohol consumption in a general population survey. *Journal of Studies on Alcohol*, *49*(2), 131–135.

Levola, J., Kaskela, T., Holopainen, A., Sabariego, C., Tourunen, J., Cieza, A., & Pitkänen, T. (2014). Psychosocial difficulties in alcohol dependence: a systematic review of activity limitations and participation restrictions. *Disability and Rehabilitation*, *36*(15), 1227–1239. https://doi.org/10.3109/09638288.2013.837104

Linden, W., Wen, F., & Paulhus, D. L. (1995). Measuring alexithymia: reliability, validity, and prevalence. *Advances in Personality Assessment*, *10*, 51–95.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences*, *35*(3), 121–143. https://doi.org/10.1017/S0140525X11000446

Liversedge, S. P., & Findlay, J. M. (2000). Liversedge (2000) Saccadic eye movements and cognition. *Trends in Cognitive Sciences*, *4*(1), 6–14.

Loeber, S., Duka, T. T., Welzel, H., Nakovics, H., Heinz, A., Flor, H., & Mann, K. (2009). Impairment of cognitive abilities and decision making after chronic use of alcohol: The impact of multiple detoxifications. *Alcohol and Alcoholism*, *44*(4), 372–381. https://doi.org/10.1093/alcalc/agp030

Loughland, C. M., Williams, L. M., & Gordon, E. (2002). Visual scanpaths to positive and negative facial emotions in an outpatient schizophrenia sample. *Schizophrenia Research*, *55*(1–2), 159–170. https://doi.org/10.1016/S0920-9964(01)00186-4

Loughland, C. M., Williams, L. M., & Gordon, E. (2003). Schizophrenia and affective disorder show different visual scanpath patterns to faces and facial expressions: Is this a trait versus state-based distinction? *Schizophrenia Research*, *60*(1), 267. https://doi.org/10.1016/s0920-9964(03)80413-9

Luminet, O., Bagby, R. M., & Taylor, G. J. (2001). An evaluation of the absolute and relative stability of alexithymia in patients with major depression. *Psychotherapy and Psychosomatics*, *70*(5), 254–260.

Luna, B., Velanova, K., & Geier, C. F. (2008). Development of eye-movement control. *Brain and Cognition*, *68*(3), 293–308. https://doi.org/10.1016/j.bandc.2008.08.019

Mackie, C. J., Conrod, P. J., Rijsdijk, F., & Eley, T. C. (2011). A Systematic Evaluation and Validation of Subtypes of Adolescent Alcohol Use Motives: Genetic and Environmental Contributions. *Alcoholism: Clinical and Experimental Research*, *35*(3), 420–430. https://doi.org/10.1111/j.1530-0277.2010.01359.x

Manchery, L., Yarmush, D. E., Luehring-Jones, P., & Erblich, J. (2017). Attentional bias to alcohol stimuli predicts elevated cue-induced craving in young adult social drinkers. *Addictive Behaviors*, *70*, 14–17. https://doi.org/10.1016/j.addbeh.2017.01.035

Mannan, S., Ruddock, K., & Wooding D. (1995). Automatic control of saccadic eye movements made in visual inspection of briefly presented 2-D images. *Spatial Vision*, *9*(3), 363–386.

Marshall, A. D., & Holtzworth-Munroe, A. (2010). Recognition of Wives' Emotional Expressions: A Mechanism in the Relationship Between Psychopathology and Intimate Partner Violence Perpetration. *Journal of Family Psychology*, *24*(1), 21–30. https://doi.org/10.1037/a0017952

Martin, L. M., & Sayette, M. A. (2018). A review of the effects of nicotine on social functioning. *Experimental and Clinical Psychopharmacology*, *26*(5), 425–439. https://doi.org/10.1037/pha0000208

Mason, O., Tyson, M., Jones, C., & Potts, S. (2005). Alexithymia: its prevalence and correlates in a British undergraduate sample. *Psychology and Psychotherapy: Theory, Research and Practice*, *78*(1), 113–125.

Mathews, A. (1990). Why worry? The cognitive function of anxiety. *Behaviour Research and Therapy*, *28*(6), 455–468. https://doi.org/10.1016/0005-7967(90)90132-3

Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annu.Rev.Clin.Psychol.*, *1*, 167–195.

Mathôt, S., Cristino, F., Gilchrist, I. D., & Theeuwes, J. (2012). A simple way to estimate similarity between pairs of eye movement sequences. *Journal of Eye Movement Research*, *5*(1), 1–15. https://doi.org/10.16910/jemr.5.1.4

Matsumoto et al. (2008). Facial Expressions of Emotion. In M. Lewis, J. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* - (3rd ed., pp. 211–234). Guildford Publications.

Maurage, P., Bestelmeyer, P. E. G., Rouger, J., Charest, I., & Belin, P. (2013). Binge drinking influences the cerebral processing of vocal affective bursts in young adults. *NeuroImage: Clinical*, *3*, 218–225. https://doi.org/10.1016/j.nicl.2013.08.010

Maurage, P., Campanella, S., Philippot, P., Charest, I., Martin, S., & De Timary, P. (2009). Impaired emotional facial expression decoding in alcoholism is also present for emotional prosody and body postures. *Alcohol and Alcoholism*, *44*(5), 476–485. https://doi.org/10.1093/alcalc/agp037

Maurage, P., Campanella, S., Philippot, P., Pham, T. H., & Joassin, F. (2007). The crossmodal facilitation effect is disrupted in alcoholism: A study with emotional stimuli. *Alcohol and Alcoholism*, *42*(6), 552–559. https://doi.org/10.1093/alcalc/agm134

Maurage, P., Grynberg, D., Noel, X., Joassin, F. F., Hanak, C., Verbanck, P., Luminet, O., de Timary, P., Campanella, S., Philippot, P., Noël, X., Joassin, F. F., Hanak, C., Verbanck, P., Luminet, O., de Timary, P., Campanella, S., & Philippot, P. (2011). The "Reading the Mind in the Eyes" test as a new way to explore complex emotions decoding in alcohol dependence. *Psychiatry Research*, *190*(2–3), 375–378. https://doi.org/10.1016/j.psychres.2011.06.015

Maurage, P., Joassin, F., Speth, A., Modave, J., Philippot, P., & Campanella, S. (2012). Cerebral effects of binge drinking: Respective influences of global alcohol intake and consumption pattern. *Clinical Neurophysiology*, *123*(5), 892–901. https://doi.org/10.1016/j.clinph.2011.09.018

Maurage, P., Pesenti, M., Philippot, P., Joassin, F., & Campanella, S. (2009). Latent deleterious effects of binge drinking over a short period of time revealed only by electrophysiological measures. *Journal of Psychiatry and Neuroscience*, *34*(2), 111–118.

Maurage, P., Petit, G., & Campanella, S. (2013). Pathways to alcohol-induced brain impairment in young people: a review by Hermens, et al., 2013. *Cortex*, *49*(4), 1155–1159.

McDonald, S., Bornhofen, C., Shum, D., Long, E., Saunders, C., & Neulinger, K. (2006). Reliability and validity of The Awareness of Social Inference Test (TASIT): A clinical test of social perception. *Disability and Rehabilitation*, *28*(24), 1529–1542. https://doi.org/10.1080/09638280600646185

McIntosh, C., & Chick, J. (2004). Alcohol and the nervous system. In *Neurology in Practice* (Vol. 75, Issue 3). https://doi.org/10.1136/jnnp.2004.045708

McKown, C., Gumbiner, L. M., Russo, N. M., & Lipton, M. (2009). Social-emotional learning skill, self-regulation, and social competence in typically developing and clinic-referred children. *Journal of Clinical Child and Adolescent Psychology*, *38*(6), 858–871. https://doi.org/10.1080/15374410903258934

McNair, D. M., Lorr, M., & Droppleman, L. F. (1971). *Manual for the profile of mood states (POMS).* (Educational and Industrial Testing Service (ed.)). Educational and Industrial Testing Service.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1992). *Profile of mood states: manual* (EdITS (ed.)).

McNeil, J. E., & Warrington, E. K. (1993). Prosopagnosia: A face-specific disorder. *The Quarterly Journal of Experimental Psychology*, *46*(1), 1–10.

Meganck, R., Inslegers, R., Vanheule, S., & Desmet, M. (2011). The convergence of alexithymia measures. *Psychologica Belgica*, *51*(3–4).

Mehrabian, A., & Russell, J. A. (1978). A questionnaire measure of habitual alcohol use. *Psychological Reports*, *43*, 803–806.

Melaugh McAteer, A., Curran, D., & Hanna, D. (2015). Alcohol attention bias in adolescent social drinkers: An eye tracking study. *Psychopharmacology*, *232*(17), 3183–3191. https://doi.org/10.1007/s00213-015-3969-z

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy*, *36*(9), 809–848. https://doi.org/10.1016/S0005-7967(98)00063-1

Mogg, K., Bradley, B. P., De Bono, J. O., & Painter, M. (1997). TIME COURSE OF ATTENTIONAL BIAS FOR THREAT INFORMATION IN NON-CLINICAL ANXIETY. In *Behav. Res. Ther* (Vol. 35, Issue 4).

Molnar, S. M., Beaton, L. E., Happer, J. P., Holcomb, L. A., Huang, S., Arienzo, D., & Marinkovic, K. (2018). Behavioral and brain activity indices of cognitive control deficits in binge drinkers. *Brain Sciences*, *8*(1), 1–19. https://doi.org/10.3390/brainsci8010009

Montebarocci, O., Surcinelli, P., Rossi, N., & Baldaro, B. (2011). Alexithymia, verbal ability and emotion recognition. *Psychiatric Quarterly*, *82*(3), 245–252. https://doi.org/10.1007/s11126-010-9166-7

Moriguchi, Y., & Komaki, G. (2013). Neuroimaging studies of alexithymia: physical, affective, and social perspectives. *BioPsychoSocial Medicine*, *7*(1), 8.

Morrison, R., & Bellack, A. (1981). The role of social perception in social skill. *Behavior Therapy*, *12*(1), 69–79. https://doi.org/10.1016/S0005-7894(81)80107-4

Moselhy, H., Georgiou, G., & Kahn, A. (2001). FRONTAL LOBE CHANGES IN ALCOHOLISM: A REVIEW OF THE LITERATURE. *Alcohol and Alcoholism*, *36*(5), 357–368. https://doi.org/10.1093/alcalc/36.5.357

Mota, N. R., Bau, C. H. D., Banaschewski, T., Buitelaar, J. K., Ebstein, R. P., Franke, B., Gill, M., Kuntsi, J., Manor, I., & Miranda, A. (2013). Association between DRD2/DRD4 interaction and conduct disorder: a potential developmental pathway to alcohol dependence. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, *162*(6), 546–549.

Muggleton, N. G., Juan, C. H., Cowey, A., Walsh, V., & O'Breathnach, U. (2010). Human frontal eye fields and target switching. *Cortex*, *46*(2), 178–184. https://doi.org/10.1016/j.cortex.2009.01.011

Murray, E. A. (2007). The amygdala, reward and emotion. *Trends in Cognitive Sciences*, *11*(11), 489–497. https://doi.org/10.1016/j.tics.2007.08.013

Nelis, D., Quoidbach, J., Mikolajczak, M., & Hansenne, M. (2009). Increasing emotional intelligence: (How) is it possible? *Personality and Individual Differences*, *47*(1), 36–41. https://doi.org/10.1016/j.paid.2009.01.046

NHS. (n.d.). *NHS long-term plan will help problem drinkers and smokers* [Press release]. https://www.england.nhs.uk/2019/01/nhs-long-term-plan-will-help-problem-drinkers-and-smokers/

Nie, D., Wang, X. W., Shi, L. C., & Lu, B. L. (2011). EEG-based emotion recognition during watching movies. *2011 5th International IEEE/EMBS Conference on Neural Engineering, NER 2011*, 667–670. https://doi.org/10.1109/NER.2011.5910636

Noton, D., & Stark, L. (1971). Scanpaths in Eye Movements during Pattern Perception. *Science: AAAS*, *171*(3968), 308–311. https://www.jstor.org/stable/1731012

Nutt, D. (2020). *Drink?: the new science of alcohol and your health*. Hachette UK.

Nyenhuis, D. L., Yamamoto, C., Luchetta, T., Terrien, A., & Parmentier, A. (1999). Adult and geriatric normative data and validation of the profile of mood states. *Journal of Clinical Psychology*, *55*(1), 79–86.

O'Daly, O. G., Trick, L., Scaife, J., Marshall, J., Ball, D., Phillips, M. L., Williams, S. S. C., Stephens, D. N., & Duka, T. (2012). Withdrawal-associated increases and decreases in functional neural connectivity associated with altered emotional regulation in alcoholism. *Neuropsychopharmacology*, *37*(10), 2267–2276. https://doi.org/10.1038/npp.2012.77

Ochsner, K. N. (2004). Current directions in social cognitive neuroscience. In *Current Opinion in Neurobiology* (Vol. 14, Issue 2, pp. 254–258). https://doi.org/10.1016/j.conb.2004.03.011

Ohira, H., Nomura, M., Ichikawa, N., Isowa, T., Iidaka, T., Sato, A., Fukuyama, S., Nakajima, T., & Yamada, J. (2006). Association of neural and physiological responses during voluntary emotion suppression. *NeuroImage*, *29*(3), 721–733. https://doi.org/10.1016/j.neuroimage.2005.08.047

Oishi, S., Schiller, J., & Gross, E. B. (2013). Felt Understanding and Misunderstanding Affect the Perception of Pain, Slant, and Distance. *Social Psychological and Personality Science*, *4*(3), 259–266. https://doi.org/10.1177/1948550612453469

Ortony, A., & Turner, T. J. (1990). What's basic about basic emotions? *Psychological Review*, *97*(3), 315.

Oscar-Berman, M., & Marinkovic, K. (2003). *Alcoholism and the brain: An Overview*. https://www.researchgate.net/publication/8406770

Oscar-Berman, M., & Marinković, K. (2007). Alcohol: Effects on Neurobehavioral Functions and the Brain. *Neuropsychology Review*, *17*(3), 239–257. https://doi.org/10.1007/s11065-007-9038-6

Palermo, R., & Coltheart, M. (2004). Photographs of facial expression: Accuracy, response times, and ratings of intensity. *Behavior Research Methods, Instruments, and Computers*, *36*(4), 634–638. https://doi.org/10.3758/BF03206544

Papachristou, H., Nederkoorn, C., Havermans, R., Van Der Horst, M., & Jansen, A. (2012). Can't stop the craving: The effect of impulsivity on cue-elicited craving for alcohol in heavy and light social drinkers. *Psychopharmacology*, *219*(2), 511–518. https://doi.org/10.1007/s00213-011-2240-5

Parada, M. M., Corral, M., Mota, N., Crego, A., Rodríguez Holguín, S., Cadaveira, F., Holgun, S. R., & Cadaveira, F. (2012). Executive functioning and alcohol binge drinking in university students. *Addictive Behaviors*, *37*(2), 167–172. https://doi.org/10.1016/j.addbeh.2011.09.015

Parker, J. D. A., Taylor, G. J., & Bagby, R. M. (2003). The 20-Item Toronto Alexithymia Scale: III. Reliability and factorial validity in a community population. *Journal of Psychosomatic Research*, *55*(3), 269–275. https://doi.org/10.1016/S0022-3999(02)00578-0

Parsons, O. A. (1998). Neurocognitive deficits in alcoholics and social drinkers: a continuum? *Alcoholism: Clinical and Experimental Research*, *22*(4), 954–961.

Parsons, T. D. (2015). Virtual reality for enhanced ecological validity and experimental control in the clinical, affective and social neurosciences. *Frontiers in Human Neuroscience*, *9*(DEC). https://doi.org/10.3389/fnhum.2015.00660

Patton J, S, S. M., & S, B. E. (1995). Factor Structure of the Barratt Impulsiveness Scale. In *Journal of Clinical Psychology* (Vol. 51, Issue 6, pp. 768–774).

Pedersen, W., & Von soest, T. (2015). Adolescent alcohol use and binge drinking: An 18-year trend study of prevalence and correlates. *Alcohol and Alcoholism*, *50*(2), 219–225. https://doi.org/10.1093/alcalc/agu091

Pennington, C. R., Qureshi, A. W., Monk, R. L., Greenwood, K., & Heim, D. (2019). Beer? Over here! Examining attentional bias towards alcoholic and appetitive stimuli in a visual search eye-tracking task. *Psychopharmacology*. https://doi.org/10.1007/s00213-019-05313-0

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage*, *16*(2), 331–348. https://doi.org/10.1006/nimg.2002.1087

Philippot, P., Kornreich, C., Blairy, S., Baert, I., Dulk, A. Den, Bon, O. Le, Streel, E., Hess, U., Pelc, I., & Verbanck, P. (1999). Alcoholics' deficits in the decoding of emotional facial expression. *Alcoholism: Clinical & Experimental Research*, *23*(6), 1031–1038. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med4&AN=10397287

Phillips, D. C., & Burbules, N. C. (2000). *Postpositivism and educational research*. Rowman & Littlefield.

Pitcher, D., Dilks, D. D., Saxe, R. R., Triantafyllou, C., & Kanwisher, N. (2011). Differential selectivity for dynamic versus static information in face-selective cortical regions. *NeuroImage*, *56*(4), 2356–2363. https://doi.org/10.1016/j.neuroimage.2011.03.067

Polich, J. (2007). Updating P300: An Integrative Theory of P3a and P3b John. *Clinical Neurophysiology*, *118*(10), 2128–2148. https://doi.org/10.1016/j.clinph.2007.04.019.Updating

Posamentier, M. T., & Abdi, H. (2003). Processing Faces and Facial Expressions. In *Neuropsychology Review* (Vol. 13, Issue 3, pp. 113–143). https://doi.org/10.1023/A:1025519712569

Posner, M. I., Walker, J. A., Friedrich, F. J., & Rafal, R. D. (1984). Effects of parietal injury on covert orienting of attention. *Journal of Neuroscience*, *4*(7), 1863–1874. https://doi.org/10.1523/jneurosci.04-07-01863.1984

Preti, E., Richetin, J., Suttora, C., & Pisani, A. (2016). Individual differences in components of impulsivity and effortful control moderate the relation between borderline personality disorder traits and emotion recognition in a sample of university students. *Psychiatry Research*, *238*, 109–115. https://doi.org/10.1016/j.psychres.2016.02.037

Recio, G., Sommer, W., & Schacht, A. (2011). Electrophysiological correlates of perceiving and evaluating static and dynamic facial emotional expressions. *Brain Research*, *1376*, 66–75. https://doi.org/10.1016/j.brainres.2010.12.041

Reinert, D. F., & Allen, J. P. (2007). The alcohol use disorders identification test: An update of research findings. *Alcoholism: Clinical and Experimental Research*, *31*(2), 185–199. https://doi.org/10.1111/j.1530-0277.2006.00295.x

Rezaei, A., & Khosroshahi, J. B. (2018). Optimism, social intelligence and positive affect as predictors of university students' life satisfaction. *European Journal of Mental Health*, *13*(2), 150–162. https://doi.org/10.5708/EJMH.13.2018.2.3

Rinck, M., Glowalla, U., & Schneider, K. (1992). Mood-congruent and mood-incongruent learning. *Memory & Cognition*, *20*(1), 29–39.

Rolls, E. T., & Grabenhorst, F. (2008). The orbitofrontal cortex and beyond: From affect to decision-making. *Progress in Neurobiology*, *86*(3), 216–244. https://doi.org/10.1016/j.pneurobio.2008.09.001

Rose, A. K., & Duka, T. (2007). The influence of alcohol on basic motoric and cognitive disinhibition. *Alcohol and Alcoholism*, *42*(6), 544–551. https://doi.org/10.1093/alcalc/agm073

Rottenberg, J., Gross, J. J., & Gotlib, I. H. (2005). Emotion context insensitivity in major depressive disorder. *Journal of Abnormal Psychology, 114*(4), 627.

Roy, S., Roy, C., Ethier-Majcher, C., Fortin, I., Belin, P., & Gosselin, F. (2007). STOIC: A database of dynamic and static faces expressing highly recognizable emotions. *J Vis*, *7*(514), 944. https://pdfs.semanticscholar.org/d453/e0d308919867b5814beb1394cd0cc1cb2378.pdf%0Ahttp://www.mapageweb.umontreal.ca/gosselif/sroyetal_sub.pdf

Ruffman, T., Henry, J. D., Livingstone, V., & Phillips, L. H. (2008). A meta-analytic review of emotion recognition and aging: Implications for neuropsychological models of aging. In *Neuroscience and Biobehavioral Reviews* (Vol. 32, Issue 4, pp. 863–881). https://doi.org/10.1016/j.neubiorev.2008.01.001

Rupp, C. I., Derntl, B., Osthaus, F., Kemmler, G., & Fleischhacker, W. W. (2017). Impact of Social Cognition on Alcohol Dependence Treatment Outcome: Poorer Facial Emotion Recognition Predicts Relapse/Dropout. *Alcoholism: Clinical & Experimental Research*, *41*(12), 2197–2206. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med13&AN=28992398

Russell, T. A., Green, M. J., Simpson, I., & Coltheart, M. (2008). Remediation of facial emotion perception in schizophrenia: Concomitant changes in visual attention. *Schizophrenia Research*, *103*(1–3), 248–256. https://doi.org/10.1016/j.schres.2008.04.033

Rusting, C. L., & DeHart, T. (2000). Retrieving positive memories to regulate negative mood: consequences for mood-congruent memory. *Journal of Personality and Social Psychology*, *78*(4), 737–752.

Rybakowski, J., Ziółkowski, M., Zasadzka, T., & Brzeziński, R. (1988). High prevalence of alexithymia in male patients with alcohol dependence. *Drug and Alcohol Dependence*, *21*(2), 133–136.

Salloum, J. B., Ramchandani, V. A., Bodurka, J., Rawlings, R., Momenan, R., George, D., & Hommer, D. W. (2007). Blunted rostral anterior cingulate response during a simplified decoding task of negative emotional facial expressions in alcoholic patients. *Alcoholism: Clinical and Experimental Research*, *31*(9), 1490–1504. https://doi.org/10.1111/j.1530-0277.2007.00447.x

Sasson, N., Tsuchiya, N., Hurley, R., Couture, S. M., Penn, D. L., Adolphs, R., & Piven, J. (2007). Orienting to social stimuli differentiates social cognitive impairment in autism and schizophrenia. *Neuropsychologia*, *45*(11), 2580–2588. https://doi.org/10.1016/j.neuropsychologia.2007.03.009

Saunders, J. B., Aasland, O. G., Babor, T. F., la Fuente, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. *Addiction*, *88*(6), 791–804.

Sawyer, K. S., Maleki, N., Urban, T., Marinkovic, K., Karson, S., Ruiz, S. M., Harris, G. J., & Oscar-Berman, M. (2019). Alcoholism gender differences in brain responsivity to emotional stimuli. *ELife*, *8*. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=prem&AN=31038125

Sayette, M. A. (2017). The effects of alcohol on emotion in social drinkers. *Behaviour Research & Therapy*, *88*, 76–89. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med13&AN=28110679

Schmid, P. C., Mast, M. S., Bombari, D., Mast, F. W., & Lobmaier, J. S. (2011). How mood states affect information processing during facial emotion recognition: An eye tracking study. *Swiss Journal of Psychology*, *70*(4), 223–231. https://doi.org/10.1024/1421-0185/a000060

Schmid, P. C., & Schmid Mast, M. (2010). Mood effects on emotion recognition. *Motivation and Emotion*, *34*(3), 288–292. https://doi.org/10.1007/s11031-010-9170-0

Schmidt-Daffy, M. (2011). Modeling Automatic Threat Detection: Development of a Face-in-the-Crowd Task. *Emotion*, *11*(1), 153–168. https://doi.org/10.1037/a0022018

Schotten, M. T. De, Urbanski, M., Duffau, H., Volle, E., Levy, R., Dubois, B., & Bartolomeo, P. (2010). Direct Evidence for a Parietal- Frontal Pathway Subserving Spatial Awareness in Humans. *Science: AAAS*, *309*(5744), 2226–2228. https://doi.org/10.1126/science.1116251

Schurgin, M. W., Nelson, J., Iida, S., Ohira, H., Chiao, J. Y., & Franconeri, S. L. (2014). Eye movements during emotion recognition in faces. *Journal of Vision*, *14*(13), 1–16. https://doi.org/10.1167/14.13.14.doi

Schyns, P. G., Petro, L. S., & Smith, M. L. (2009). Transmission of facial expressions of emotion co-evolved with their efficient decoding in the brain: Behavioral and brain evidence. *PLoS ONE*, *4*(5). https://doi.org/10.1371/journal.pone.0005625

Senior, C., Hassel, S., Waheed, A., & Ridout, N. (2018). Naming Emotions in Motion: Alexithymic Traits Impact the Perception of Implied Motion in Facial Displays of Affect. *Emotion*, *20*(2), 311–316. https://doi.org/10.1037/emo0000546

Shacham, S. (1983). A shortened version of the Profile of Mood States. *Journal of Personality Assessment*, *47*(3), 305–306.

Shasteen, J. R., Sasson, N. J., & Pinkham, A. E. (2014). Eye tracking the face in the crowd task: Why are angry faces found more quickly? *PLoS ONE*, *9*(4). https://doi.org/10.1371/journal.pone.0093914

Shin, S. H., Hong, H. G., & Jeon, S.-M. (2012). Personality and alcohol use: the role of impulsivity. *Addictive Behaviors*, *37*(1), 102–107.

Slutske, W. S. (2005). Alcohol Use Disorders Among US College Students and Their Non–College-Attending Peers. *Archives of General Psychiatry*, *62*(3), 321–327. https://doi.org/10.1001/archpsyc.62.3.321

Smeraldi, C., Angelone, S. M., Movalli, M., Cavicchioli, M., Mazza, G., Notaristefano, A., & Maffei, C. (2015b). Testing three theories of cognitive dysfunction in alcohol abuse. *Journal of Psychopathology*, *21*(2), 125–132.

Spezio, M. L., Adolphs, R., Hurley, R. S. E., & Piven, J. (2007). Abnormal use of facial information in high-functioning autism. *Journal of Autism and Developmental Disorders*, *37*(5), 929–939. https://doi.org/10.1007/s10803-006-0232-9

Spielberger, C., & Gorsuch, R. (1983). *State-trait anxiety inventory for adults: Manual and sample: Manual, instrument and scoring guide*.

Spilka, M. J., Pittman, D. J., Bray, S. L., & Goghari, V. M. (2019). Manipulating Visual Scanpaths During Facial Emotion Perception Modulates Functional Brain Activation in Schizophrenia Patients and Controls Michael. *Journal of Abnormal Psychology*, *128*(8), 855–866. https://doi.org/10.1037/abn0000468.supp

Spinella, M. (2004). Neurobehavioral correlates of impulsivity: evidence of prefrontal involvement. *International Journal of Neuroscience*, *114*(1), 95–104.

Spinella, M. (2007). Normative data and a short form of the Barratt Impulsiveness Scale. *International Journal of Neuroscience*, *117*(3), 359–368.

Sprengelmeyer, R., Young, A. W., Sprengelmeyer, A., Calder, A. J., Rowland, D., Perrett, D., Hömberg, V., & Lange, H. (1997). Recognition of Facial Expressions: Selective Impairment of Specific Emotions in Huntington's Disease. *Cognitive Neuropsychology*, *14*(6), 839–879. https://doi.org/10.1080/026432997381376

Sripada, C. S., Angstadt, M., McNamara, P., King, A. C., & Phan, K. L. (2011). Effects of alcohol on brain responses to social signals of threat in humans. *NeuroImage*, *55*(1), 371–380. https://doi.org/10.1016/j.neuroimage.2010.11.062

Stanford, M. S., Houston, R. J., Mathias, C. W., Villemarette-Pittman, N. R., Helfritz, L. E., & Conklin, S. M. (2003). Characterizing aggressive behavior. *Assessment*, *10*(2), 183–190.

Stanford, M. S., Mathias, C. W., Dougherty, D. M., Lake, S. L., Anderson, N. E., & Patton, J. H. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences*, *47*(5), 385–395.

Stapinski, L. A., Edwards, A. C., Hickman, M., Araya, R., Teesson, M., Newton, N. C., Kendler, K. S., & Heron, J. (2016). Drinking to Cope: a Latent Class Analysis of Coping Motives for Alcohol Use in a Large Cohort of Adolescents. *Prevention Science*, *17*(5), 584–594. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med12&AN=27129479

Statistics on Alcohol, England 2020. (2020, February 4). NHS. Retrieved September 8, 2021, from https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-alcohol/2020

Stephens, D. N., & Duka, T. (2008). Cognitive and emotional consequences of binge drinking: role of amygdala and prefrontal cortex. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1507), 3169–3179.

Stephens, D. N., Ripley, T. L., Borlikova, G., Schubert, M., Albrecht, D., Hogarth, L., & Duka, T. (2005). Repeated ethanol exposure and withdrawal impairs human fear conditioning and depresses long-term potentiation in rat amygdala and hippocampus. *Biological Psychiatry*, *58*(5), 392–400. https://doi.org/10.1016/j.biopsych.2005.04.025

Stets, J., & Turner, J. (2008). The sociology of emotions. In M. Lewis, J. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (3rd ed., pp. 32–47). The Guildford Press.

Streit, M., Wölwer, W., & Gaebel, W. (1997). Facial-affect recognitionand visual scanning behaviour in the course of schizophrenia. *Schizophrenia Research*, *24*(3), 311–317. https://doi.org/10.1016/S0920-9964(96)00126-0

Sullivan, S., Campbell, A., Hutton, S. B., & Ruffman, T. (2017). What's good for the goose is not good for the gander: Age and gender differences in scanning emotion faces. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, *72*(3), 441–447. https://doi.org/10.1093/geronb/gbv033

Surguladze, S. A., Young, A. W., Senior, C., Brébion, G., Travis, M. J., & Phillips, M. L. (2004). Recognition Accuracy and Response Bias to Happy and Sad Facial Expressions in Patients With Major Depression. *Neuropsychology*, *18*(2), 212–218. https://doi.org/10.1037/0894-4105.18.2.212

Tabachnick, B. G., & Fidell, L. S. (2014). *Using multivariate statistics: Pearson new international edition*. Pearson.

Tajfel, H., & Turner, J. (1979). *An Integrative Theory of Intergroup Conflict* (pp. 33–47).

Taylor, A. J. G., & Jose, M. (2014). Physical aggression and facial expression identification. *Europe's Journal of Psychology*, *10*(4), 650–659. https://doi.org/10.5964/ejop.v10i4.816

Taylor, G. J., Bagby, R. M., & Luminet, O. (2000). Assessment of alexithymia: Self-report and observer-rated measures. *The Handbook of Emotional Intelligence*, 301–319.

Taylor, G. J., Bagby, R. M., & Parker, J. D. A. (2003). The 20-Item Toronto Alexithymia Scale: IV. Reliability and factorial validity in different languages and cultures. *Journal of Psychosomatic Research*, *55*(3), 277–283. https://doi.org/10.1016/S0022-3999(02)00601-3

Taylor, S. P., & Chermack, S. T. (1993). Alcohol, drugs and human physical aggression. *Journal of Studies on Alcohol, Supplement*, *11*, 78–88.

Tellegen, A. (1985). *Structures of mood and personality and their relevance to assessing anxiety, with an emphasis on self-report.*

Terry, P. C., & Lane, A. M. (2003). Construct validity of the POMS-A for use with adults. *Psychology of Sport and Exercise*, *4*, 125–139.

Terry, P. C., Lane, A. M., Lane, H. J., & Keohane, L. (1999). Development and validation of a mood measure for adolescents. *Journal of Sports Sciences*, *17*(11), 861–872.

Thompson, A. E., Voyer, D., Thompson, A. E., & Voyer, D. (2018). Sex differences in the ability to recognise non- verbal displays of emotion : A meta-analysis Sex differences in the ability to recognise non-verbal displays of emotion : A meta-analysis. *Cognition and Emotion*, *28*(7), 1164–1195. http://dx.doi.org/10.1080/02699931.2013.875889

Thomson, A. D., Guerrini, I., Bell, D., Drummond, C., Duka, T., Field, M., Kopelman, M., Lingford-Hughes, A., Smith, I., Wilson, K., & Marshall, E. J. (2012). Alcohol-Related Brain Damage: Report from a Medical Council on Alcohol Symposium, June 2010. *Alcohol and Alcoholism*, *47*(2), 84–91. https://doi.org/10.1093/alcalc/ags009

Thorberg, F. A., Young, R. M., Sullivan, K. A., & Lyvers, M. (2009). Alexithymia and alcohol use disorders: a critical review. *Addictive Behaviors*, *34*(3), 237–245. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med6&AN=19010601

Tognin, S., Catalan, A., Modinos, G., Kempton, M. J., Bilbao, A., Nelson, B., Pantelis, C., Riecher-Rössler, A., Bressan, R., Barrantes-Vidal, N., Krebs, M. O., Nordentoft, M., Ruhrmann, S., Sachs, G., Rutten, B. P. F., Van Os, J., De Haan, L., Van Der Gaag, M., McGuire, P., & Valmaggia, L. R. (2020). Emotion recognition and adverse childhood experiences in individuals at clinical high risk of psychosis. *Schizophrenia Bulletin*, *46*(4), 823–833. https://doi.org/10.1093/schbul/sbz128

Tomkins, S. S., & McCarter, R. (1964). What and Where are the Primarey Affeccts? Some evidence for a theory. *Perceptual and Motor Skills*, *18*, 119–158. https://doi.org/10.2466/pms.1964.18.1.119

Torro-Alves, N., Bezerra, I. A. de O., Rodrigues, M. R., Machado-de-Sousa, J. P. J. P., de Lima Osrio, F., Crippa, J. A., e Claudino, R. G., Rodrigues, M. R., Machado-de-Sousa, J. P. J. P., Osório, F. de L., & Crippa, J. A. (2016). *Facial emotion recognition in social anxiety: The influence of dynamic information*. *9*(1). https://doi.org/10.1037/pne0000042

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., Marcus, D. J., Westerlund, A., Casey, B., & Nelson, C. (2009). The NimStim set of facial expressions: Judgments from untrained research participants Nim. *Psychiatry Research*, *168*(3), 242–249. https://doi.org/doi:10.1016/j.psychres.2008.05.006.

Townshend, J. M., & Duka, T. (2002). Patterns of alcohol drinking in a population of young social drikers: A comparison of questionnaire and diary measures. *Alcohol & Alcoholism*, *37*(2), 187–192. http://www.ncbi.nlm.nih.gov/pubmed/11912076

Townshend, J. M., & Duka, T. (2003). Mixed emotions: alcoholics' impairments in the recognition of specific emotional facial expressions. *Neuropsychologia*, *41*(7), 773–782. https://doi.org/10.1016/S0028-3932(02)00284-1

Townshend, J. M., & Duka, T. (2005). Binge drinking, cognitive performance and mood in a population of young social drinkers. *Alcoholism: Clinical and Experimental Research*, *29*(3), 317–325. https://doi.org/10.1097/01.ALC.0000156453.05028.F5

Townshend, J. M., Kambouropoulos, N., Griffin, A., Hunt, F. J., & Milani, R. M. (2014). Binge drinking, reflection impulsivity, and unplanned sexual behavior: impaired decision-making in young social drinkers. *Alcoholism: Clinical and Experimental Research*, *38*(4), 1143–1150.

Tracy, J. L., & Robins, R. W. (2008). The Automaticity of Emotion Recognition. *Emotion*, *8*(1), 81–95. https://doi.org/10.1037/1528-3542.8.1.81

Trautmann, S. A., Fehr, T., & Herrmann, M. (2009). Emotions in motion: Dynamic compared to static facial expressions of disgust and happiness reveal more widespread emotion-specific activations. *Brain Research*, *1284*, 100–115. https://doi.org/10.1016/j.brainres.2009.05.075

Turner, J. C., Brown, R. J., & Tajfel, H. (1979). Social comparison and group interest in ingroup favouritism. *European Journal of Social Psychology*, *9*(2), 187–204. https://doi.org/10.1002/ejsp.2420090207

Ucros, C. G. (1989). Mood state-dependent memory: A meta-analysis. *Cognition and Emotion*, *3*(2), 139–169.

Uddin, L., Nomi, J., Hebert-Seropian, B., Ghaziri, J., & Boucher, O. (2017). Structure and function of the human insula Lucina. *Journal of Cliniical Neurophysiology*, *34*(4), 300–306. https://doi.org/10.1097/WNP.0000000000000377.Structure

Van Kleef, G. A. (2010). The Emerging View of Emotion as Social Information. *Social and Personality Psychology Compass*, *4*(5), 331–343. https://doi.org/10.1111/j.1751-9004.2010.00262.x

Vassallo, S., Cooper, S. L., & Douglas, J. M. (2009). Visual scanning in the recognition of facial affect: Is there an observer sex difference? *Journal of Vision*, *9*(3), 1–10. https://doi.org/10.1167/9.3.11

Vernet, M., Quentin, R., Chanes, L., Mitsumasu, A., & Valero-Cabré, A. (2014). Frontal eye field, where art thou? Anatomy, function, and non-invasive manipulation of frontal regions involved in eye movements and associated cognitive operations. *Frontiers in Integrative Neuroscience*, *8*(AUG), 1–24. https://doi.org/10.3389/fnint.2014.00066

Vernooij, M. W., Ikram, M. A., Tanghe, H. L., Vincent, A. J. P. E., Hofman, A., Krestin, G. P., Niessen, W. J., Breteler, M. M. B., & van der Lugt, A. (2007). Incidental findings on brain MRI in the general population. *New England Journal of Medicine*, *357*(18), 1821–1828.

Visser-Keizer, A. C., Westerhof-Evers, H. J., Gerritsen, M. J. J., Van Naalt, J. Der, & Spikman, J. M. (2016). To fear is to gain? The role of fear recognition in risky decision making in TBI patients and healthy controls. *PLoS ONE*, *11*(11), 1–16. https://doi.org/10.1371/journal.pone.0166995

Wagner, H. L. (1993). On measuring performance in category judgment studies of nonverbal behavior. *Journal of Nonverbal Behavior*, *17*(1), 3–28. https://doi.org/10.1007/BF00987006

Walker-Smith, G. J. (1980). Memorizing facial identity, expression and orientation. *British Journal of Psychology*, *71*(3), 415–424. https://doi.org/10.1111/j.2044-8295.1980.tb01756.x

Walter, N. T., Mutic, S., Markett, S., Montag, C., Klein, A. M., & Reuter, M. (2011). The influence of alcohol intake and alcohol expectations on the recognition of emotions. *Alcohol and Alcoholism*, *46*(6), 680–685. https://doi.org/10.1093/alcalc/agr082

Watson, D., & Clark, L. A. (1997). Measurement and mismeasurement of mood: Recurrent and emergent issues. *Journal of Personality Assessment*, *68*(2), 267–296.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin*, *98*(2), 219.

Weafer, J., Gallo, D. A., & de Wit, H. (2016). Acute Effects of Alcohol on Encoding and Consolidation of Memory for Emotional Stimuli. *Journal of Studies on Alcohol & Drugs*, *77*(1), 86–94. https://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med12&AN=26751358

Wechsler, H., & Austin, S. B. (1998). Binge drinking: the five/four measure. In *Journal of studies on alcohol* (Vol. 59, Issue 1).

Weierich, M. R., Treat, T. A., & Hollingworth, A. (2008). Theories and measurement of visual attentional processing in anxiety. In *Cognition and Emotion* (Vol. 22, Issue 6). https://doi.org/10.1080/02699930701597601

Weschler, H., Davenport, A., Dowdall, G., Moeykens, B., & Castillo, S. (1994). *Health and behavioral consequences of binge drinking in college*. *272*(21), 1672–1677.

Whiteside, S. P., & Lynam, D. R. (2001). The five factor model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences*, *30*(4), 669–689.

Williams, D. E., Reingold, E. M., Moscovitch, M., & Behrmann, M. (1997). Patterns of eye movements during parallel and serial visual search tasks. In *Canadian Journal of Experimental Psychology* (Vol. 51, Issue 2, pp. 151–164). https://doi.org/10.1037/1196-1961.51.2.151

Wolfe, J. M. (1994). Guided Search 2.0 A revised model of visual search. *Psychonomic Bulletin & Review*, *1*(2), 202–238. https://doi.org/10.3758/BF03200774

Wrase, J., Makris, N., Braus, D. F., Mann, K., Smolka, M. N., Kennedy, D. N., Caviness, V. S., Hodge, S. M., Tang, L., Albaugh, M., Ziegler, D. A., Davis, O. C., Kissling, C., Schumann, G., Breiter, H. C., & Heinz, A. (2008). Amygdala volume associated with alcohol abuse relapse and craving. *American Journal of Psychiatry*, *165*(9), 1179–1184. https://doi.org/10.1176/appi.ajp.2008.07121877

Yang, J., Wang, A., Yan, M., Zhu, Z., Chen, C., & Wang, Y. (2012). Distinct processing for pictures of animals and objects: Evidence from eye movements. *Emotion*, *12*(3), 540–551. https://doi.org/10.1037/a0026848

Yantis, S. (2000). Goal-directed and stimulus-driven determinants of attentional control. In S. Monsell & J. Driver (Eds.), *Control of Cognitive Processes: Attention and Performance* (pp. 73–103). MIT MA.

Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. In *Cognition and Emotion* (Vol. 24, Issue 1, pp. 3–47). https://doi.org/10.1080/02699930903205698

Yilmaz, K. (2013). Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. *European Journal of Education*, *48*(2), 311–325. https://doi.org/10.1111/ejed.12014

Young, A. W., McWeeny, K. H., Hay, D. C., & Ellis, A. W. (1986). Matching familiar and unfamiliar faces on identity and expression. *Psychological Research*, *48*(2), 63–68. https://doi.org/10.1007/BF00309318

Zhu, X. L., Tan, S. P., De Yang, F., Sun, W., Song, C. S., Cui, J. F., Zhao, Y. L., Fan, F. M., Li, Y. J., Tan, Y. L., & Zou, Y. Z. (2013). Visual scanning of emotional faces in schizophrenia. *Neuroscience Letters*, *552*, 46–51. https://doi.org/10.1016/j.neulet.2013.07.046

Zhu, Y., Zhang, L., Fan, J., & Han, S. (2007). Neural basis of cultural influence on self-representation. *NeuroImage*, *34*(3), 1310–1316. https://doi.org/10.1016/j.neuroimage.2006.08.047

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361–370.

APPENDICES

The DSM-5 merged the terms 'alcohol abuse' and alcohol dependence' to one condition alcohol use disorder (AUD). Any **two** of the criteria below experienced in the previous 12 months is sufficient for an AUD diagnosis. Two to three symptoms is a **mild** disgnosis , 4-5 is **moderate** and experiencing 6 or more is a **severe** AUD.

1. Had times when you ended up drinking more, or longer, than you intended
2. More than once wanted to cut down or stop drinking, or tried to, but couldn't
3. Spent a lot of time drinking, or being sick, or getting over other aftereffects
4. Wanted a drink so badly you couldn't think of anything else?
5. Found that drinking, or being sick from drinking, often interfered with taking care of your home or family or caused job or school problems
6. Continued to drink even though it was causing trouble with your family or friends
7. Given up or cut back on activities that were important or interesting to you, or gave you pleasure, in order to drink
8. More than once gotten into situations while or after drinking that increased your chances of getting jurt (such as driving, swimming, using machinery, waling in a dangerous area, or having unsafe sex)
9. Continued to drink even though it was making you feel depressed or anxious or adding to another health problem, or after having had a memory blackout
10. Had to drink much more than you once did to get the effect you want or hound that your usual number of drinks had much less effect than before
11. Found that when the effects of alcohol were wearing off, you had withdrawal symptoms, such as trouble sleeping, shakiness, restlessness, nausea, sweating, a racing heart, or a seizure, or sensed things that were not there

APPENDIX 2 - ERT Administration script (Chapters 4,5 and 6)

First assessed block–90 trials

With the ERT start screen displayed, say this:

Before we start, I will give you some instructions about how to dothis test. Please listen carefully to the instructions as there will be no practice tries.

In this task you have to identify emotions from facial expressions. First there will be a white cross on the screen. Please always look at the cross, so you are ready for the face which will be shown immediately afterwards.
The face will only appear on the screen for a very short time, so please watch carefully.
Then the face will be covered up, and you will see six boxes describing different emotions. These are: Anger, Happiness, Sadness, Fear, Surprise and Disgust.

Touch the box that you think best describes the emotion on the face that you saw. Try to touch it as quickly as you can.
After you choose an emotion, the white cross will be displayed again, immediately followed by another face. Please always look at the white cross so you are ready for the next problem.

You will find that some faces are harder to read than others, and often you may just have to guess the emotion. This is because the test has been designed so that you are not always conscious of the information presented. But this does not mean that you did not process it!

Remember to always look at the white cross. Do you have any questions before we start?

Repeat the instructions if necessary, then ask:

Are you ready to start?

Press k to start the first assessed block. If the subject needs encouragement, or is hesitating, you can say:

If you can't decide which emotion has been shown, just make your best guess.
Try to respond as quickly as possible.

Second Assess Block-90 Trials

With 'Please wait' on the screen, say this:

You will now see some more faces. Please respond as before.
Are you ready?

When the subject has indicated that they are ready to continue, press k. The test ends after the 90th choice in this block has been made.

APPENDIX 3

DEMOGRAPHICS QUESTIONNAIRE (CHAPTERS 4 AND 5)

Please answer the following questions and then continue by moving on to the next questionnaire. Please be aware that this study requires a response to every question, even if you feel that your response is 'none' or 'not applicable'

Age: ☐ Occupation: eg.Student)___________________

Gender: Male ☐ Female ☐ Year of Study:______________

Ethnicity: ___________________ What is your first language: ______________

What age were you when you had your first alcoholic drink? _________________

What age were you when you first become drunk?_________________________

What age were you when you started to drink alcohol regularly?______________

Have you ever been diagnosed with a learning or reading disability?
Yes_____ No______

Do you have a current Mental Health Diagnosis? Yes ______ No _______

If Yes, what is the diagnosis? ______________________________

Do you currently take any medication for this condition? ____________________

Using the last 7 days as an example, please estimate the number of hours you usually sleep at night? (This is not the length of time spent in bed but actual sleep time)_______________

How many hours did you sleep *last night* ______________________________

Using the last 7 days as an example, how would you rate your sleep quality overall?

Very good ❍ Fairly good ❍ Fairly bad ❍ Very bad ❍

And how would you rate your sleep quality *last night*?

Very good ❍ Fairly good ❍ Fairly bad ❍ Very bad ❍

We are asking you the following questions in order to establish if you have used any drugs that are likely to have an effect on your mood or your response times. This information will be kept entirely anonymous and confidential and will not be shared with any other parties.

Have you ever been diagnosed with substance misuse disorder? Yes_____

No_______

If YES please specify_______________________________________

Please provide details of any drug (including prescribed medications) or alcohol intake during the last 24 hours:

Number of alcoholic drinks in the last 24 hours: ☐

Number of drinks containing caffeine drunk in the last 24 hours: ☐

Number of cigarettes smoked in the last 24 hours: ☐

Please provide details below of any regular (e.g. daily or weekly) drug use. Please include all drugs used, whether they are prescription, non-prescription, legal or illegal drugs?

Thank you for taking the time to complete this questionnaire

APPENDIX 4

DEMOGRAPHICS QUESTIONNAIRE (CHAPTER 6)

DEMOGRAPHICS

Please answer the following questions and then continue by moving on to the next questionnaire. Please be aware that this study requires a response to every question, even if you feel that your response is 'none' or 'not applicable'

Age: ☐ Occupation: eg.Student)________________________

Gender: Male ☐ Female ☐ Year of Study:_______________

Ethnicity: ______________________ What is your first language: _______________________

What age were you when you had your first alcoholic drink? _______________________

What age were you when you first become drunk?_________________________________

What age were you when you started to drink alcohol regularly?____________________

Have you ever been diagnosed with a learning or reading disability? Yes_____ No_____

Do you have a current Mental Health Diagnosis? Yes ______ No ________

If Yes, what is the diagnosis? _______________________________

Do you currently take any medication for this condition?

____

Using the last 7 days as an example, please estimate the number of hours you usually sleep at night? (This is not the length of time spent in bed but actual sleep time)_______________

How many hours did you sleep *last night* _______________________________

Using the last 7 days as an example, how would you rate your sleep quality overall?

Very good ❍ Fairly good ❍ Fairly bad ❍ Very bad ❍

And how would you rate your sleep quality *last night*?

Very good ❍ Fairly good ❍ Fairly bad ❍ Very bad ❍

We are asking you the following questions in order to establish if you have used any drugs that are likely to have an effect on your mood or your response times. This information will be kept entirely anonymous and confidential and will not be shared with any other parties.

If you do not find an answer that fits exactly, indicate the one that comes closest. Please, mark the appropriate answer to each question by making an 'X' on the line.

How frequently have you smoked cigarettes during the LAST 30 DAYS?

____ Not at all
____ Less than 1 cigarette per week
____ Less than 1 cigarettes per day
____ 1-3 cigarettes per day
____ 4-5 cigarettes per day
____ 6-10 cigarettes per day
____ 11-20 cigarettes per day
____ More than 20 cigarettes per day

Have you ever taken tranquillisers or sedatives because a doctor told you to take them?

Tranquillisers and sedatives, (for example Valium, Diazepam, Valium, Temazepam, Restoril, Alprazolam, Niravam, Xanax, Lorazepam, Ativan), are sometimes prescribed by doctors to help people to calm down, get to sleep or to relax. Pharmacies are not supposed to sell them without a prescription

____ No, never
____ Yes, but for less than 3 weeks
____ Yes, for 3 weeks or more

Think about the last year, on how many occasions (if any) have you drunk alcohol together with other psychoactive substances?

Occasions in the last year						
0	1-2	3-5	6-9	10-19	20-39	40 or more

Think about the last year, on how many occasions (if any) have you used recreational drugs?

Occasions in the last year						
0	1-2	3-5	6-9	10-19	20-39	40 or more

Have you ever been diagnose with a substance misuse disorder? Yes _____ No_____

If YES please specify____

Participant Number:

Alcohol Use Questionnaire

The following questions ask you about your use of various types of alcoholic drinks. Please consider your drinking during the last **6 months** when answering these questions.

1. On how many days per week do you drink wine, or any wine-type product (e.g. sherry, port, martini etc.)? Please state your usual brand(s): _________
2. On the days that you drink wine (or similar), about how many glasses (standard pub measure) do you drink? _______ If unsure, please estimate the number of bottles or parts of a bottle: _________
3. How many glasses of wine do you have in a week? ________
4. On how many days per week do you drink beer or cider (at least half a pint)? ______ Please state your usual brand (e.g.: Carling, Harvey's Strongbow etc.): ________
5. On the days that you drink beer/cider, about how many pints do you typically have? ______
6. How many pints of beer/cider do you drink in a week? ______
7. On how many days per week do you drink spirits (e.g. whisky, vodka, gin, rum, alcopops etc.)? _______ Please state your usual brand (e.g. Smirnoff, Bells, Gordon's etc.): _________________________
8. On the days that you drink spirits, about how many standard pub measures do you typically have? ______ If unsure, please estimate the number of bottles or parts of a bottle: ________
9. How many drinks of spirit, do you typically have in a week? _________
10. A) Thinking about the last 6 months, how many times did you get drunk?

Never (0)____Once a month or less (1-6)_____Once a week or less (6-26)___

A few times a week (26-104)______ Almost daily (104-180)_________

B) Thinking about your answer to 10A, approximately how many times have you been drunk in the last 6 months (e.g. loss of co-ordination, nausea, and/or inability to speak clearly)? _______

1. What percentage of the times that you drink do you get drunk?____

2. When you drink, how fast do you drink? (Here, a drink is a glass of wine, a pint of beer, a shot of spirits, straight or mixed). Please tick the appropriate box.

Number of drinks per hour	1 drink	2 drinks	3 drinks	4 drinks	5 drinks	6 drinks	7 + drinks
One drink in 2 hours							
One drink in 3 or more hours							

For the following questions please circle the appropriate responses:

3. On the occasions that you have become drunk, was it your intention to do so? Please circle the appropriate response:

   Never Occasionally Often Always

4. Do you feel under pressure to match the alcohol intake of others, when drinking in company?

   Never Occasionally Often Always

5. How would you rate yourself as a drinker?

   Light drinker Moderate drinker Heavy drinker

The next questions refer to your drinking during the previous <u>12 months</u>

1. How often during the last year have you been unable to remember what happened the night before because you had been drinking?

Never Once 2-3 Times 4-6 Times More than six times

2. How often during the last year have you found that you were not able to stop drinking once you had started?

Never Less than monthly Monthly Weekly Daily or almost daily

3. How often during the last year have you failed to do what was normally expected from you because of drinking?

Never Less than monthly Monthly Weekly Daily or almost daily

4. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?

Never Less than monthly Monthly Weekly Daily or almost daily

5. Do you regard your level of alcohol consumption as problematic?

Never Sometimes Often Always

Thank you for taking the time to complete this questionnaire.

APPENDIX 6 - Alexithymia Questionnaire Toronto TAS-20 (Chapters 4, 5 & 6)

Toronto Alexithymia Scale - T A S – 20

Using the scale provided as a guide, indicate how much you agree or disagree with each of the following statements by circling the corresponding number. Give only one answer for each statement.

Circle 1 if you STRONGLY DISAGREE
Circle 2 if you MODERATELY DISAGREE
Circle 3 if you NEITHER DISAGREE NOR AGREE
Circle 4 if you MODERATELY AGREE
Circle 5 if you STRONGLY AGREE

	Strongly Disagree	**Moderately Disagree**	**Neither Disagree Nor Agree**	**Moderately Agree**	**Strongly Agree**
1. I am often confused about what emotion I am feeling.	1	2	3	4	5
2. It is difficult for me to find the right words for my feelings.	1	2	3	4	5
3. I have physical sensations that even doctors don't understand.	1	2	3	4	5
4. I am able to describe my feelings easily.	1	2	3	4	5
5. I prefer to analyze problems rather than just describe them.	1	2	3	4	5
6. When I am upset, I don't know if I am sad, frightened, or angry.	1	2	3	4	5
7. I am often puzzled by sensations in my body.	1	2	3	4	5
8. I prefer to just let things happen rather than to understand why they turned out that way.	1	2	3	4	5
9. I have feelings that I can't quite identify.	1	2	3	4	5
10. Being in touch with emotions is essential	1	2	3	4	5

	Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree
11. I find it hard to describe how I feel about people.	1	2	3	4	5
12. People tell me to describe my feelings more.	1	2	3	4	5
13. I don't know what's going on inside me.	1	2	3	4	5
14. I often don't know why I am angry.	1	2	3	4	5
15. I prefer talking to people about their daily activities rather than their feelings.	1	2	3	4	5
16. I prefer to watch "light" entertainment shows rather than psychological dramas	1	2	3	4	5
17. It is difficult for me to reveal my innermost feelings, even to close friends.	1	2	3	4	5
18. I can feel close to someone, even in moments of silence.	1	2	3	4	5
19. I find examination of my feelings useful in solving personal problems.	1	2	3	4	5
20. Looking for hidden meanings in movies or plays distracts from their enjoyment.	1	2	3	4	5

APPENDIX 7 – Mood Questionnaire (Chapters 4, 5, and 6)

The PANAS

(Positive Affect Negative Affect Schedule)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way **right now, at this moment**. Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

_______interested	_______irritable
_______distressed	_______alert
_______excited	_______ashamed
_______upset	_______inspired
_______strong	_______nervous
_______guilty	_______determined
_______scared	_______attentive
_______hostile	_______jittery
_______enthusiastic	_______active
_______proud	_______afraid

Thank you for taking the time to complete this questionnaire

APPENDIX 8 – Impulsivity Questionnaire (Chapters 4, 5, and 6)

Barratt Impulsivity Scale

People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X in the appropriate box on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly – the first answer that comes to mind is usually best.		Rarely/Never	Occasionally	Often	Almost Always
1.	I plan tasks carefully				
2.	I do things without thinking.				
3.	I make-up my mind quickly.				
4.	I am happy-go-lucky.				
5.	I don't "pay attention."				
6.	I have "racing" thoughts.				
7.	I plan trips well ahead of time.				
8.	I am self-controlled.				
9.	I concentrate easily.				
10.	I save regularly.				
11.	I "squirm" at plays or lectures.				
12.	I am a careful thinker.				
13.	I plan for job security.				
14.	I say things without thinking.				
15.	I like to think about complex problems.				
16.	I change jobs.				
17.	I act "on impulse."				
18.	I get easily bored when solving thought problems.				
19.	I act on the spur of the moment.				
20.	I am a steady thinker.				
21.	I change residences.				
22.	I buy things on impulse.				
23.	I can only think about one thing at a time.				
24.	I change hobbies.				
25.	I spend or charge more than I earn.				
26.	I often have extraneous thoughts when thinking.				
27.	I am more interested in the present than the future.				
28.	I am restless at the theatre or lectures.				
29.	I like puzzles.				
30.	I am future oriented.				

Thank you for taking the time to complete this questionnaire

APPENDIX 9 – Anxiety Measure (Chapter 6)

State-trait Anxiety Inventory State

How do you feel RIGHT NOW, at this moment on the following scale:

1, not at all; 2, somewhat; 3, moderate; 4, very much.

1)	I feel calm	[1]	[2]	[3]	[4]
2)	I feel secure	[1]	[2]	[3]	[4]
3)	I am tense	[1]	[2]	[3]	[4]
4)	I feel strained	[1]	[2]	[3]	[4]
5)	I feel at ease	[1]	[2]	[3]	[4]
6)	I feel upset	[1]	[2]	[3]	[4]
7)	I am presently worrying over misfortunes	[1]	[2]	[3]	[4]
8)	I feel satisfied	[1]	[2]	[3]	[4]
9)	I feel frightened	[1]	[2]	[3]	[4]
10)	I feel comfortable	[1]	[2]	[3]	[4]
11)	I feel self-confident	[1]	[2]	[3]	[4]
12)	I feel nervous	[1]	[2]	[3]	[4]
13)	I am jittery	[1]	[2]	[3]	[4]
14)	I feel indecisive	[1]	[2]	[3]	[4]
15)	I am relaxed	[1]	[2]	[3]	[4]
16)	I feel content	[1]	[2]	[3]	[4]
17)	I am worried	[1]	[2]	[3]	[4]
18)	I feel confused	[1]	[2]	[3]	[4]
19)	I feel steady	[1]	[2]	[3]	[4]
20)	I feel pleasant	[1]	[2]	[3]	[4]

State-trait Anxiety Inventory Trait

How do you GENERALLY feel on the following scale:

1, not at all; 2, somewhat; 3, moderate; 4, very much.

21)	I feel pleasant	[1] [2] [3] [4]
22)	I feel nervous and restless	[1] [2] [3] [4]
23)	I feel satisfied with myself	[1] [2] [3] [4]
24)	I wish I could be as happy as others seem to be	[1] [2] [3] [4]
25)	I feel like a failure	[1] [2] [3] [4]
26)	I feel rested	[1] [2] [3] [4]
27)	I am „calm, cool and collected“	[1] [2] [3] [4]
28)	I feel that difficulties are piling up so that I cannot overcome them	[1] [2] [3] [4]
29)	I worry too much over something that really doesn't matter	[1] [2] [3] [4]
30)	I am happy	[1] [2] [3] [4]
31)	I have disturbing thoughts	[1] [2] [3] [4]
32)	I lack self-confidence	[1] [2] [3] [4]
33)	I feel secure	[1] [2] [3] [4]
34)	I make decisions easily	[1] [2] [3] [4]
35)	I feel inadequate	[1] [2] [3] [4]
36)	I am content	[1] [2] [3] [4]
37)	Some unimportant thought runs through my mind and bothers me	[1] [2] [3] [4]
38)	I take disappointments so keenly that I can't put them out of my mind	[1] [2] [3] [4]
39)	I am a steady person	[1] [2] [3] [4]
40)	I get in a state of tension or turmoil over my recent concerns and interests	[1] [2] [3] [4]

APPENDIX 10 – Empathy Questionnaire (Chapter 6)

Interpersonal Reactivity Index (IRI)

The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate number on the scale: 1, 2, 3, 4, or 5 where **1 = does not describe me well** and **5 = describes me very well**. READ EACH ITEM CAREFULLY BEFORE RESPONDING. Answer as honestly as you can. Thank you.

Please circle the appropriate number on the scale below where 1=does not describe me well and 5=describes me very well.

	Does not describe me well				Describes me very well
1. I daydream and fantasize, with some regularity, about things that might happen to me.	1	2	3	4	5
2. I often have tender, concerned feelings for people less fortunate than me.	1	2	3	4	5
3. I sometimes find it difficult to see things from the "other guy's" point of view.	1	2	3	4	5
4. Sometimes I don't feel very sorry for other people when they are having problems.	1	2	3	4	5
5. I really get involved with the feelings of the characters in a novel.	1	2	3	4	5
6. In emergency situations, I feel apprehensive and ill-at-ease.	1	2	3	4	5
7. I am usually objective when I watch a movie or play, and I don't often get completely caught up in it.	1	2	3	4	5
8. I try to look at everybody's side of a disagreement before I make a decision.	1	2	3	4	5
9. When I see someone being taken advantage of, I feel kind of protective towards them.	1	2	3	4	5
10. I sometimes feel helpless when I am in the middle of a very emotional situation.	1	2	3	4	5
11. I sometimes try to understand my friends better by imagining how things look from their perspective.	1	2	3	4	5
12. Becoming extremely involved in a good book or movie is somewhat rare for me.	1	2	3	4	5

Interpersonal Reactivity Index Ctd.,

	Please circle the appropriate number on the scale below 1=Does not describe me well				5=Describes me very well
1. When I see someone get hurt, I tend to remain calm.	1	2	3	4	5
2. Other people's misfortunes do not usually disturb me a great deal.	1	2	3	4	5
3. If I'm sure I'm right about something, I don't waste much time listening to other people's arguments.	1	2	3	4	5
4. After seeing a play or movie, I have felt as though I were one of the characters.	1	2	3	4	5
5. Being in a tense emotional situation scares me.	1	2	3	4	5
6. When I see someone being treated unfairly, I sometimes don't feel very much pity for them.	1	2	3	4	5
7. I am usually pretty effective in dealing with emergencies.	1	2	3	4	5
8. I am often quite touched by things that I see happen.	1	2	3	4	5
9. I believe that there are two sides to every question and try to look at them both.	1	2	3	4	5
10. I would describe myself as a pretty soft-hearted person.	1	2	3	4	5
11. When I watch a good movie, I can very easily put myself in the place of a leading character.	1	2	3	4	5
12. I tend to lose control during emergencies.	1	2	3	4	5
13. When I'm upset at someone, I usually try to "put myself in his shoes" for a while.	1	2	3	4	5
14. When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.	1	2	3	4	5
15. When I see someone who badly needs help in an emergency, I go to pieces.	1	2	3	4	5
16. Before criticizing somebody, I try to imagine how I would feel if I were in their place.	1	2	3	4	5

APPENDIX 11 – Participant Information Sheet

Participant Number:

Participant Information Sheet

Project title: Emotion Recognition and Visual Scan Paths in Social Drinkers.

Investigator: Carmel Corcoran
Project supervisor: Dr Raffaella Milani

Invitation to participate

You are being invited to take part in a research study. The main topic areas include alcohol use, emotion recognition and how individuals gather information about emotions to process. You will be asked to complete questionnaires on impulsivity and emotions amongst others and complete two computer tasks involving facial expressions of emotions. Taking part is voluntary; it is up to you to decide whether or not to take part. It is important for you to understand what the research is about and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. If anything is not clear to you or you would like more information please ask.

What is the project about?

The aim of the study is to gain a better understanding of whether different patterns of drinking impact an individual's ability to recognise emotions through facial expressions. Also to identify if there are differences in the way that participants gather information about facial expressions for processing.

What will I be asked to do?

You will be requested to complete some questionnaires that ask about your alcohol intake, mood, impulsivity, empathy and emotion recognition. These questionnaires are completely anonymous and at no time are your responses linked to your name. You will also be asked to complete some computer based tasks. One is an emotion recognition task. You will be shown a series of facial expressions and will be asked to identify which emotion is being expressed from a list displayed on the screen. The second task involves being shown a series of dynamic and static faces on the screen with an eye-tracker again with different facial expressions and you will be asked to identify and rate them.

What will happen to the results of the research study?

The results of this study will be used to help produce my PhD thesis and may be published in academic journals or presented at a conference. Only grouped results will be reported; no individual results will be presented or published. You can be assured that your answers to the questionnaires are completely anonymous and confidential. Your name is never linked to any of the results; a unique participant code is used to link questionnaires and computer tasks.

Can I change my mind?

Yes, you can stop taking part in the study at any time. You can also ask for part or all of your data to be destroyed. You can do this without any negative consequences and you do not need to provide a reason. If you would like to withdraw your data, please contact the lead researcher (details below) with your participant number (at the head on your information sheet) up until the point of submission of the report.

Who can I contact for further information?

If you would like any further information or would like a summary of results once the project is complete please feel free to contact the lead researcher or principal supervisor:

Carmel Corcoran
Email: Carmel.Corcoran@uwl.ac.uk

Raffaella Milani
Email: Raffaella.Milani@uwl.ac.uk

Thank you for your time.

APPENDIX 12 – Consent Form

Participant Number:

CONSENT FORM

Title of Project: Alcohol Use and Emotion Recognition

Name of Lead Investigators: Carmel Corcoran, Dr. Raffaella Milani

Please initial box

1. I confirm that I have read and understand the information sheet dated…………………………. for the above study and have had the opportunity to ask questions. ☐

2. I understand that my response may be recorded. ☐

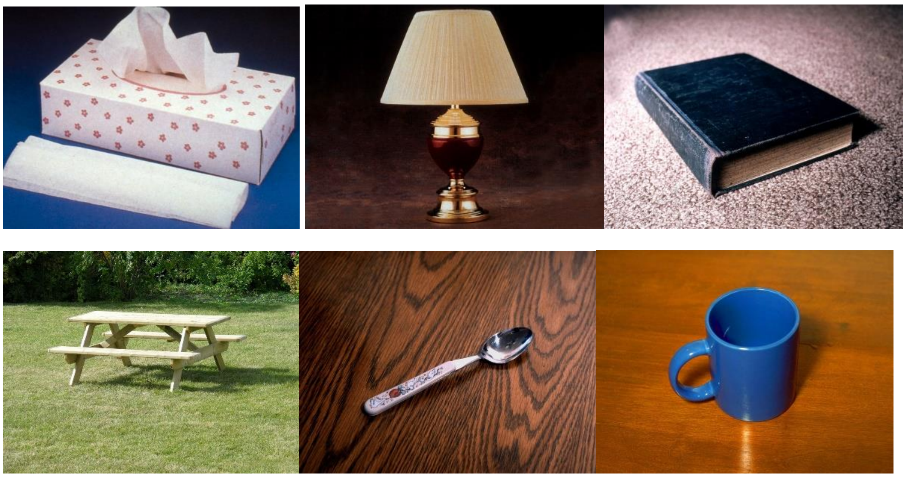
3. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. ☐

4. I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

APPENDIX 13 – IAPS Images

Neutral Images

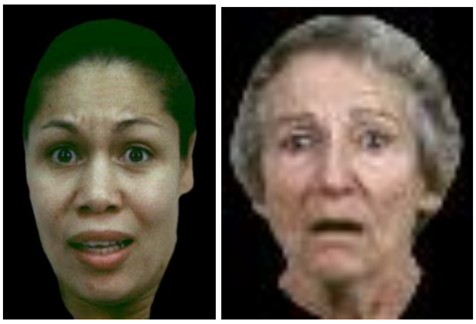


Positive Images

Appendix X – Negative Images

APPENDIX 14 – Facial expressions of emotion (Chapter 5)

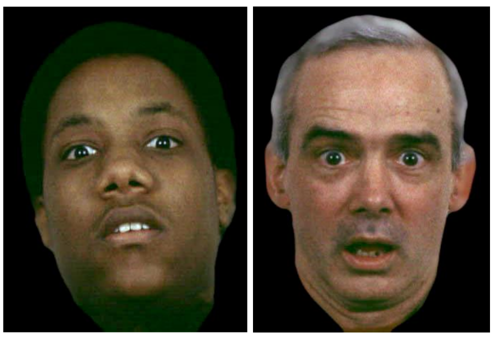
Anger



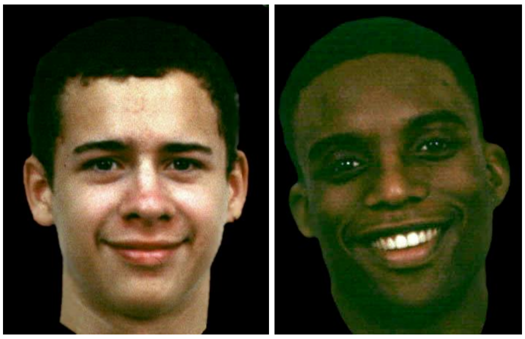
Fear

Happy

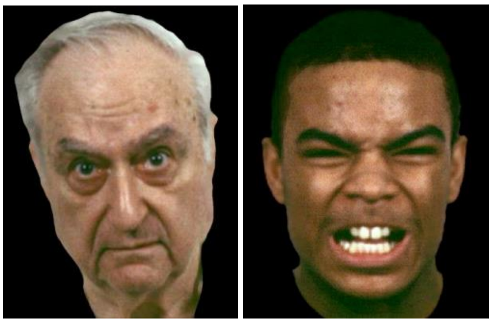
Sad



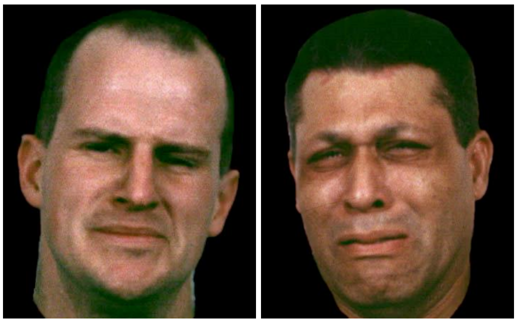
Fear



Happy

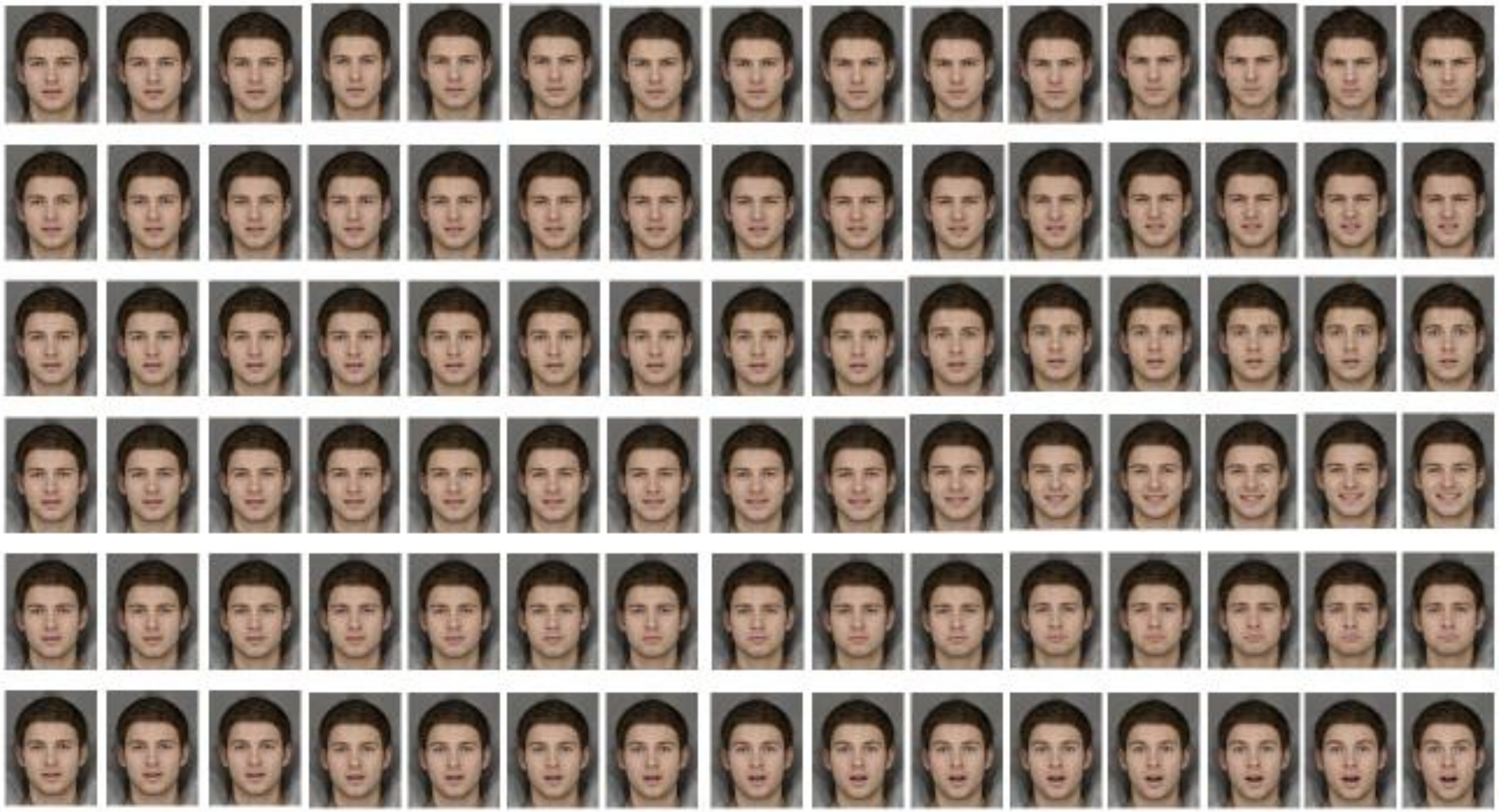


Anger



Sad

APPENDIX 15 – CANTAB Facial expressions with 15 intensities (Chapters 4,5 and 6)



APPENDIX 16 –Static Facial expressions (Chapter 6)

Anger Disgust Fear Happy Neutral Sad Surprise