Investigation of Attention and Mindfulness Training on Attentional bias and Cognitive Control in Drug Addiction

A thesis submitted by

Naranchaya Sriburapar

To the School of Psychology, University of Kent

In partial fulfilment of the requirements for

Doctor of Philosophy

Word count 51,305

June 2020

CONTENTS

CONTENTS ii

LIST OF TABLES iv

LIST OF FIGURES v

DECLARATION ix

ACKNOWLEDGEMENTS x

ABSTRACT xii

Introduction 1

Situation and Impact of drug addiction 1

Definition of drug addiction 2

Treatment of drug addiction 4

Overview of thesis 8

Aim of the thesis and implications 9

Chapter 1 Drug addiction: Theories and Models 10

1.1 Dual-process model 10

1.2 Cognitive model of drug urge and drug-use behaviour 15

1.3 Motivation model of drug-use behaviour 18

1.4 Other contemporary models 19

Chapter 2 Attentional bias, Cognitive control, Attention training: Empirical finding 21

2.1 Attentional bias 21

2.2 Cognitive control 28

2.3 Attention training in drug addiction 29

Chapter 3 Investigation of attentional bias and attention training in drug addiction 41

3.1 Study 1: Attention training in social drinkers 41

3.1.1 Method 44

3.1.2 Result 50

3.1.3 Summary 58

3.2 Study 2: Attentional bias in methamphetamine patients 61

3.2.1 Method 62

3.2.2 Results 64

3.2.3 Summary 85

Chapter 4 Experimental test of mindfulness-based intervention in drug addiction 88

4.1 Study 3: Effects of mindful-colouring on attention and cognitive control in social drinkers 90

4.3.1 Method *91*

4.3.2 Result *94*

4.3.3 Summary *110*

4.2 Study 4: Effects of mindful-colouring on attentional bias and cognitive control in methamphetamine female inpatients 113

4.2.1 Method *113*

4.4.2 Result *116*

4.4.3 Summary *125*

4.3 Study 5: Effects of mindfulness practising in alcohol in-patients 128

4.3.1 Method *130*

4.3.2 Result *133*

4.4.3 Summary *141*

4.4 Study 6: Mindfulness practising in Methamphetamine Patients 144

4.4.1 Method *144*

4.4.2 Result *147*

4.4.3 Summary *159*

Chapter 5 General discussion 164

5.1 Key findings of the present research *164*

5.2 General conclusions *177*

5.3 Theory Implication *178*

5.4 Future research *179*

Reference 180

Appendices 199

Appendix A: Stimuli *199*

Appendix B: Questionnaire and Apparatus *214*

LIST OF TABLES

Table 1 Characteristics of participants allocated to the control and experimental group 50

Table 2 Correlations among variables of interest study 1 55

Table 3 Multiple regression analysis of self-report on attentional bias and sequential modulation 57

Table 4 Descriptive statistic of participants. 64

Table 5 Correlations among variables of interest study 2 68

Table 6 Multiple regression analysis of demography, treatment history, and motivation to change on attentional bias and sequential modulation 69

Table 7 Characteristics of participants allocated to the control and experimental group 95

Table 8 Correlations among variables of interest study 3 106

Table 9 Multiple regression of self-report on attentional bias and sequential modulation 107

Table 10 Comparison of pre-intervention measure data across each group 117

Table 11 Correlations among variables of interest study 4 123

Table 12 Multiple regression of self-report on attentional bias and sequential modulation 124

Table 13 Comparison of pre-training measure data across each group 134

Table 14 Correlations among variables of interest study 5 139

Table 15 Multiple regression of self-report on attentional bias and sequential modulation 140

Table 16 Comparison of pre-intervention measure data across each group 148

Table 17 Correlations among variables of interest study 6 157

Table 18 Multiple regression of self-report on attentional bias and sequential modulation 158

LIST OF FIGURES

Figure 1. A schematic overview of different processes involved in the development of addictive behaviours. This figure is taken from Wiers & Stacy (2006). Implicit cognition and addiction. *Current Directions in Psychological Science, 15(6),* 292–296., p. 293 11

Figure 2. The Baker's model; Panel A: Prototypic drug motivational processing in addiction at low levels of affect and Panel B: Prototypic drug motivational processing in addiction at high levels of affect. This figure is taken from Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological review, 111(1)*, 33., p. 35-36 12

Figure 3. Panel A: The Bindra-Toates model (1974) showing wanting and liking as a single concept, and Panel B: The incentive sensitization model proposed by Robinson & Berridge (1993) showing liking and wanting as two separate concepts. This figure is taken from Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain research reviews, 18(3)*, 247-291., p. 263 14

Figure 4. The cognitive processing model. In an alcoholic who is not trying to quit drinking, alcohol use is controlled by an automatic cognitive process. Under these circumstances, "stimulus triggers" activate automatic processes that result in automatized drug use, and cravings play no role in the control of drinking. When the automatized alcohol use sequences (e.g. driving to favorite bar, entering, sitting down at the bar, and ordering a drink) are blocked by any environmental obstacle (e.g. the bar is closed), the alcoholic must activate non-automatic processes to cope with that problem. These non-automatic processes generate cravings for alcohol (Tiffany, 1999). 17

Figure 5. Model of the alcohol-behaviour link proposed by Moss and Albery (2009). This figure is taken from Moss, A. C., & Albery, I. P. (2009). A dual-process model of the alcohol–behavior link for social drinking. *Psychological Bulletin, 135(4)*, 516., p. 526..... 18

Figure 6. Franken's model showing the possible role of attentional bias in craving, drug use and relapse. This figure is taken from Franken, I. H. (2003). Drug

craving and addiction: integrating psychological and neuropsychopharmacological approaches. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 27(4)*, 563-579., p. 572 19

Figure 7. Field and Cox's integrated model showing relationship between attentional bias, subjective craving and conditioned drug cues. This figure taken from Field, M., & Cox, W. M. (2008). Attentional bias in addictive behaviors: a review of its development, causes, and consequences. *Drug and alcohol dependence, 97(1-2),* 1-20., p. 14 20

Figure 8. Example of Drug Visual probe task. This figure is taken from Lopes, F. M., Pires, A. V., and Bizarro, L. (2014). Attentional bias modification in smokers trying to quit: A longitudinal study about the effects of number of sessions. *Journal of Substance Abuse Treatment*, *47*(1), 50–57., p. 53 31

Figure 9. Example of drug-word Stroop task, participants were asked to identify the font colors of the drug-related words and the neutral words. This figure is taken from Ersche Kd, B. E. T. C. K. J., and et al. (2010). Influence of compulsivity of drug abuse on dopaminergic modulation of attentional bias in stimulant dependence. *Archives of General Psychiatry*, *67*(6), 632–644., p. 634 31

Figure 10. Schema detailing the effects of mindfulness-based intervention components on mechanisms and outcomes implicated in the treatment of addictive behavior. This figure is taken from Garland, E. L., and Howard, M. O. (2018). Mindfulness-based treatment of addiction: current state of the field and envisioning the next wave of research. *Addiction Science & Clinical Practice*, *13*(1), 14., p. 5 38

Figure 11. A model describing the mechanism of de-automatization facilitated by mindfulness. This figure is taken from Kang, Y., Gruber, J., and Gray, J. R. (2013). Mindfulness and de-automatization. *Emotion Review*, *5*(2), 192–201., p. 193 39

Figure 12 Timeline of the procedure of study 1 46

Figure 13. Timeline of Stroop task, showing two trials, an incongruent trial followed by an incongruent trial, with an alcohol image between them. This figure was taken from Sharma, D. (2017). The variable nature of cognitive control in a

university sample of young adult drinkers. *Journal of Applied Social Psychology*, *47*(3), 118–123., p. 120 47

Figure 14. Timeline of one trial of visual probe task 48

Figure 15. Changes in Stroop interference (Incongruent – Congruent) across Time. 52

Figure 16. Stroop interference preceded by each image 52

Figure 17. Current incongruent speed up when previous trial was incongruent 52

Figure 18. At baseline (Time 1), attentional bias was not found in AB.vp and AB, however it was found in AB.SI. 59

Figure 19. Interaction between Previous congruency and Current congruency in patients. 66

Figure 20. Timeline of testing and interventions of study 3 94

Figure 21. The interaction of Image type x Current congruency 97

Figure 22. The interaction of Previous congruency x Current congruency 97

Figure 23. The interaction of Time x Previous x Current 98

Figure 24. The control group (which trained to ignore the neutral picture) showed SM which was preceded by a neutral picture decreased after the intervention. .. 99

Figure 25. Sequential modulation which preceded by neutral picture decreased after 5 minutes mindful colouring. 100

Figure 26. The interaction between Time and Position 101

Figure 27. The interaction between Probe position and Intervention groups 102

Figure 28. Effects of the mindful-colouring task on each variable. 103

Figure 29. Attention task effects at testing before (Time 1and 2) and after (Time 3 and 4) the intervention 105

Figure 30. Timeline of testing and interventions of study 4 116

Figure 31. The interaction between Time and Previous congruency 118

Figure 32. Craving decreased over time 121

Figure 33. Timeline of study 5 133

Figure 34. Movement group had SM preceded by alcohol picture larger than neutral picture. 136

Figure 35. Motivation changes in each group 138

Figure 36. Procedure and Timeline of study 6 147

Figure 37. The interaction between Image and Previous 150

Figure 38. State mindfulness and curiosity increased after the intervention. 151

Figure 39. Pleasant and Arousal were not changed from attentional tasks (Stroop task and Visual probe task) (Time 1 and 2, and Time 3 and 4) and the intervention (Time 2 and 3) 152

Figure 40. Craving scores at pre- and post-intervention 153

Figure 41 Shows the interaction between Group (experimental, control) and Time (2, 4) for all subscales in motivation to change (problem Recognition, Ambivalence, Taking Steps). 154

DECLARATION

The research presented in this thesis was conducted at the School of psychology, University of Kent whilst enrolled as a full-time postgraduate student, and was supported by The Royal Thai Government. The theoretical and empirical work was supported by the supervision of Dr Dinkar Sharma, and the data collection with limited assistance from others. The present work has not contributed to any other degree or qualification.

ACKNOWLEDGEMENTS

Many people have supported me, in many different ways, along the lengthy road to my Ph.D., but there are some to whom I am especially grateful.

Dr Dinkar Sharma, my supervisor, without whose support this thesis would not have been possible. Your trust in me began the day you welcomed me, and has borne me up whenever my confidence has faltered. I believe that the beauty of success lies in the joy it brings, and working with you and your 'Metta', I have learned both research skills and the ability to conduct that research with passion and a smile in my heart. I started this journey to gain additional knowledge and skills in order to help people suffering from addiction. With the journey complete, I know I made the right decision.

My mother, Tassanee Sriburapar, a 74-year-old lady who had previously never been separated from her only child. By sacrificing your own personal happiness, you allowed me to venture far away in order to render an important service to Thailand and make you proud. As I struggled with my task, you endured loneliness. I love you and thank you for being my role model in strength, independence and mindfulness.

My extended family members, Mae Tim, auntie Tim, auntie Nu, cousin Pak, and Pom; my close friends the Young Suwai girl group; my gang of sisters Kuan, Tatt, Gob, Pom, Aoy; the hospital director Thanyarak, and colleagues who have always supported me with love and care. Without you guys, my time in England would have been fraught and lonely.

The Royal Thai government, the official funder, who agreed with my assertion that although drug addiction is a brain disease, Thailand lacks an addiction specialist who has trained in cognitive psychology/neuropsychology. Thank you very much for recognising how important this is for the Thai health care system in Thailand, especially regarding drug addiction. In addition, OEA-UK and OCSC staff have enabled me to enjoy a life as smooth as Thai silk while living and studying in the UK.

My lifetime teacher, Dr. Somchai Teaukul, and Asst. Prof. Pimmas Tapanya, who have always trusted me and raised my spirits. Thank you, Rory Magee and Dr. Kanok Uttawichai, MD., for being my best friends in my job at the drug rehab; without your support, I might never have been able to apply for this Ph.D.

My dearest friends and language experts: Dave Kendall and Aaron Wadsworth.

The Allen family, John, and Alison: thank you for all your help and an unforgettable time in your home. Likewise the Gunning family, Note and Shaun: thank you for being my oasis in the desert.

All the Psychology school staff and friends, especially Lizanne, George, Gary, Frank, and Carly; my Woodlands colleagues Zaffie, Vennessa, Chiao Wei, Jacinta, Vaida, Saghi, and Dr Arnaud Wisman: you guys brought me smiles, laughter and a wonderful workplace environment.

All my Thai friends at Kent Uni. Thai Society, with special thanks to Champ, Mangmoom, Pom, Mark, Natt, Phot, and Bryant. Finally, Mitchell Gibbins, a friend who has walked beside me until the end of my PhD journey (in Covid19 era!), you have always cheered me up and never tired of supporting me with smiles.

ABSTRACT

This thesis investigates the effects of attention and mindfulness training on attentional bias and cognitive control in drug addiction. The thesis begins by describing theoretical models of attentional bias in addictions and the approaches taken to measure addiction-related attentional bias. It then presents six empirical studies. That two studies tested social drinkers who are undergraduate students in the UK, and four studies tested alcohol and methamphetamine inpatients in Thailand. The Stroop task and visual probe task were used to examine attentional bias and cognitive control. The interventions were based on the visual probe paradigm and mindfulness-based activities.

In summary, the findings show i) Attentional bias modification training or daily mindfulness practice did not change attentional bias or cognitive control. ii) Attentional bias was found in non-patients but not in patients whereas cognitive control was found in all studies and was stronger in patients. iii) A new mindful-colouring task was developed that induces cognitive control in patients, decreases craving in both patients and non-patients, and alters affect in non-patients. iv) The daily practice of mindful-breathing and body scan increased motivation to change in alcohol inpatients but not methamphetamine inpatients. Our findings highlight important avenues for further developing attention training programs alongside other treatments.

Introduction

Situation and Impact of drug addiction

Alcohol and drug addiction is the issue over which governments and the World Health Organization (WHO) do not refrain from action because of its impact that not only to individual well-being but to the community and society .A recent Global Status Report (GSR) published by WHO highlights that alcohol consumption is responsible for 3 million deaths annually across the globe, and over 5% of the global burden of disease and injury can be attributed to the consumption of alcohol. Excessive alcohol consumption is known to act as a major risk factor for non-communicable diseases such as cardiovascular disease and cancer, communicable diseases such as tuberculosis, HIV and AIDS, and it is also ranked the seventh leading risk factor for premature death and disability and has also been linked to violent and antisocial behaviour (World Health Organization, 2018a). Furthermore, the use of psychoactive drugs is responsible for causing over 450,000 deaths in 2015 (World Health Organization, 2018b).

In 2019, Thailand had 320 thousand drug abusers (Thai Health Promotion Foundation, 2019). Thailand's Action plan for prevention, suppression and drug treatment in 2019 was to bring drug abusers into the treatment, totaling 219,275 cases (Office of the Narcotics Control Board, 2019). The statistics of drug addiction patients reported by the Princess Mother National Institute on Drug Abuse Treatment (PMNIDAT), the largest hospital for drug addiction in Thailand, governed by the Royal Thai Government, illustrate that the average number of patients who receive treatment from the institute was above 5,500 patients annually between 2015 to 2019, of these about 50% were methamphetamine dependent and 20% were alcohol dependent (Princess Mother National Institute on Drug Abuse Treatment, 2019).

Definition of drug addiction

The World Health Organization provides a clinical description of addiction in the Tenth Revision of the International Classification of Diseases and Health Problems (ICD-10), referring to it as a dependent (to drug) individual who consumes psychoactive drugs (which may or may not have been medically prescribed) and has a tendency to use more and more over time because of the expectation of drug action with effects to physiological, behavioural, and cognition. Evidence indicates a possible return to drug use after a period of abstinence with a reappearance of dependency syndrome that occurs more rapidly than in nondependent individuals (World Health Organization, 1993).

The American psychological association (APA) defines drug addiction in the fifth diagnostic and statistical manual of mental disorders (DSM-5) as, substance use disorder that has two or more substance use disorder criteria within a 12-month period (Hasin, D. S., O'Brien, C. P., Auriacombe, M., Borges, G., Bucholz, K., Budney, A., … Grant, 2013). The criteria are:

1) Unable to control amount of substance that planned to use or using substance for a longer time than desired
2) Failed to stop using substance despite desire to do so
3) Spending time all day or lots of time to recovery from substance use.
4) Having craving or desire for substance
5) Inability to have productive work or social interaction.
6) Continuing usage despite knowing that it causes school/career or professional failure
7) Giving up an important social, professional, or leisure activities because of substance usage
8) Using substance in physically harmful situation.
9) Continuing substance usage despite aware of its consequences.

10) Having tolerance; needing more amount of substance for its desire effects.

11) Having withdrawn symptoms when substance in the body decreases.

The American Society of Addiction Medicine (2019) defines addiction as, dysfunction of reward, motivation, memory and related circuitry that arises in individuals' biological, psychological, social and spiritual expressions of self. Addicts have difficulty in controlling their desires and behaviours related to drugs, easily falling into relapses after periods of abstinence. As is the case with other chronic diseases, it manifests in cycles which cause progressive harm to themselves and the lives around them.

Recently, as part of the addiction theory network (ATN), a group of addiction scholars and researchers argue that addiction is not a brain disease. Addiction is a result of brain developmental, that when the individual repeats a particular behaviour this can lead to changes in the brain. This is how people generally learn and can also characterise addiction (Lewis, 2017). Wiers (see Heather et al., 2018) states that the brain disease model of addiction could be proven, especially if there is focus on the neuron changes specifically related to severity of addiction, these changes do not reverse with prolonged abstinence and these changes increase the risk of relapse after a period of abstinence. It is too early to conclude that addiction is a brain disease in this current state of knowledge. Field, Heather & Wiers (2019) proposed to rethink addiction based on Borsboom et al.'s framework which considers addiction involving*"rational relations"* and *"intentionality"*. For example, *rational relations*: addiction can be primarily determined by the broader social, environmental, cultural, and historical context; *intentionality*: the addict uses the drug to manage negative mood because they remember that the drug has provided short-term relief in the past; many of the addicts eventually recover from addiction without any treatment. This aspect highlights the lack of explanatory power of the brain disease model of addiction.

In conclusion, the medical and mental health field characterizes drug addiction as a state where individuals continue drug consumption; despite it having health, mental health, and social consequences, they have difficulties in stopping usage, and can easily return to drug use after abstinence. Addiction might be looked in medical aspect or psycho-social aspect which might lead to the direction of treatment.

Treatment of drug addiction

The national institute on drug abuse (2018) introduced 13 principles of effective drug treatment:

1) Drug addiction is treatable although it is a complex disease.
2) Choices of treatment must be available due to there is no best treatment for everyone.
3) As soon as having the treatment is the better result in treatment.
4) Effective treatment would provide all that patient needs not only to treat drug for example, education or vocational skills to support life after treatment, interpersonal skills,
5) Duration of treatment is critical for success in maintaining sober.
6) The main and most common addiction treatment is counselling and other behavioural therapies.
7) Medications are needed in many patients, especially when combined with behavioural therapies.
8) Treatment plan needs to be reviewed and modified for patients benefit.
9) Co-occurring with mental health must be addressed, also its treatment plan,
10) Medication-assisted is needed for detoxification at the first stage of the treatment,

11) Motivation to stop drug is important, however, involuntary at the beginning also able to have the expected treatment result,
12) Drug use during treatment must be monitored continuously.
13) Other infection diseases such as HIV, Hepatitis should be tested, also provide information and skills to cope with this illness.

Regarding to the 13 principles of effective drug treatment, medication and behavioural therapy are needed due to the different purpose. These principles covers both medical and non-medical treatment. Medication treatment aims to manage withdrawal symptoms and suppress withdrawal symptoms during detoxification; prevent relapse by helping to re-establish normal brain function and decrease cravings; and treat co-occurring conditions such as depression, anxiety, and psychosis. Medication treatment for cigarette, alcohol and opioid dependency is available, while stimulant and other drugs have no specific medicine to treat them but can be helped by non-medical treatment or behavioural therapy.

Behavioural therapy aims to modify attitudes and behaviours related to drug use, increase healthy life skills, and help the user to persist with other forms of treatment, such as medication, and to continuing a drug-free state. Example of the conventional behavioural therapy are;

Psychotherapy such as cognitive-behavioural therapy (CBT), Motivational interviewing (MI).

Self-help program, a 12 Steps program such as Narcotic Anonymous (NA), Alcoholic anonymous (AA).

Therapeutic Community (TC), a residential program which uses social-learning-behavioural therapy-based model that is concerned with role models, peer pressure, work

and group therapy, and behaviour shaping tools such as promotion and degradation in hierarchy.

Matrix model, an outpatient treatment program for stimulant drugs, CBT-based offering early recovery and relapse prevention knowledge and skills, individual and family counseling and social support group.

Harm reduction, a program to reduce the risks associated with drug-taking, offering testing and treatment for hepatitis or HIV.

These treatments focus on thought and behaviour that clients are consciously aware of, or referred to as explicit cognition. Cognitive psychology distinguishes cognitive process into two types; explicit processes or non-automatic processes, these processes are intentional, controllable, ultimately modifiable, and have relatively slow action, and operate with the conscious awareness; in contrast, implicit processes, or automatic processes are effortless, carried out without intention, relatively stable, and difficult to change. Implicit measures, such as attentional bias (the effect for which drug addicts involuntarily orient their attention toward drug-related cues) have overcome the problems of studying addiction through an explicit approach, that relies on self-report of individuals' attitudes and perceptions, since as individual is unaware of the mechanisms that triggers their drug use behavior (Albery, Sharma, Niazi, & Moss, 2006), the explicit approach is retendered unreliable.

Recently, the behavioural treatment that focuses on the implicit (automatic) processes, such as attention training or attentional bias modification training that train drug addicts' attention away from drug-related cues, has become a promising method in the treatment of addiction (Attwood, O'Sullivan, Leonards, Mackintosh, & Munafò, 2008; R. W. Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013; Rettie, Hogan, & Cox, 2018). This is due to evidence revealing that attentional bias plays a key role in craving and drug relapsing (Sharma, Albery, & Cook, 2001; Cox, Hogan, Kristian, & Race, 2002; Field,

Mogg, & Bradley, 2004). Furthermore, Cox and colleagues suggest that repeated attention training may help heavy drinkers to learn to control their drinking (see Wiers et al., 2006). The training also strengthens cognitive control, the ability to engage in goal-oriented behaviors and allows the brain to overcoming automatic responses (Miller & Cohen, 2001). Wiers & Stacy (2006) suggest that training control over the impulse to use drugs may help to moderate the influence of appetitive processes on drug seeking behavior. However, most of the studies have been conducted in Western culture and with few drug types, which might lead to different effects from those found in Eastern culture.

Additionally, mindfulness-based attentional training targeting compulsive behavior such as over eating behavior and addictive behavior have reported that mindfulness training can decouple craving and eating in overweight individuals (Brewer et al., 2018). Kang, Gruber, & Gray (2013) suggest that mindfulness could discontinue automatic interference, and enhance cognitive control capacity with is the key to success in stopping addictive behaviour. A review of neuropsychological findings of the effects of mindfulness training on cognitive abilities suggests that early phases of mindfulness training could be associated with improvements in selective and executive attention, whereas the following phases could be associated with improved unfocused sustained attention abilities (Chiesa et al., 2011). However, a systematic review by Zgierska et al. (2009) suggest that mindfulness-based intervention in drug addiction treatment is effective and safe but it is lack of studies to suggest specific usage, such as how to use mindfulness-based intervention which would provide the most benefit.

Attention training targeting attentional bias and cognitive control is needed particularly in Eastern culture, in order to expand this knowledge more clearly, and to offer benefits of further development of drug addiction treatment forms.

Overview of thesis

Chapter 1: This chapter presents the theories and models of drug addiction: the Dual-process model, the Cognitive model of drug urges and drug-use behaviour, the Motivation model of drug-use behaviour, and the Neurobiological model of craving.

Chapter 2: Literature review of Attentional bias, Cognitive control and Attention training. Also describes the main methodological approaches that have been adopted to examine attentional bias and cognitive control in relation to addiction and attention training in computer-based attentional modification and mindfulness-based intervention.

Chapter 3: The experiments that investigate attentional bias and cognitive control in social drinkers and methamphetamine inpatients. This chapter presents two studies: Study 1 identified the effect of attention training in social drinkers, use a computer-based attention training (which contained a single session training in the laboratory and a multisession online training), and Study 2 conducted in methamphetamine patients in Thailand, a patient group not previously studied. This study investigated attentional bias in the different treatment states, regarding the treatment system based on Therapeutic community where patients stay in hospital as a resident for 4 months and have a monthly evaluation for promotion.

Chapter 4: This chapter presents the finding of effects of the mindfulness-based attention training on attentional bias and cognitive control. The intervention in study 3 and 4 is a single session designed to implement the dot-probe paradigm and focused attention meditation. Study 3 conducted in undergraduate student social drinkers whereas study 4 adopted the procedure from study 3 to study in female methamphetamine inpatients. Studies 5 and 6 examined the effect of a multiple session mindfulness-based practicing in alcohol in-patients and methamphetamine inpatients respectively.

Chapter 5: General discussion

Aim of the thesis and implications

The overall aim of this thesis is to examine attention training in relation to attentional bias and cognitive control in drug addiction. Not only does this research have practical implications, but also it will increase understanding and the identification of the factors that influence attentional bias and cognitive control. The information collected will be useful for health professionals and drug rehabilitation or hospital setting, particularly those in Thailand. In addition, this research will test whether drug attentional bias can be manipulated, and the ways in which this can be achieved. This will have direct implications for future development of interventions and programmes. Recent theoretical development in addiction research suggested the importance of cognitive mechanisms. Our research will inform the importance of dual processes models of addiction and in particular interplay between top down and bottom up processes.

Chapter 1

Drug addiction: Theories and Models

This chapter provides a brief review on four theories explaining drug addiction in implicit cognition, which mainly focus on the Dual-process model on which the thesis is based. Additionally, other theories such as Cognitive model of drug urge and drug use, Motivation model of drug-use behavior, and other contemporary models are included.

1.1 Dual-process model

The new dual-process model of addictive behaviours (Wiers & Stacy, 2006) explains addictive behaviours as the result of two processing pathways that rely on two different operating principles: 1) fast associative "impulsive" processes, which include automatic appraisal of stimuli in terms of their emotional and motivational significance; 2) slower "reflective" processes, which include controlled processes related to conscious deliberations, emotion regulation, and expected outcomes. This model is presented in Figure 1. When an addictive behaviour develops, the automatic processing of drug-related stimuli increases in strength, through adaptations at neural level called sensitization due to repeated exposure to a stimulus. However, the automatic processing can be moderated or inhibited by emotion regulation if sufficient motivation and cognitive resources are available to do so (controlled or "reflective" processes). The two processes have also been described with a "horse and rider" metaphor, in which the horse represents the impulsive processes that can be controlled by the rider (representing reflective processes), if the rider is skilled and powerful (Friese et al., 2011).

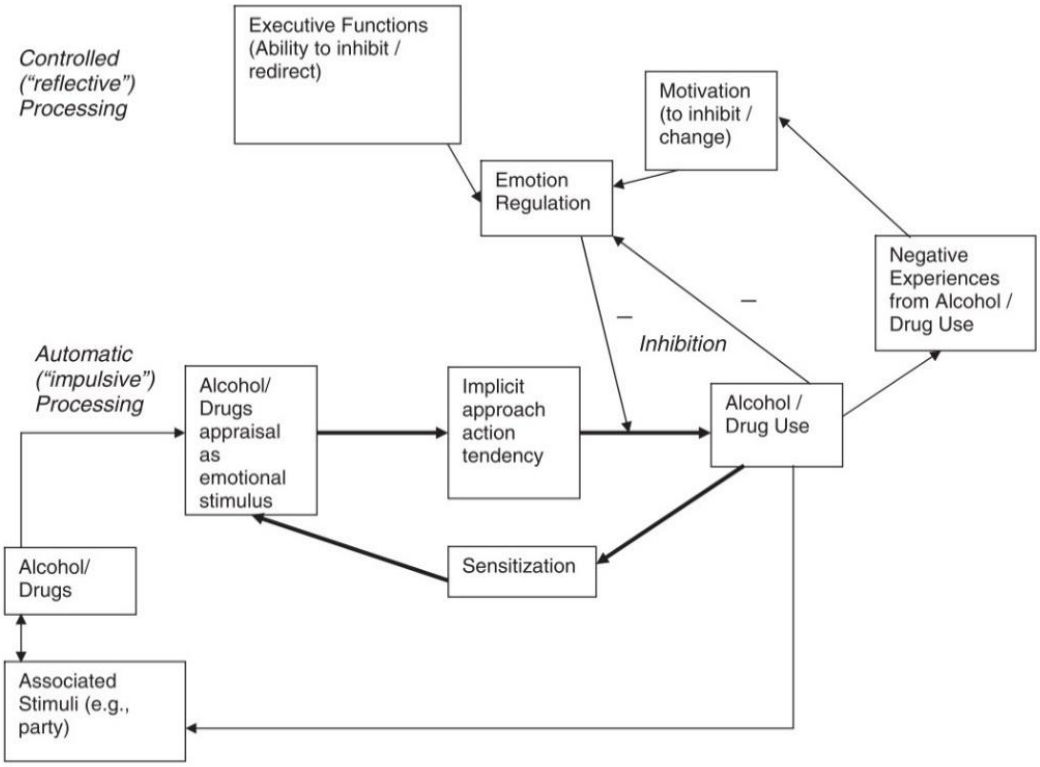
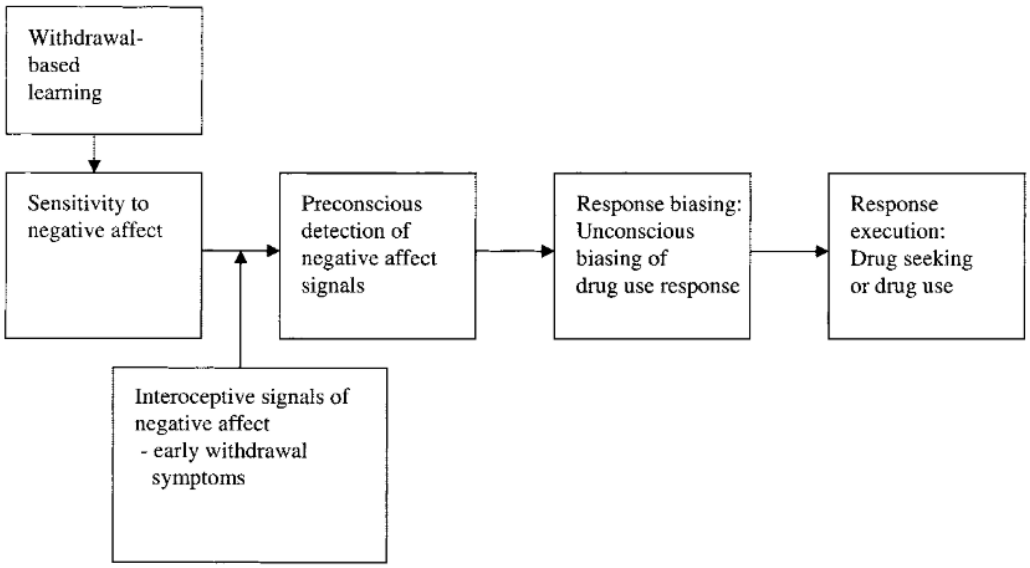
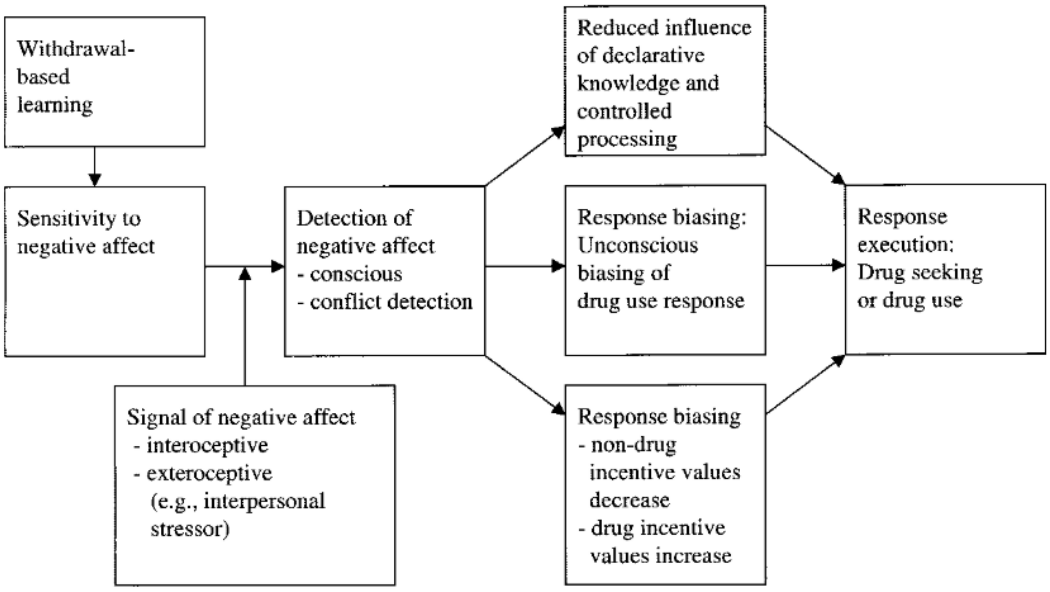


Figure 1. A schematic overview of different processes involved in the development of addictive behaviours. This figure is taken from Wiers & Stacy (2006). Implicit cognition and addiction. *Current Directions in Psychological Science, 15(6),* 292–296., p. 293

Previously, Baker, Morse & Sherman (1987) proposes the Dual-affect model in which drug taking is a result from positive and negative reinforcement. Drug-related stimuli become associated with positive reinforcing of properties of drugs and as a result, drug related stimuli turns to be the conditioned incentive properties that "grab" individuals' attention and result in drug taking. Moreover, the Bakers model (Baker, Piper, McCarthy, Majeskie, & Fiore (2004) also proposes that drug-related stimuli become more salient when negative affect increases, such as withdrawal or being in a stressful situation. Since high negative affect enhances attentional distribution specifically to information that is stands out for the individual, thus commanding attentional bias. This model is presented in Figure 2.



A: Prototypic drug motivational processing in addiction at low levels of affect



B: Prototypic drug motivational processing in addiction at high levels of affect

Figure 2. The Baker's model; Panel A: Prototypic drug motivational processing in addiction at low levels of affect and Panel B: Prototypic drug motivational processing in addiction at high levels of affect. This figure is taken from Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological review, 111(1)*, 33., p. 35-36

Baker's model was adapted from the positive-reinforcement model by Stewart, de Wit, & Eikelboom (1984), which suggested that drug-use is driven by appetitive motivational states that result from positive affective states. Addicts continue drug consumption due to the pleasurable outcome, which is paired with drug-related stimuli. Once conditioned, drug-related stimuli mimic the pleasurable effects of the drug, activating reward pathways that are commonly activated during drug consumption. This leads to the increased probability of drug-related thoughts and actions that subsequently can lead to physiological responses and the increased chance of drug consumption. This model reflects earlier models of incentive learning, such as the Bindra-Toates model of incentive motivation.

The Bindra-Toates model (Bindra, 1974) (see Figure 3, Panel A) proposes that conditioned and unconditioned stimuli have pleasurable incentive properties that lead to a wanting (or liking) for the stimuli that subsequently result in outcomes including attraction, consumption, subjective pleasure and affective actions. Thus, according to the Bindra-Toates model, conditioned and unconditioned stimuli are sought as a result of their association with the pleasurable effects of substance consumption rather than the consequences of withdrawal.

After the Bindra-Toates model was presented, Robinson and Berridge (1993, see Figure 3 Panel B) propose the Incentive sensitization theory of addiction by separating two processes underlying positive reinforcement into "Liking" and "Wanting". Liking refers to a stimulus's hedonic impact or the pleasurable effects of drugs, it responsible for subjective evaluation of drug effects. Whereas, Wanting refers to the ability of a stimulus to evoke approach behaviour or the sensitization of the dopamine-regulated neural system, it is responsible for subjectively experienced craving for drug effects. Liking and wanting are usually related to each other (Nesse & Berridge, 1997) and an individual who responds with wanting to drug cues often reduces liking (Wiers et al., 2013).

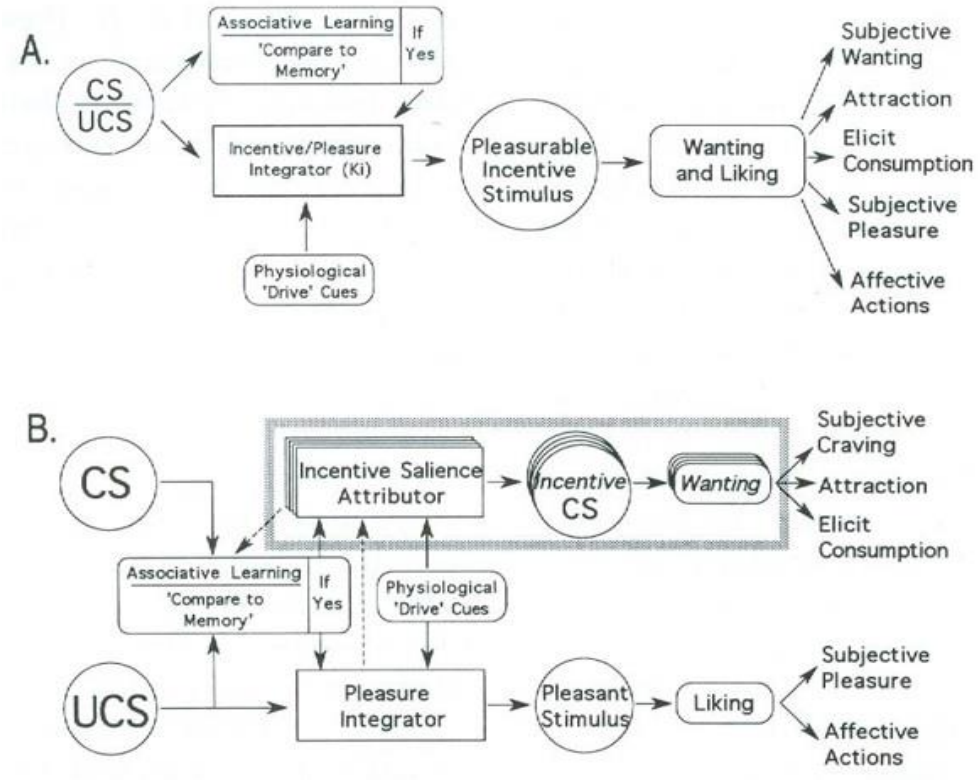


Figure 3. Panel A: The Bindra-Toates model (1974) showing wanting and liking as a single concept, and Panel B: The incentive sensitization model proposed by Robinson & Berridge (1993) showing liking and wanting as two separate concepts. This figure is taken from Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain research reviews, 18(3)*, 247-291., p. 263

There are noticeable differences in light of attentional bias between the positive-reinforcement models and the Incentive-Sensitization model. The positive-reinforcement model predicts that drug-stimuli would "grab" the attention of a user only due to its association with the pleasurable effects of consuming the drug, whereas the Incentive-sensitization model would predict that attentional biases would be present after drug-taking behaviours have been extinguished. This is due to the long-term neuroadaptations in the reward systems of the brain which lead to increased sensitivity of attentional systems to drug-related stimuli.

The negative reinforcement models by Koob (1996) argue that drug-seeking and drug-taking behaviour stemmed from a users' need to achieve "hedonic homeostasis", the

normal dopamine state of addicts. He suggested that the dopamine levels are reduced during abstinence to that which is representative of a non-normal state, whereas dopamine levels during drug-use represent a normal state. Therefore, relapsing occurs due to addicts trying to avoid the negative from withdrawal, and this is a form of self-medication. In relation to attentional bias, negative reinforcement models predict that attention is 'grabbed' by drug-related stimuli when users are experiencing negative affect. However, it has been argued that whilst withdrawal symptoms provide powerful incentives to seek drugs after extended periods of drug administration, it cannot explain the early stage of drug seeking behaviour (Glautier, 2004).

1.2 Cognitive model of drug urge and drug-use behaviour

Tiffany (1990) propose the cognitive model of drug urge and drug-use behaviour that drug-use behaviours are controlled by the automatic system, whereas drug cravings are controlled by the non-automatic system. This model was based on Shiffrin and Schneider's (1977) model that attention was governed by "controlled" (non-automatic) processes and 'automatic' processes. Both processes have specific properties and different effects on concurrent cognitive processes. Controlled or non-automatic processes are restively slow, requite attention and are voluntary. In contrast, automatic processes are fast, relatively stable and do not require attention.

Drug use become automatic after drugs have been taken for a while. This is the same as for many daily activities, for example, people generally eat, walk, talk, dress and drive while paying little or no attention. These activities have become so automatic that people may have difficulty remembering what their performance was like when they first started those skills. With practice, however, performance improves, and what once was a demanding activity becomes effortless and highly coordinated. For example, driving people are acutely aware of every step when they start to learn how to drive; however after

practising, they may not be aware of when they change gear or brake to slow down while they were driving. Problem drinking or smoking may be viewed as examples of these kinds automatic of behaviours in the way that they exhibit similar automated responses (Tiffany & Carter, 1998) such that after repeated practice, the alcohol consumption of a problem drinker can be seen as stimulus bound, difficult to control, effortless and without awareness. Similarly, drug use behaviour is an automatic process because it may start from using a drug with awareness but after this the action becomes internalised, after practising, this behaviour becomes faster and less variable.

In contrast, craving or drug urges represent controlled or non-automatic processing. The characteristic of non-automatic processing is slow, flexible, intention-dependent, cognitive effort is required and restricted by limited cognitive capacity. These processes occur under three circumstances: (1) when a person first learns a skill, (2) when a highly automatized sequence is activated but some environmental obstacle blocks the completion of that sequence, and (3) when a person wants to prevent the execution of activated automatized sequences (Shiffrin & Schneider 1977). Therefore, when addicts can not use a drug because of a lack of availability of the drug then a non-automatic process is activated and leads to drug cravings or drug urges. This model is presented in Figure 4.

Tiffany suggests that non-automatic processes activate drug urges and provoke attentional bias, since resource-demanding processes are recruited to overcome the obstacle. Non-automatic processes become particularly obvious when automatic processes are disturbed, for instance, when an alcohol stimulus is encountered but drinking behaviour is unavailable. Thus, Tiffany's model predicts that attentional bias should be most noticeable during abstinence, when drug-use behaviour is not possible, rather than when drug-use behaviour is possible.

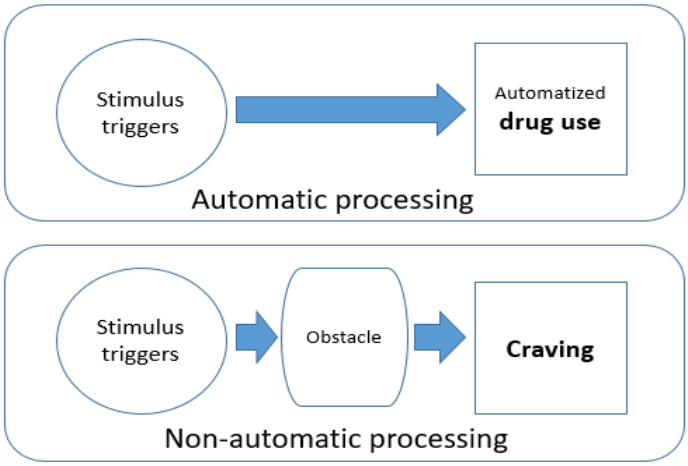


Figure 4. The cognitive processing model. In an alcoholic who is not trying to quit drinking, alcohol use is controlled by an automatic cognitive process. Under these circumstances, "stimulus triggers" activate automatic processes that result in automatized drug use, and cravings play no role in the control of drinking. When the automatized alcohol use sequences (e.g. driving to favorite bar, entering, sitting down at the bar, and ordering a drink) are blocked by any environmental obstacle (e.g. the bar is closed), the alcoholic must activate non-automatic processes to cope with that problem. These non-automatic processes generate cravings for alcohol (Tiffany, 1999).

In relation to alcohol, the model suggests that drinking behavior is a consequence of impaired controlled processes. Moss & Albery (2009) suggest how important it is to understand the cognitive processes between pre-consumption and the consumption phase. At the pre-consumption phase, when drug-related cues occur, the cognitive processes of expectancies, beliefs, and action schemata are activated. This can lead to changes in behaviour before the commencement of drinking, such as becoming more outgoing, chatty, relaxed or ordering high-alcohol content drinks, and drinking the first few drinks more quickly. However, in the consumption phase, once alcohol enters the bloodstream, it begins to impair cognitive processing. The controlled system that contains the individual's goals and actions will become weaker due to the fact that alcohol reduces the capacity and influencing behaviour of the automatic system. This model is presented in Figure 5.

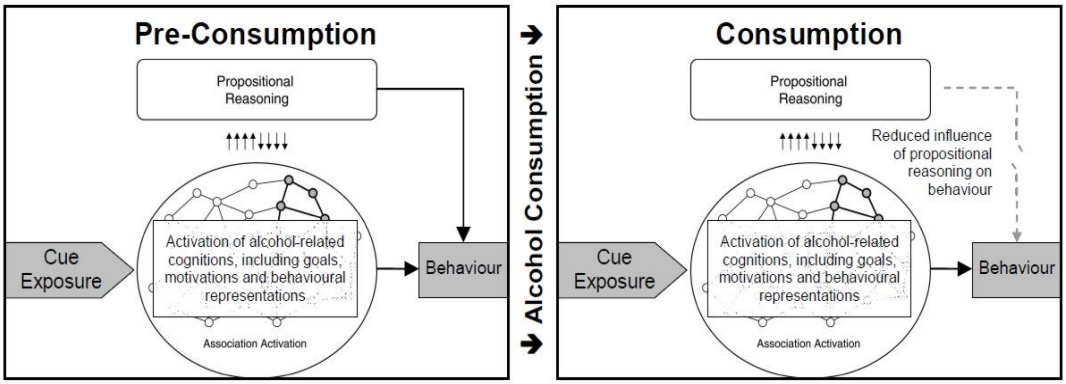


Figure 5. Model of the alcohol-behaviour link proposed by Moss and Albery (2009). This figure is taken from Moss, A. C., & Albery, I. P. (2009). A dual-process model of the alcohol–behavior link for social drinking. *Psychological Bulletin, 135(4)*, 516., p. 526

1.3 Motivation model of drug-use behaviour

Cox & Klinger (1988) propose the motivation model of drug use behaviour, in their view, motivation is "the internal states of the organism that lead to the instigation, persistence, energy, and direction of behaviour towards a goal" (Klinger and Cox 2004, pp. 4). They used the term "current concern" to refer to the internal processes that provide the neural substrate for attempting to achieve a goal. A goal is an endpoint, it might be an object or event that the individual expected which that the success might bring positive affect or reduce negative affect. A current concern sensitizes the individual to process cues related to the goal (Cox et al., 2015). Characteristics of current concern: an individual might have many concerns and each concern can be compatible or incompatible with each other (e.g. drinking alcohol heavily and working productively); a concern is latent (implicit) and maintains until the goal is to succeed or the individual give up; a current concern is an active body which supports motivational processes to reach or give up the goal. Drug users were motivated to use drug by expectation of emotional payoff.

1.4 Other contemporary models

Ryan (2002) proposes that drug-use behaviour might be a subsequence of the attentional system in that drug-related stimuli grab attention that then leads to a craving which is related to drug seeking behaviour.

Franken (2003) also proposes a model which focusses on a link between craving and attentional bias. He explains the psychological mechanism of attentional bias and provides neuropsychopharmacological mechanisms for this bias, that conditioning of drug stimuli increases dopamine levels which increases attentional bias for drug stimuli, which increases craving and reduces attentional resources for other mental activities. Thus attentional bias for drug-related cues could be considered an important determinant of drug craving and drug seeking behaviour. If drug users could be trained to allocate their attention away from drug-related cues, this may in turn reduce their craving and drug seeking behaviour. This model is presented in Figure 6.

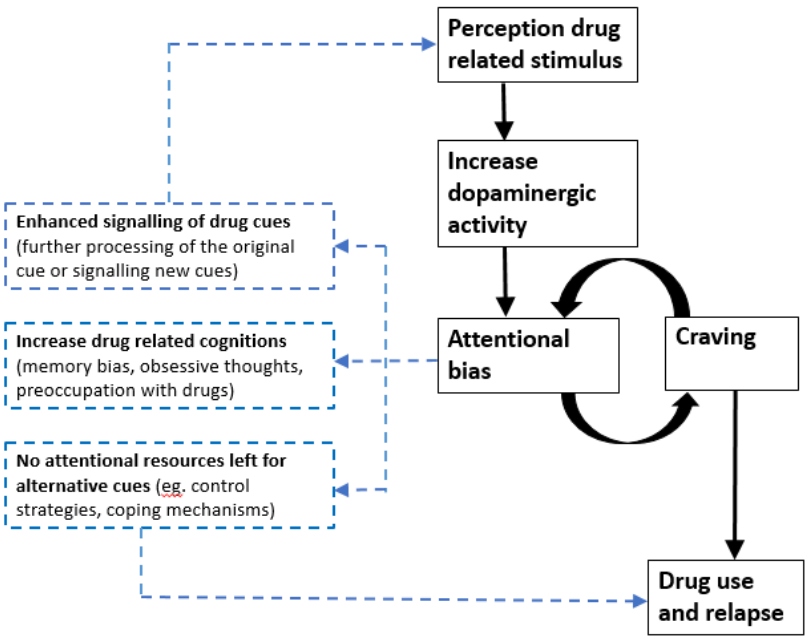


Figure 6. Franken's model showing the possible role of attentional bias in craving, drug use and relapse. This figure is taken from Franken, I. H. (2003). Drug craving and addiction: integrating psychological and neuropsychopharmacological approaches. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 27(4)*, 563-579., p. 572

Furthermore, Field and Cox (2008) also propose a model to explain the relationship between attentional bias, subjective craving and conditioned drug cues. They explain that the occurring of attentional bias and drug craving are from expectation of drug availability, which is a consequence of conditioned drug cues. Moreover, subjective craving and attentional bias could be altered by attempting to suppress craving or attentional bias, and inhibitory control compromising (due to impaired executive control). This model is presented in Figure 7.

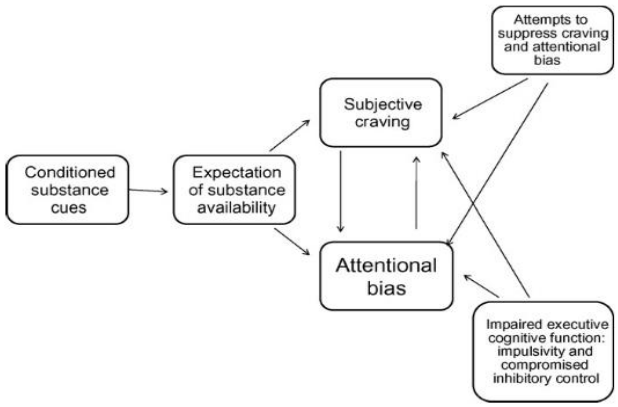


Figure 7. Field and Cox's integrated model showing relationship between attentional bias, subjective craving and conditioned drug cues. This figure taken from Field, M., & Cox, W. M. (2008). Attentional bias in addictive behaviors: a review of its development, causes, and consequences. *Drug and alcohol dependence, 97(1-2),* 1-20., p. 14

Previous research has highlighted the importance of attentional bias in addiction research. Various models have been suggested highlighting the interplay between top down and bottom up processes. Based on the cognitive model of addiction, attention retaining has been suggested as a therapeutic intervention which targets changes in implicit processes. This thesis will try to extend the previous research by not only investigating attentional bias but also another cognitive mechanism, called cognitive control which indicates how cognitive biases can change over time (previous trial history). This thesis also explores therapeutic interventions to see if they can modulate attentional bias and cognitive control.

Chapter 2

Attentional bias, Cognitive control, Attention training: Empirical finding

This chapter contains a literature review of attentional bias and cognitive control in term of definitions and measurement, and of attention training that focus on probe paradigms, and is mindfulness-based.

2.1 Attentional bias

Attentional bias is a phenomenon of attention that is always directed to stimuli that are related to a person's current thoughts at the time, or their failure to consider alternative possibilities due to the current interest-related grabs of their attention. Attention allows an individual to filter in or filter out environmental events (C. M. MacLeod & MacDonald, 2000) which can lead to the formation of attentional distraction, or attentional bias. Addiction is associated with biases in selective attention for drug-related stimuli. Attentional biases operate in the early stages of attention processing and it may be automatic. The literature on the addiction-related attentional bias, in the case of alcohol consumption, concludes that the magnitude of the attentional bias is generally proportional to the amount of alcohol that people habitually consume; dependent drinkers have the most attentional bias while heavy drinkers, moderate drinkers and non-drinkers have proportionately less attentional bias respectively (Cox et al., 2006). Moreover, attentional bias predicts later substance use, although the evidence for this is inconclusive (Field et al., 2013).

Attentional bias is measured by the modified Stroop task in the study of emotion (such as anxiety, depression), eating disorders, and addiction. Modified colour Stroop tasks have demonstrated that alcohol words are distracting for drinkers (Bauer & Cox, 1998), and alcohol abusers show longer reaction time to alcohol words than neutral words in the

emotion Stroop task (Stormark et al., 2000; Sharma et al., 2001). Cox, W. M., Hogan, L. M., Kristian, M. R., & Race (2002) demonstrated alcohol abusers who did not complete the treatment program, compared to alcohol abusers who completed the treatment program and non-alcohol abusers, were highly distracted by alcohol-related cues at treatment admission, and alcohol abusers whose treatment was unsuccessful had increased attentional distraction for alcohol stimuli during 4 weeks in treatment, whereas control and successful treatment group did not show such distractions.

Researchers have considered attentional bias as a key factor in relapse, which is the major problem in individuals who are suffer from addiction. Attentional biases are closely associated with subjective drug craving and this relationship may be bidirectional in nature (Field, Duka, Tyler, & Schoenmakers, 2009; Field, Kiernan, Eastwood, & Child, 2008). Elevated drug cravings may make drug-related cues more salient and pronounced attentional biases may promote further increases in craving. Additionally, attentional bias may be a valid target for cannabis use disorder interventions (for a review, see O'Neill, Bachi, & Bhattacharyya, 2020)

Measures of attentional bias in drug addiction

Of a number of attentional tasks that are utilized for assessment of attentional bias, the thesis mainly used Stroop and probe detection paradigm. Other paradigms were provided.

Stroop paradigm

The Addiction Stroop task was developed from the classic Stroop test, which uses words in a variety of ink colours to assess selective attention and cognitive inhibitability. In the classic Stroop task, participants are instructed to name the ink colour and ignore the word. Word reading is the dominant tendency than colouring naming, thus participant has

to suppress the dominant tendency. Typically, participants respond slower and less accurate when that word and colour are incongruent (eg. BLUE printed in red ink) compare with when they congruent (BLUE in blue ink). The differences of responding time called the Stroop interference effect, which expresses the difficulty to name the ink colour of a colour word if there is a mismatch ink colour and words.

Subsequently, it has been modified and adapted to other fields in psychology such as mood and anxiety. The addiction Stroop was created by using stimuli related to an addictive substance, alcohol and other drugs, to measure effect from addictive related stimuli, which is calculated as the difference between participants' performance in the presence of substance-related distractors and their performance in the presence of neutral distractors. It reflects how performance suffers from selective attention to aspects of a stimulus that should be ignored during a task. Sharma et al. (2001) suggest that it is possible to use a modified Stroop task as a measure of implicit processing of alcohol stimuli. The Stroop task is well-known and commonly used because factors that influence Stroop performance are now reasonably well understood.

Examples of using Stroop task in drug addiction: Waters & Feyerabend (2000) found that nicotine abstinent smokers displayed slower colour naming latencies for smoking related words than did non-abstinent smokers; Cox, Yeates, & Regan, (1999) found that heavy social drinkers colour-named alcohol related words more slowly than neutral matched words only when in the presence of an alcohol cue; Stormark et al. (2000) found that current alcohol abusers colour-named alcohol related words more slowly than neutral matched words; and Sharma et al. (2001) found that drinkers had significantly longer time to respond to the colour of alcohol-related words than to neutral words; Cocaine patients who receive a longer duration of CBT program showed a greater reduction of Stroop effect than a control group (DeVito, Kiluk, Nich, Mouratidis, & Carroll , 2018); The alcohol abuser group in India had a lower score on colour Stroop and

alcohol colour word Stroop than a control group (Modi, Malik, Punia, Kumar, & Dogra, R., 2019); Young and adult smokers displayed longer response times to cigarette related words compare to cigarette unrelated words on a Smoking Stroop, Turkish version (Kisacik & Çakir, 2020); Smith, N'Diaye, Fortias, Mallet, & Vorspan (2020) used an emotion Stroop task to compare attentional bias towards cocaine-related words in former and current cocaine-dependent patients. They found that there was no differences of reaction time between naming cocaine-related words and neutral words in cocaine abstinence patietns, whereas there was a difference in attentional bias between cocaine-dependent patients and controls; Van Kampen, Cousijn, Engel, Rinck, & Dijkstra (2020) did not find attentional bias for cannabis words through the Dutch cannabis Stroop task among adolescents and young adults diagnosed with cannabis use disorder.

The Stroop that we used in this thesis is the face-word Stroop, which is adopted from Sharma (2017). He used drug images instead of emotionally negative images, which the original version by Padmala, Bauer, & Pessoa (2011) used. This Stroop task demonstrates drug attentional bias, as well as cognitive control. The task started with a fixation cross, followed by face and word, which represent congruent and incongruent trial types. After the offset of the face stimulus, a neutral or drug image was shown. Participants were instructed to give gender naming, and ignore the word. The participant performed 48 trials each block for six blocks, with brief practice before critical trials started.

Probe detection paradigm

Visual Probe task: The Visual Probe Task measures the allocation of visuospatial attention by presenting two images side by side on a computer screen followed by the probe that will be on one side, replacing one of the images. In critical trials, one of the images will be an image of a drug and another one will be an image that is not related to drug-use, but has similar characteristics, for example, one image might be a hand holding

a glass of wine, while the other image will be a hand holding a glass of water. After the images disappear, immediately a small probe stimulus will come up on one side. Participants have to respond as fast as they can. People will respond faster if the probe appears on the same side as that which already has their attention. The reaction time to the probe indicates the level of attentional bias toward drug-related stimuli. Probe paradigm is often used in attentional bias measurement in drug addiction study. However, Ataya et al. (2012) suggest that the visual probe task showed poor internal reliability, as well as, Christiansen, Schoenmakers, and Field (2015) suggest that visual probe task might have poor reliability in clinical settings. Jones, Christiansen & Field (2018) reanalysed previous studies and added novel studies to improve the internal consistency and test-retest reliability of visual probe task for alcohol and smoking. They did not find adequate internal consistency or test-re-test reliability.

Example of the visual probe task demonstrates attentional bias in substance abusers: Mogg & Bradley (2002) found that smokers have attentional bias for smoking-related pictures but non-smokers do not; Field et al. (2004) demonstrated that heavy social drinkers have significantly larger attentional bias for alcohol related pictures than social drinkers; Field, Mogg, & Bradley (2004) found attention bias for cannabis-related words associated with high levels of craving; Visual probe task showed an attentional bias toward smoking cues in former smokers and current smokers when cues were presented for 500 ms but not when cues were presented for 2000 ms (Rehme et al., 2018); Modified visual probe also showed that cannabis users respond faster on cannabis cues compared to neutral cues, which indicate attentional bias toward canabis (Alcorn,Marks, Stoops, Rush, & Lile., 2019); Gladwin (2019) tested reliability of visual probe task by calculating bias scores from visual probe task and questionnaire scales such as drinking motive (DMQ-R), reasons to abstain from drinking (RALD), and alcohol craving (ACQ) and risky drinking (AUDIT-C). Results showed only higher AUDIT scores associated with a bias towards

alcohol; Liang et al. (2019) investigated attentional bias from visual probe task and concluded that attention bias to methamphetamine cues may be a more reliable indicator than experiential craving report; Alcorn, Strickland, Lile, Stoops, & Rush (2020) used visual probe to observe cocaine attentional bias in acute methylphenidate administration.

Other paradigms

Dual Task: The Dual Task paradigm requires participants to work on two tasks at the same time and aims to investigate how one task interferes with the other. The reasoning behind the dual task paradigm test is that the human processing resources are limited and sharable and can be subdivided into several classes. When testing the Dual task paradigm in addiction, as in the Visual Probe Task test, participants are required to respond to the probe stimuli. The latency of reacting to probe stimuli depends on the available attentional resources, therefore if attentional resources are involved in ongoing processing of other stimuli, response latencies to the probe will be slowed. Example of studies using dual tasks; is that of Cepeda-Benito and Tiffany (1996), who used a dual-task procedure, Tiffany (1990) suggested that drug craving should confuse activities that demand non-automatic cognitive processing. The initial task required smokers to imagine sentences that incorporate urge or no-urge descriptors. During imagery, the subjects also responded to a secondary reaction time (RT) task. The results show that imagery of urge sentences produced slower probe RTs, greater urge and negative mood reports, and lower positive mood ratings.

Eye movement: In psychology, researchers have also measured eye positions and eye movement to detect attentional bias. For example, Mogg et al. (2003) measured eye movements of smokers and non-smokers whilst they completed a visual probe task with smoking-related and matched control pictures. The results indicated that smokers have

significantly longer gaze duration on smoking-related pictures compared with the control pictures. Zhao et al. (2017) and Schoenmakers, Wiers, and Field (2008) have also found the same result in heroine patients who had more initial number of fixations and maintained longer initial fixation durations towards substance-related pictures than neutral pictures.

Flickers: During this task, picture of drug-related or neutral is presented on the computer screen for 250 ms, and then a mask is briefly presented. The initial picture is presented again with one object changed. This object can be drug-related or not. This sequence is repeated until the participant detects the changing object. The evidence showed that compared to non-drinkers, heavy drinkers had faster detected alcohol-related changes than neutral changes (B. T. Jones et al., 2003). This indicates heavy drinkers' attention is automatically grabbed and captured by alcohol-related cues, making it easier for them to detect changes associated with such cues and harder to detect changes in the neutral stimuli.

Visual search task: This task requires attention for active scanning of the visual environment for the target. It can be used with or without an eye movement tracker. Recently, visual search task was used in addiction study to measure attentional bias. For example, Pennington, Qureshi, Monk, Greenwood & Heim (2019) and Pennington et al. (2020) exhibited attentional bias to alcohol-related cues among social drinkers, that they were quicker to detect alcoholic and non-alcoholic appetitive targets compared to non-appetitive targets in an array of matching and mismatching distractors. The study also demonstrated that visual search task has excellent reliability and superior to other paradigms.

2.2 Cognitive control

As mentioned in Chapter 1, Wiers and Stacy (2006) propose in the new dual-process models of addictive behaviour that addictive behaviour is the result of two semi-dependent cognitive processes, automatic (impulsive) and non-automatic (controlled or reflective) processes, which are imbalanced. Imbalanced processes explain how it is difficult for addicts to stop returning to drug although they know its harmful. During individuals have continuing drug use; the automatic processes have been strengthened whereas the controlled processes have been weakened. The new dual-process models suggest that the automatic processes (also called stimulus-driven or bottom-up processing) could be inhibited if sufficient motivation and cognitive resources are available.

Cognitive control, the top-down process which is the ability to engage in goal-directed behaviours, allows the brain to solve difficult, novel, or complex tasks such as overcoming automatic processing (Miller & Cohen, 2001) as that which is related to addictive behaviour. Cognitive control is also referred to as conflict monitoring, or conflict adaptation, because its main function is to adapt the cognitive system to context demands (Botvinick et al., 2001). Whenever a conflict is detected, cognitive control would arise.

Measurement of cognitive control uses conflict tasks. Three tasks which have been largely used in research are the Stroop task (Stroop, 1935), the Flanker task (Eriksen, B. A., & Eriksen, 1974), and the Simon task (Simon, 1969). Evidence for the cognitive control mechanism comes from:

1) *The proportion congruent effect (PC)*: the congruent effects are smaller when a task is mostly incongruent trials (eg. 75% incongruent, 25% congruent), since subjects experience more frequency of conflict. Thus, they are adapting attention more strongly away from distractors, and more strongly toward the target. This is a summed effect of many small adjustments.

2) *The Sequential modulation (SM) effect (aka: congruency sequence effect, or Gratton effect)*: the Stroop (or congruency) effects are smaller when preceded by an incongruent trial, since subjects increase their ability to inhibit attention to the distracter and/or focus in attention to the target after the presence of incongruent trials. This is an effect of immediately preceding adjustment. Cognitive control in this thesis refers to the sequential modulation seen in the face-word Stroop task. On this face-word Stroop task the effect of Cognitive control can be seen by either an interaction between previous trial congruency x current trial congruency or by a main effect of previous trial congruency.

2.3 Attention training in drug addiction

In terms of treatment for drug addiction, the training, which is targeting on altering a drug attentional bias, that this thesis focuses on, is attentional bias modification training (ABM) and mindfulness-based attention training.

2.3.1 Attentional bias modification in drug addiction

Attentional bias modification (ABM) training has been used to change attentional bias by using procedures that manipulate participants' attention. These procedures are based on a dual-process model of addiction, which affirms that relatively automatic (impulsive) processes surmount controlled (reflective) ones. A number of procedures have been developed to target attentional bias modification that are mostly based on experimental, computer-based tasks in which participants are trained with many repetitions of pairs of stimuli. Probe paradigm and Stroop paradigm are mostly used, due to the tasks measuring implicit cognitive processes to which participants have to respond quickly without explicit awareness either avoiding or directing attention to, addiction-related stimuli.

Most of this training has been tested with cigarette smokers (Attwood et al., 2008; Begh et al., 2015; Field, Munafo, et al., 2009; Kerst & Waters, 2014; Lopes, Pires, & Bizarro,

2014; McHugh, Murray, Hearon, Calkins, & Otto, 2010) and alcohol drinkers (Cox et al., 2015; Field & Eastwood, 2005; McGeary, Meadows, Amir, & Gibb, 2014; T. M. Schoenmakers et al., 2010; T. Schoenmakers, Wiers, Jones, Bruce, & Jansen, 2007) . Fewer studies of attentional bias modification have been conducted with drug abusers. One such study involved drug abusers undergoing methadone maintenance therapy (MMT) (Zhao et al., 2017) and another involved drug abusers undergoing detoxification (Ziaee et al., 2016). No studies have as yet been conducted with non-western drug abusers (Cox et al., 2014).

In the attentional bias modification training that uses probe paradigm, the location of the probes is manipulated in such a way that participants can be taught to direct their attention either toward, or away from, the location that the drug-related stimulus occupies. Figure 8 illustrates an example of a drug visual probe task. In the standard visual probe task (Standard VPT) that aims to not manipulate attention, an arrow would replace substance-related cue (SRC) and non-substance-related cue (non-SRC) equally, whereas, the modified VPT that aims to train the attention away from drug, an arrow would always replace non-SRC.

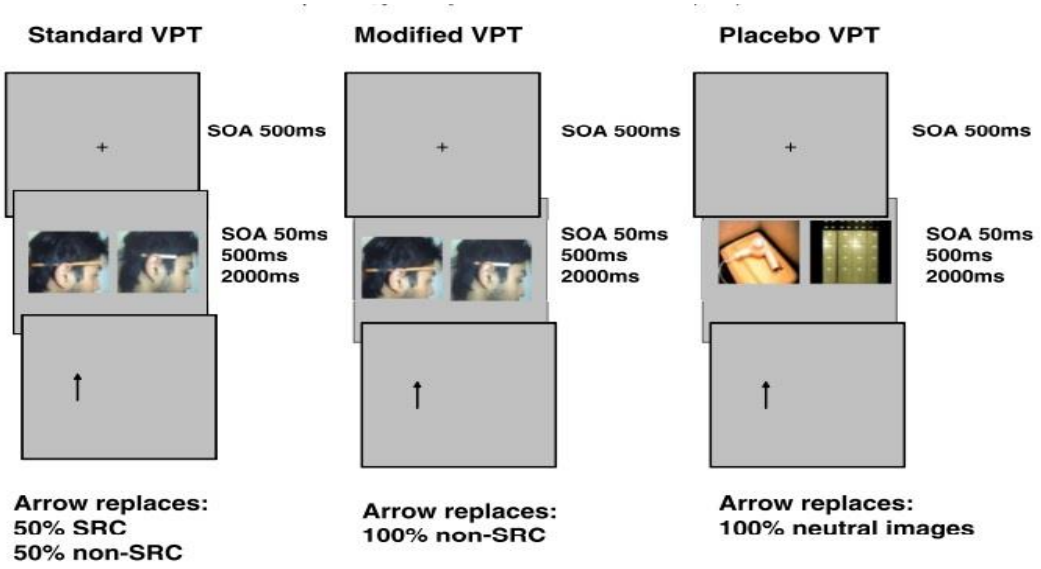


Figure 8. Example of Drug Visual probe task. This figure is taken from Lopes, F. M., Pires, A. V., and Bizarro, L. (2014). Attentional bias modification in smokers trying to quit: A longitudinal study about the effects of number of sessions. *Journal of Substance Abuse Treatment*, *47*(1), 50–57., p. 53

In the modified Stroop task, which is used in drug addiction, some versions use words and colour, for example Figure 9 illustrates a drug-word Stroop task. In this task, participants are asked to name the colour and ignore the word. The words would be drug-related words and non-drug-related words (neutral).

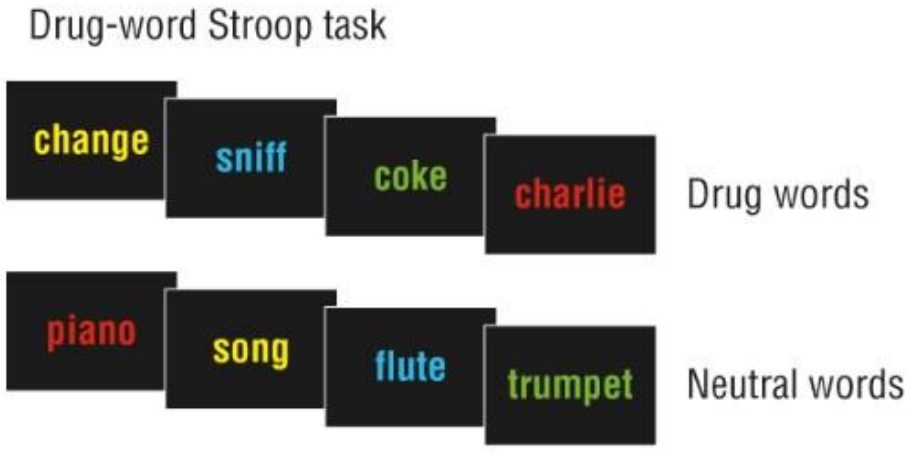


Figure 9. Example of drug-word Stroop task, participants were asked to identify the font colors of the drug-related words and the neutral words. This figure is taken from Ersche Kd, B. E. T. C. K. J., and et al. (2010). Influence of compulsivity of drug abuse on dopaminergic modulation of attentional bias in stimulant dependence. *Archives of General Psychiatry*, *67*(6), 632–644., p. 634

Empirical finding of Attentional bias modification training

Alcohol drinkers

Schoenmakers et al. (2010) conducted a randomised trial with alcohol-dependent patients. The results showed that five training sessions on a modified visual probe task reduced attentional bias and resulted in earlier discharge from treatment and for participants in delayed time before relapse. Furthermore, McGeary, Meadows, Amir, and Gibb (2014) used personalized stimuli in a visual probe task study. This study was conducted over eight sessions of training involving computer-based tasks, in which the target group (undergraduate student drinkers) undertook at home. This study found that attentional bias modification training decreases attentional bias in conditioned participants.

Fadardi and Cox (2009) created The Alcohol Attentional Control Training Program (AACTP). This program aims to help drinkers gain control over the distraction from alcohol-related stimuli. It integrates motivation by giving feedback to participants after training sessions. The intervention has three components: 1) a pretest for the baseline score of attentional bias in alcohol, 2) the training goal set up by the participants with the aim of reducing distractions, and 3) feedback to participants to motivate them to reach their goal. AACTP is a computer- based method that uses a modified Stroop task and involves 2 categories of pictures: alcohol-related and non-alcohol-related pictures. The task contains three series of increasing degrees of difficulty wherein participants have to name the colour as quickly and accurately as possible. The effect scores are calculated by subtracting the participant's reaction time to non-alcoholic stimuli from their mean reaction times to alcohol-related stimuli. In Fadardi and Cox's research studies took place utilising 2 methods; in-lab and web-based at home. The results confirmed that both patterns, lab and over the web, yielded the expected result that attention bias can be modified.

Cigarette smokers

In smoking addiction, the visual probe paradigm is the only one that has been used in attentional bias modification training. Attwood, O'Sullivan, Leonards, Mackintosh, and Munaf, (2008) used the visual probe task in attentional bias modification (ABM) to train cigarette smokers. One training session at the lab used 16 picture pairs of smoking-related and matched neutral pictures, 768 trials, and 500 ms duration fixation cross. The result of this study showed that attention training increased attentional bias among participants in the attend group, and decreased attentional bias among those in the avoid group. Field et. al. (2009) used a modified visual probe task in one session training, the ABM produced the predicted changes in attentional bias. Lopes, Pires, and Bizarro (2014) used three ABM sessions in 67 smokers trying to quit. Participants in 3 avoid sessions training maintained ABM effect at the 6 month horizon. Kerst and Waters (2014) used modified visual probe task to train smokers for one week, personal digital assistant (PDA) delivered in natural treatment. The training reduced attentional bias and reduced craving. Begh et al. (2015) use a modified visual probe task to train smokers in UK smoking cessation clinics. This was conducted over five weekly sessions of attention retention, utilizing the visual probe task method in which 12 picture pairs were presented to participants. Result showed that post-training bias was not significantly lower in the retraining group compared with the placebo group.

Other drugs

Most attentional bias modification training studies are in smokers and drinkers however, there are a number of examples of studies in drug abusers. Firstly, Drug-ACTP was developed and tested using 2 samples: (a) drug abusers having methadone maintenance therapy (MMT) (Mayer et al., 2016) and (b) drug abusers undergoing detoxification (Zhao et al., 2017). The procedure for the Drug-ACTP is similar to regular AACTP which uses

modified Stroop. The results showed that drug-abusers in MMT and drug-abusers in detoxification benefited from the training. Furthermore, the latest study protocol of internet-based attentional bias modification training in the regular treatment of alcohol and cannabis dependent outpatients used a procedure called the bouncing image training task (BITT), which is based on the "follow the face task". This computerized task was developed to promote attentional disengagement from substance-relevant cues and attentional engagement with neutral, substance-irrelevant cues. The task requires participants to engage their attention on substance-irrelevant cues while ignoring substance-relevant cues, and to disengage their attention from the currently attended locus whenever substance-relevant cues appear there (Heitmann et al., 2017). Other drugs have been investigated (Mayer et al., 2016; Zhao et al., 2017) but due to the relatively small number of studies it is difficult to reach a conclusion. Moreover, the delivery platforms are various; lab, clinic, home, computer-delivered, and game-like. These have been developed with the aim of increased convenience to participants, decreased cost of administering the tests and for heightened accessibility.

The conclusion of effectiveness of ABM on attentional bias is still unclear. Although several studies showed a positive effect of AMB, however, weakness of research methodology and statistic is reported. As Christiansen et al., (2015) investigated the issue of attentional bias study in addiction and found serious limitations on methodology and statistic. They suggest that attentional bias is an output of the underlying motivational state at that moment in time, therefore, attentional bais has a fluctuation all the time. As well as a systematic review of the effectiveness of ABM (Heitmann et al., 2018) showed that there are eighteen studies included; ten studies reported symptoms of addictive behaviour change whereas eight studies were not. The effect of ABM, however, are not a direct relationship with baseline attentional bias and its change from baseline to post-test.

2.3.2 Mindfulness-based attention training

Definition of mindfulness

Mindfulness is the ability of humans to be present attending to what is happening, knowing directly what is going on inside and outside ourselves, moment by moment without judgement. The word mindfulness is derived from "Sati", in the Pali language, which means an awareness of things in relation to things, and hence an awareness of their relative value. Mindfulness practices are a subgroup of meditation practices. Meditation is the ancient mind practice that has been practiced in Asia for over two thousand years. It is three decades since meditation has been implemented in modern treatments such as mindfulness-based stress reduction (Kabat-Zinn, Lipworth, and Burney, 1985), mindfulness-based cognitive therapy (Segal, Williams, and Teasdale, 2002) and mindfulness-integrated cognitive behavioural therapy (Cayoun, 2011), for a wide range of conditions such as pain and stress (Kabat-Zinn, 2003), depression and anxiety (Teasdale et al., 2002; Baer, 2003; Kang & Whittingham, 2010), and borderline personality (Feigenbaum, 2007). Mindfulness studies illustrate meditation practice and levels of mindfulness are positively related to attentional performance and cognitive flexibility. It has been found that meditators perform significantly better than non-meditators on all measures of attention (Moore & Malinowski, 2009), and selective attention could be improved by mindfulness practice (Chiesa et al., 2011) since they improve attention, working memory and executive function (Zeidan, Johnson, Diamond, David, & Goolkasian, 2010; Farb, Segal, & Anderson, 2013) and have significant benefit on health, including reduced alcohol and substance consumption (Murphy, Pagano, & Marlatt, 1986; Bowen et al., 2006). Mindfulness-based intervention for addiction treatment is the mind exercise which targets to a number of neurocognitive processes. Garland, Froeliger, and Howard (2014) conceptualized mindfulness-based intervention as a means of mental

training. This training would modulate a number of neurocognitive processes to be back to the state as before becoming drug-addicted.

Type of mindfulness practice

Meditation practices include three types (see a review, Lippelt, Hommel, & Colzato (2014); focused attention meditation, open-monitoring meditation, and loving-kindness meditation. Focused meditation is usually a beginning of meditation learning, where practitioners are required to pay attention to a single object or event, such as the breath or the moving of the abdomen, and have to keep focusing on there single focus and avoid mind wondering (Tops et al., 2014). Open-monitoring meditation and loving-kindness meditation are the techniques that practitioners learn after being able to sustain attention on the object or event. The practitioners learn to be aware of experiences or sensations that are internal or external without judgment. Each type of meditations differ on attention; for example, focused attention meditation narrows the attention due to the high amounts of concentration required, and this could be associated with significant improvements in selective and executive attention. The other meditation methods can achieve a broad attention scan by the recognition of any experiences during the meditation, this could be mainly associated with improved unfocused sustained attention abilities (for a review, see Chiesa et al., 2011). Colzato, van der Wel, Sellaro, and Hommel (2016) examined a single session of mindfulness focus and open-monitoring meditation. The findings showed attentional focus did not different between both meditations, whereas cognitive control in an open-monitoring meditation group was larger than a focus attentional meditation group. This study suggests that different kinds of meditation result in different effects on cognitive control which bias subjects processing style toward either goal-directed or cognitive flexibility.

Length of mindfulness practice and number of sessions

Mindfulness practice could be a brief mindfulness practice that lasts between 5-15 min a day, and an intensive mindfulness practice which has a longer duration and might take an hour to over ten hours a day. Mindfulness practice could be single session or multiple sessions.

Mechanism of mindfulness practice in addiction

Garland and Howard (2018) have explained the schema of mindfulness-based intervention components on mechanisms and outcomes implicated in the treatment of addictive behavior. The expected outcome of drug treatment is a reduction of craving, drug use, and distress, enhanced well-being and meaningful recovery. These are from biological mechanisms such as amplifying prefrontal activation, increasing frontostriatal connectivity, decreasing limbic reactivity, and improving automatic regulation, which that can be any form such as mindfulness breathing, body scan, mindfulness of craving, and informal mindfulness. The biological mechanism produces behavioural mechanism such as restructuring reward processing, booting executive function, strengthening dispositional mindfulness, reducing stress activity, decreasing drug cue-reactivity, and minimizing thought suppression respectively. This scheme is presented in Figure 10.

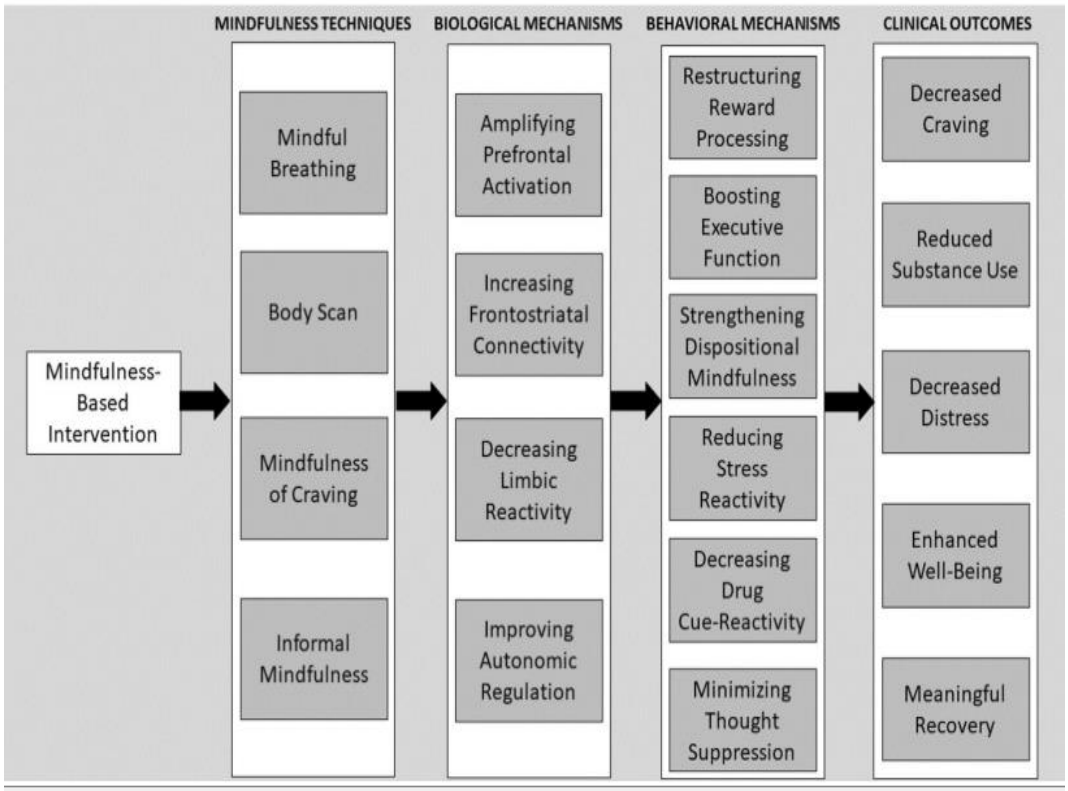


Figure 10. Schema detailing the effects of mindfulness-based intervention components on mechanisms and outcomes implicated in the treatment of addictive behavior. This figure is taken from Garland, E. L., and Howard, M. O. (2018). Mindfulness-based treatment of addiction: current state of the field and envisioning the next wave of research. *Addiction Science & Clinical Practice*, *13*(1), 14., p. 5

Moreover, Kang, Gruber, and Gray (2013) proposed a model which explain mechanism of mindfulness that overcome habitual patterns of cognitive, or automatic cognitive process, by discontinuing automatic inference, and enhancing cognitive control capacity, that four components of mindfulness (awareness, attention, present focus, and acceptance) could bring each forth the necessary environment for de-automatization to occur (see Figure 11).

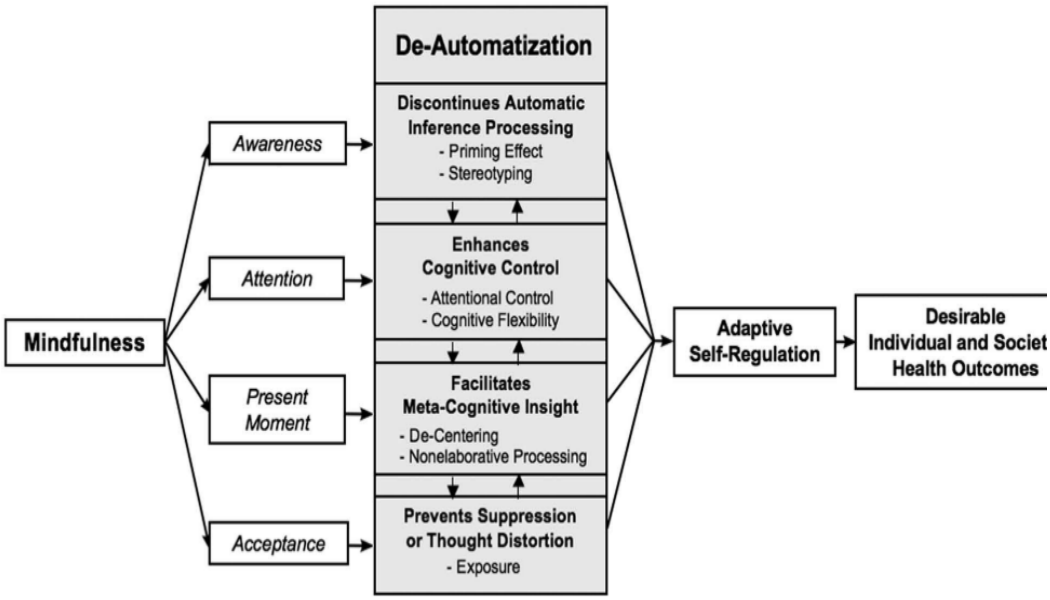


Figure 11. A model describing the mechanism of de-automatization facilitated by mindfulness. This figure is taken from Kang, Y., Gruber, J., and Gray, J. R. (2013). Mindfulness and de-automatization. *Emotion Review*, *5*(2), 192–201., p. 193

Mindfulness practice studies in addiction

Mindfulness could raise an individual's metacognitive awareness of automatic processes associated with craving, substance seeking and use, and enhance attention to triggers and the presence of urges (Garland, Froeliger, Kelly, & Howard, 2015; Witkiewitz et al., 2014). It might further facilitate disengagement of attention from substance-related cues and diminish attentional-bias toward substance-related (Garland, Manusov, et al., 2014). Mindful breathing and body scan exercises could help individuals become desensitized to distressing experiences that trigger substance misuse and could then help to reorient their attention to the sensation of breathing or other health-promoting stimuli (Garland, Froeliger, & Howard, 2014). Ostafin, Bauer, and Myxter (2012) studied effects of mindfulness practice on the relationship between automatic alcohol motivation and binge drinking in undergraduate students who were regular drinkers, and found that three sessions of brief mindfulness training reduced the relationship between motivation to drink and binge drinking behaviour. Consistent with Luberto and McLeish (2018) examined the effects of a 10 minutes sitting meditation session on the state of mindfulness in relation to distress, distress tolerance, and smoking urge in smokers. Their findings suggest that the brief mindfulness practice can reduce stress and craving. As craving has been linked to attentional bias this also suggests mindfulness practice could change cognitive biases . Moreover, the practice might also improve current moment levels of distress, but they do not appear to improve self-report or behavioural indices of distress tolerance. Furthermore, although a number of studies have found the effect of a mindfulness-based intervention on cognitive abilities, however, there are a number of studies that did not find the effect of mindfulness practice (Anderson, Lau, Segal, & Bishop, 2007; Chambers, Lo, & Allen, 2008; Heeren, Van Broeck, & Philippot, 2009).

Chapter 3

Investigation of attentional bias and attention training in drug addiction

Chapter 3 presents the findings from study 1 and 2. Study 1 aimed to investigate attention training effects on attentional bias in social drinkers. There were two forms of training in the study; a single session of training in the laboratory followed by multisession online training. Attentional bias was measured before and after the training, including 1 week and 5 weeks follow up. Study 2 aimed to investigate attentional bias in methamphetamine patients in different stages of treatment. Patients took part in a standard 4-month treatment programme with evaluation taking place monthly to monitor treatment progress. In Study 2 the attentional task was administered during the monthly evaluations to investigate whether different treatment durations produced different AB scores.

3.1 Study 1: Attention training in social drinkers

The gold standard of drug treatment is to help drug addicts to be able to stop drug use. Being able to remain drug-free is the indicator of successful drug treatment as it is craving that typically is used for predicting drug relapse. Drug treatment programs such as the MATRIX program, or Therapeutic Community (TC) contains the knowledge and coping skills for clients to analyse and practice to deal with triggers that induce addicts to return to drugs. Triggers or drug-related-stimuli were observed in cognitive psychology as a variable that grabbed addict's attention faster than neutral stimuli compared with non-drug user (Cox et al., 1999; Field, Mogg, & Bradley, 2005; Fadardi & Cox, 2009; Field et al., 2013) which is called attentional bias. Addiction studies suggest that attentional bias is an implicit process that plays an important role in drug addiction as an influencer for

craving and drug administration, a meta-analytic investigation revealed that attentional bias and craving are associated phenomena (Field, Munafò, et al., 2009).

In alcohol problem drinkers, studies showed evidence that attentional bias is associated with a craving that might lead to relapsing in alcohol abusers. For example, social drinkers with high alcohol craving showed more attentional bias toward alcohol than social drinkers with lower craving (Field, Mogg, & Bradley, 2005), and drinkers who were trained to attend to alcohol-related stimuli consumed more beer than drinkers who were trained to avoid alcohol (Field & Eastwood, 2005). On the other hand, the research argued that craving and time to relapse could not be predicted by attentional bias in alcohol patients (Snelleman et al., 2015).

Studies have indicated that attentional retraining or attentional bias modification (ABM) influences attention via an effect on the prefrontal cortex (PFC) (Browning, Holmes, Murphy, Goodwin, & Harmer, 2010; Clarke, Browning, Hammond, Notebaert, & MacLeod, 2014), a region that plays a critical role in the regulation of attention and emotion. Therefore, it is possible that ABM will subsequently modify neural reactivity to drug-related cues that have been linked to craving and repeated drug use. Recently, ABM for alcohol abusers has been developed that aims to alter attentional bias to alcohol and alcohol-related cues (Field, Mogg, Zetteler, & Bradley, 2004; Houben, Nederkoorn, Wiers, & Jansen, 2011; Eberl et al., 2013) and has various forms of training, for example, a single-session (Everaert, Mogoaşe, David, & Koster, 2014; Nelson, Jackson, Amir, & Hajcak, 2015) and multiple-sessions (Eberl et al., 2013; McGeary, Meadows, Amir, & Gibb, 2014; Eberl et al., 2014; Schoenmakers et al., 2010), lab-based and home-based (McGeary et al., 2014), also were developed as games and an application on mobile phones (Cox et al., 2014).

Randomized controlled trial reports have shown a reduction of attentional bias and subjective craving on smokers from a single session of ABM in the laboratory setting

(Attwood et al., 2008) as well as reduction of frequency of drinking or smoking and reduction of craving from multiple sessions of ABM outside the laboratory setting (Schoenmakers et al.; 2010; McGeary et al., 2014; Kerst & Waters, 2014). However, Begh et al. (2015) and Lopes, Pires, and Bizarro (2014) reported no effect of ABM in a clinical setting on craving or relapse to smoking. Recent addiction studies suggest that multiple ABM sessions might prompt reductions in craving or changes in behaviour, particularly if participants complete ABM on a computer at home, or on a mobile device as they go about their daily lives (Field et al., 2016).

Due to the result of the effectiveness of ABM for addiction being inconsistent it is still difficult to conclude the effectiveness of ABM, either in a single session, multiple sessions or even the amount and frequency of training sessions. Therefore, our study aims to investigate the effects of a single ABM session in the laboratory and the effects of multiple ABM sessions outside the laboratory setting.

A brief description of the two studies will enable the reader to understand the 4 hypotheses. For example: -

The first study investigated the effects of attention training using a visual probe task. Heavy social drinkers completed the training or control, and the effects of training were monitored using a visual probe task and Stroop task.

The study has four primary hypotheses: (i) A single-session of ABM could alter attentional bias in alcohol-related cues on social heavy drinkers, (ii) A multi-session ABM could have a greater effect than a single ABM session on attentional bias, (iii) Training effects could last for at least 1 month (the longest follow up duration that we could do in this experiment, due to participants being an undergraduate students), (iv) The effect of attention training on a visual probe task could generalize to the Stroop task.

3.1.1 Method

Participants

Undergraduate students of the University of Kent had a pre-screening of AUDIT. Seventy-three students who had AUDIT score 7 or above were invited to the study and were given a participant number. Final analyses were from 55 participants (18 participants were removed due to AUDIT less than 7 and unable to complete all questionnaires on 4 occasions). Their ages ranged from 18 to 34 (M=19.22, SD=2.46).

All participants had normal or corrected to normal vision and spoke fluent English (all university students were assumed to have fluent English as they met the university requirements of English language). The study was approved by the University of Kent Psychology Research Ethics Committee. Psychology students who participated received course credit; all other participants were compensated with £20.

Materials

Face-word Stroop task

The study used a Stroop-like paradigm. The face-word image was of a male or female face (all with neutral expressions) had the words (female, FEMALE, male, or MALE) printed on top of the face. These face images were supplied by Padmala, Bauer, and Pessoa (2011). Seventy-two pairs of alcohol-related and neutral coloured images were originally obtained from Google images and matched to be similar in size, shape and complexity. Alcohol-related images included drink-related objects (e.g. alcohol bottles, beer cans, wine glass). Neutral images were of household objects, (e.g. kettle, pen, hairbrush, bucket, candle). The alcohol and neutral set of pictures were taken from a previous study by Sharma (2017).

Visual probe task

The study used probe paradigm with fourteen pairs of images (one alcohol-related and one neutral image). The alcohol-related images such as alcohol bottles, wine glass, beer cans. The neutral pictures were pictures that matched the alcohol-related pictures as closely as possible for perceptual characteristics. These images were taken from a previous study by Field, Mogg, Zetteler, et al., 2004.

The Stroop task and the visual probe task were programmed using Inquisit version 4.0.9.0 computer software (Millisecond Software 2002) and presented on a Dell Optiplex 790 PC, with a 24-in. VGA monitor, and a standard keyboard.

Measures

Drinking severity

The Alcohol Use Disorders Identification Test (AUDIT) (Babor et al. 2001): A 10 item questionnaire to measure the frequency of drinking (see appendix). It has three questions on alcohol consumption (1 to 3), three questions on drinking behaviour and dependence (4 to 6) and four questions on the consequences or problems related to drinking (7 to 10). Questions 1 to 8 are scored on a five-point scale from 0, 1, 2, 3, and 4. Questions 9 and 10 are scored on a three-point scale scoring 0, 2 and 4. Total AUDIT scores between 0-7 are considered to be low risk, 8-15 Moderate risk, 16-19 high risk and 20-40 addiction likely.

Alcohol craving

Desire for Alcohol Questionnaire (DAQ) (Love, A., James, D., & Willner, 1998): A 14 item questionnaire to measure level or desire for alcohol on four subscales: (i) strong desires and intentions; (ii) negative reinforcement; (iii) control over drinking; and (iv) mild desire to drink. Responses were measured on a seven-point Likert scale ranging from 1(strongly disagree) to 7(strongly agree).

Alcohol consumption

Alcohol Timeline follow-back (TLFB) (Sobell, L. C. & Sobell, M. B., 2000): A one month calendar for recording drinking behaviour over the past month. Participants indicate on which days they drink and what they drink (see appendix).

Procedure

The study consisted of 4 sessions of testing in the laboratory and 5 sessions of attention training (1 at the lab, and 4 online training), the total length of the study was 60 days (Figure 12).

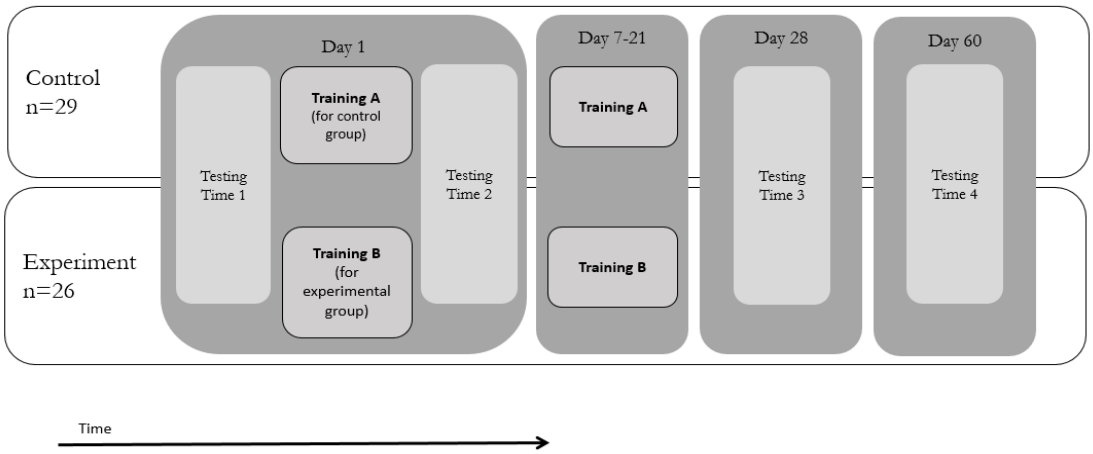


Figure 12 Timeline of the procedure of study 1

Day 1: Testing took place in the quiet laboratory, School of Psychology, University of Kent, after participants signed a consent form, then completed the AUDIT (Babor et al. 2001). Any participants who scored below 7 were excluded from the study. The remaining participants reported their drinking behaviour over the past month. The timeline follow-back calendar (TLFB) followed by completing the Desire for Alcohol Questionnaire (DAQ; Love et al. 1998). They then were instructed on how to respond during the Stroop task (288 trials), followed by the visual probe task (56 trials) to measure but not manipulate attentional bias for alcohol-related cues.

Stroop task: Trials started with a white fixation cross on the black background for 500 ms followed by a word-face image (male or female face with a word "male, MALE, female or FEMALE" printed on top). The word-face image remained until the participant responded. Participants were asked to ignore the word but respond to the face gender by using the left index finger on the keyboard "z" for female and the right index finger on the keyboard "m" for male. A 200 ms blank interval appeared after the responses were given, followed by a 500 ms presentation of an alcohol-related or neutral image. The participants were asked to ignore alcohol-related and neutral images. The sequence of tests began with 24 practice trials, in which participants were provided with feedback ("correct" or "incorrect") lasting 1000 ms, followed by the 288 experimental trials (6 blocks of 48 trials) (see Figure 13). A short break was provided between blocks.

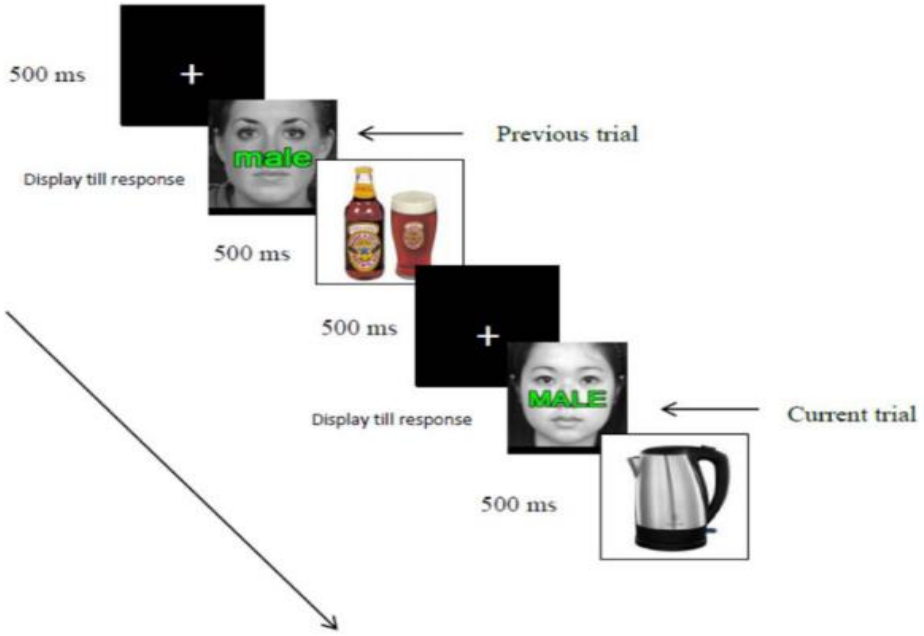


Figure 13. Timeline of Stroop task, showing two trials, an incongruent trial followed by an incongruent trial, with an alcohol image between them. This figure was taken from Sharma, D. (2017). The variable nature of cognitive control in a university sample of young adult drinkers. *Journal of Applied Social Psychology*, *47*(3), 118–123., p. 120

Visual Probe: This consisted of 3 sections; 10 practice trials, 2 buffer trials and 4 blocks of 56 critical trials respectively. Practice and buffer trials were neutral pair pictures, with a short break provided between practice and buffer trials. Critical trials were a set of the alcohol-related and neutral paired pictures. The trials were started from a 500 ms fixation cross at the centre of the screen, followed by a 500 ms paired picture presentation. Paired pictures were placed 60 mm apart; one at the left and one at the right. A visual probe stimulus (a small arrow that pointed up or down) was presented immediately after a paired picture and remained until the participant responded to the probe (see Figure 14). Participants were requested to respond to the probe by pressing the up arrow button and down arrow button on a standard keyboard. In the critical trials, the alcohol-related neutral picture pairs were presented four times, each with the alcohol-related picture presented twice on the left and twice on the right. Probes replaced alcohol-related and neutral pictures with equal frequency, and there was an equal number of probes of each type.

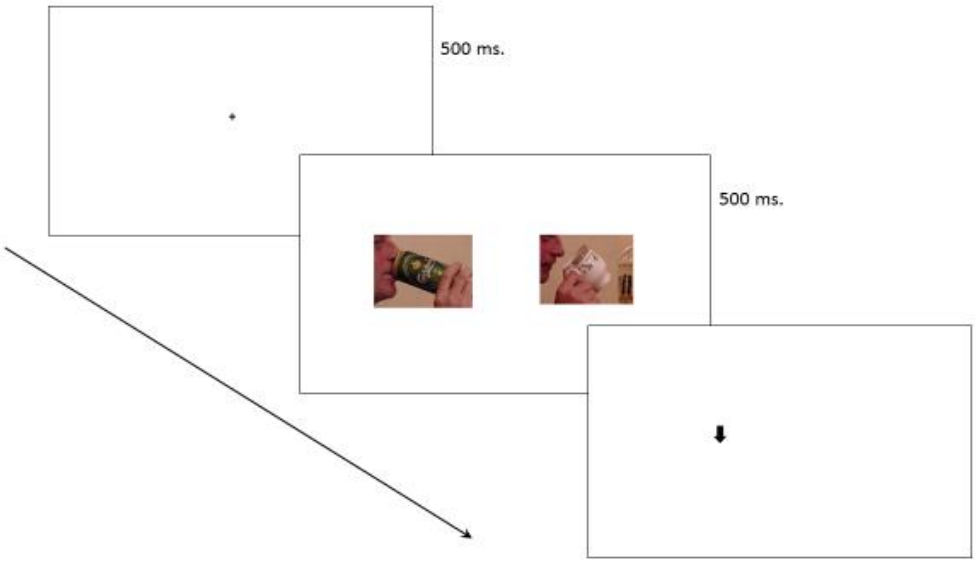


Figure 14. Timeline of one trial of visual probe task

Then *attention training* was given using the visual probe task. The control group saw the probe arrow on the same side as the alcohol image (50%) and at a neutral image (50%) equally often (Training A). The experimental group saw the probe arrow appear only at the location of the neutral image (100%) (Training B). The training involved 4 blocks of 224 trials per block. Participants were asked to take a break after each block. Responses were given on a keyboard to the target arrow as quickly and as accurately as possible. The training was taken from a previous study by Field and Eastwood (2005). After the training, participants completed testing time 2, which contained the Stroop task and the visual probe to measure attentional bias and completed the DAQ.

Day 7: Participants received the links of the training via email and completed online training task 4 times (during Day 7 - 21). The online training task was identical to the training in the laboratory.

Day 28: One week after the 4th online training, participants returned to the laboratory to complete testing time 3 which contains the visual probe task, followed by the Stroop task, TLFB and DAQ for measuring attentional bias, alcohol consumption and desire of alcohol level respectively.

Day 60: Participants again returned to the laboratory to repeat the measures (testing time 4) and were debriefed.

Data analysis

Data from both Stroop tasks and visual probe tasks were analysed using mixed-design analyses of variance (ANOVA). Any interactions were clarified by follow up ANOVAs and t-tests with Bonferroni correction where applicable. To analyse between-group characteristics in data from questionnaires taken prior to training a series of 2-way between-group ANOVAs were carried out. Analyses conducted to identify attentional bias used a series of mixed measure ANOVAs.

3.1.2 Result

Group Characteristics

A series of one-way ANOVAs were used to identify any between-group difference in age, AUDIT, desire for alcohol (DAQ) and weekly alcohol units. Each ANOVA included Group (Control and experimental) as the independent variable and each measure as the dependent variable. There was a significant difference between control and experimental groups in weekly alcohol units ($F(1, 54) = 6.55$, $p<.05$). No other significant differences were found between groups in other dependent variables (see Table 1).

Table 1 Characteristics of participants allocated to the control and experimental group

	Control (N=29)			Experimental (N=26)		
	Mean	SD	Range	Mean	SD	Range
Age (years)	19.34	3.21	16.00	19.08	1.23	4.00
AUDIT	11.31	3.72	14	12.73	6.14	30
DAQ1	2.58	0.83	3.36	2.56	0.78	2.86
WAU1	10.77	6.31	24.75	16.20	9.29	41.75

AUDIT: Alcohol Use Disorder Inventory Test
DAQ: Desire for Alcohol Questionnaire
WAU: Weekly Alcohol Use

Analysis of attentional bias and cognitive control

Stroop task

From 55 participants, 3 participants were removed because of a software error. Further cleaning of data used the procedure by Sharma (2017). The first trial of each block, error trials, trials immediately following an error, and trials with reaction time (RT) exceeding 2,000 ms and less than 200 ms and if more than 2.5 SDs per condition were removed.

To identify any between group and between condition differences in attentional bias and cognitive control, a mixed-design ANOVA 2 x 4 x 2 x 2 x 2 was performed with Group (control, experimental) as the between-subjects factor and Time (1, 2, 3, 4), Image type (neutral, alcohol), Previous congruency (congruent, incongruent), and Current

congruency (congruent, incongruent) as within-subject factors. Mean correct reaction times was the dependent variable. The analysis of reaction time revealed a significant main effect of Time ($F (3, 150) = 15.70$, $p < .001$, $\eta p^2 = .24$) which indicated that reaction time of Time 4 (M=562.82, SE=14.95) was shorter than Time1 (M=614.84, SE=13.43) suggesting the effect of practice. A significant main effect of Current congruency ($F (1, 50) = 78.28$, $p < .001$, $\eta p^2 = .61$) that reaction time to incongruent trials (M= 593.26, SE=13.48) was longer than to congruent trials (M= 555.33, SE=10.76), which indicated a Stroop effect.

There were also two-way interactions; Time x Current congruency interaction ($F (3, 150) = 7.16$, $p < .001$, $\eta p^2 = .13$), this revealed a Stroop effect that reduced with time (Time 1, M=57.24, SD=4.13; Time 4, M=37.44, SE=1.35), and indicated a general reduction in the Stroop effect with practice (see Figure 15). Image x Current interaction ($F (1, 50) = 27.77$, $p < .001$, $\eta p^2 = .36$) showed that an alcohol image (M=46.68, SE=4.83) produced a larger Stroop interference than a neutral image (M=29.36, SE=4.21), $t(51)=5.37$, $p<.001$) which indicated a form of alcohol attentional bias (see Figure 16). A Previous x Current interaction ($F (1, 50) = 41.80$, $p < .001$, $\eta p^2 = .46$), indicated incongruent previous trials had a smaller Stroop interference than previous congruent trials, this demonstrated sequential modulation (SM) (Stroop interference reduced when previous congruency was incongruent) (see Figure 17) this is indicative of cognitive control and is consistent with previous literature. No other main effect or interactions were found. As there was not an interaction with Group this suggests that the training manipulation did not have any effect on reaction times.

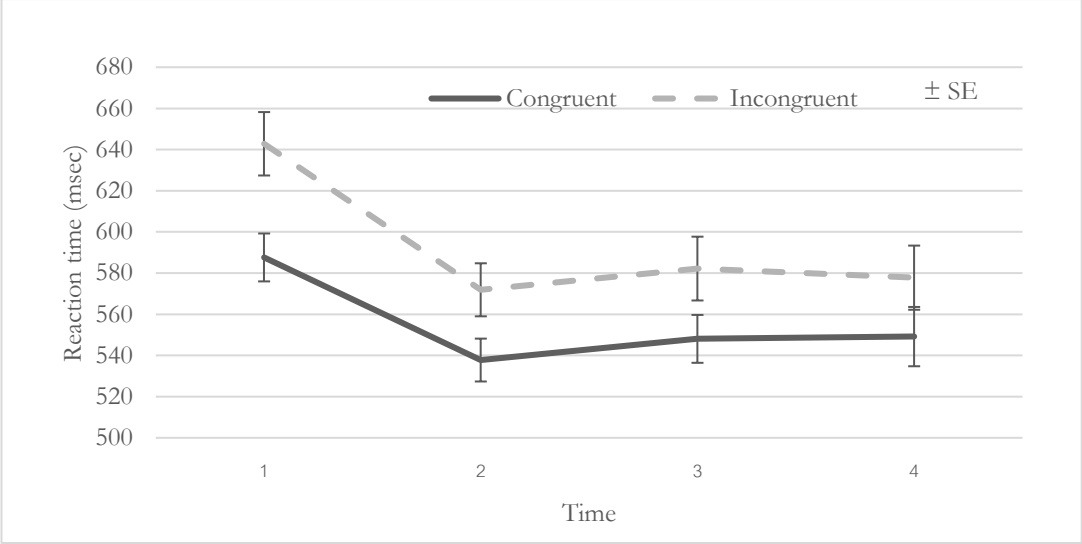


Figure 15. Changes in Stroop interference (Incongruent – Congruent) across Time.

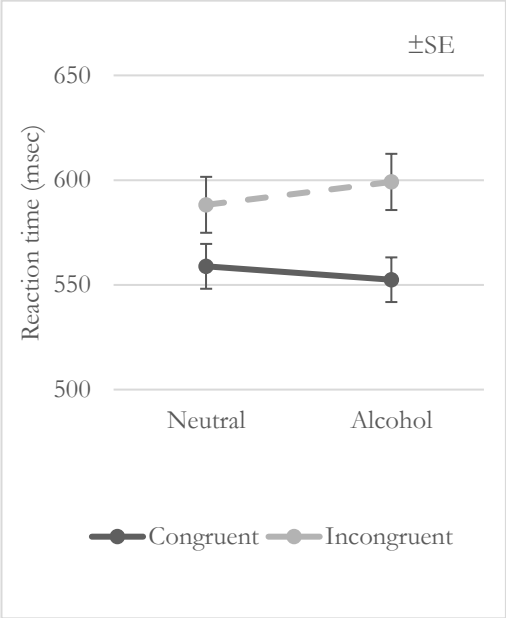


Figure 16. Stroop interference preceded by each image

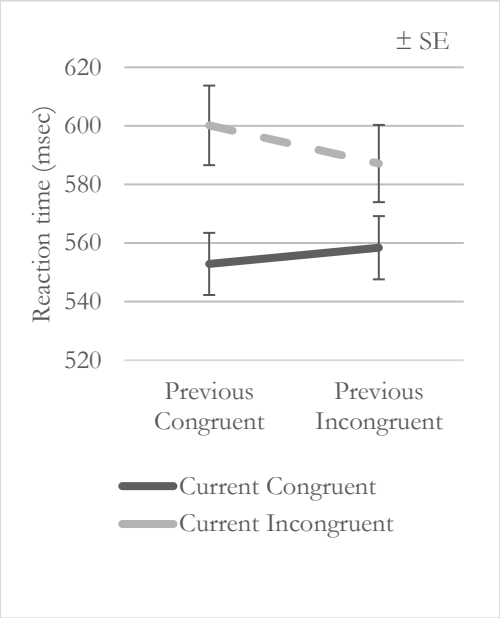


Figure 17. Current incongruent speed up when previous trial was incongruent

Visual Probe

The cleaning of data followed the procedure described by Field and Eastwood (2005). Reaction time data from practice and buffer trials, and from trials with errors were removed. To eliminate outliers, RT were excluded if they were greater than 2,000 ms, and then if they were more than 2.5 SDs above the mean per condition (7.15% of data).

To examine the effects of attentional bias training, using a factorial design 2 x 4 x 2 with Group (control, experimental) as the between-subjects factor, Time (1, 2, 3, 4) and Probe position (alcohol, neutral) as within-subject factors, and mean reaction time as a dependent variable. The only significant effect was a main effect of Time (F (3, 159) = 43.55, p<0.01, ηp^2=.45), indicating a general practice effect, with longer reaction times at Time 1 (M= 485.25, SE=7.11) than Time 4 (M=420.13, SE=5.91). There were no other significant main effects or interactions (all F's< 2.95, p>.092).

Analysis of Desire for Alcohol

To examine whether the training altered desire for alcohol, a factorial design 2 x 4 with Group (control, experimental) as the between-subjects factor and Time (1, 2, 3, 4) as within-subject factor was conducted on desire for alcohol as the dependent variable. No significant main effects or interactions were found (all F's <.69, p>.55). This revealed desire for alcohol does not change throughout the study in both the control and experimental group.

Analysis of Alcohol consumption

To examine weekly alcohol unit consumption, a factorial design 2 x 4 with Group (control, experimental) as the between-subjects factor, Time (1, 2, 3) as within-subject factors, was conducted on weekly alcohol units as a dependent variable. Results showed a significant main effect of Time (F (2, 104) = 7.05, p<.01, ηp^2=.119) showing that WAU

time 3 (M= 10.41, SE=.92) was less than WAU time 1 (M= 13.50, SE=1.08) and indicated that alcohol consumption deceased during the study but was not related to the intervention.

Correlation analysis

To examine the relationship between attentional bias, cognitive control, alcohol craving, and alcohol consumption the mean score of each variable was calculated, and bivariate correlations were performed.

Attentional bias scores from the Stroop task can be calculated using two methods;

1) Attentional bias (AB) calculated from subtracted reaction time of trials that preceded by neutral from alcohol image (RT alcohol – RT neutral). We assumed that drinker would take a longer time to disengage attention from alcohol than neutral. A positive score means alcohol attentional bias. This will reveal how type of image affects reaction time.

2) Attentional bias calculated from Stroop interference (AB.SI), subtracted Stroop interference (SI = RT Incongruent - RT Congruent) preceded by neutral image from alcohol image. We assumed that alcohol images would distract drinkers' attention resulting in taking a longer time to gender naming on face task. Positive score means alcohol attentional bias.

Attentional bias (from Visual probe task) (ABvp) can be calculated by subtracting reaction time of probe to neutral picture from alcohol (RT neutral – RT Alcohol). We assumed that drinkers would place attention at alcohol-related cue, therefore when the arrow appeared in the same position as alcohol-related cue, RT of probe would be faster than neutral picture. A positive score means alcohol attentional bias.

The analyses revealed that there was a significant positive correlation between AB and AB.SI (r=.31, *p*=.02), indicated greater attentional bias (AB) also reported greater

attentional bias in condition of SI (AB.SI). A positive significant correlation between AB and WAU (r=.31. *p*=.02), indicated that greater attentional bias also reported greater weekly alcohol consumption. A positive significant correlation between AB.SI and SMd (r=.51. *p*<.001), indicated greater attentional bias (ABI.SI) also reported greater cognitive control after the presence of alcohol cues. DAQ had a significant positive correlation with SMn (r=.28, *p*=.05) and AUDIT (r=.28, *p*=.04), indicted that greater alcohol craving also reported greater cognitive control after the presence of neutral cues, and greater drinking severity (see Table 2).

Table 2 Correlations among variables of interest study 1

	ABvp	AB	AB.SI	SMn	SMd	Age	AUDIT	DAQ
AB	-.17							
AB.SI	-.26	.31*						
SMn	.22	.03	.01					
SMd	-.14	.19	.51**	.00				
Age	.04	-.03	.02	.18	-.16			
AUD	-.09	.17	.00	.23	.16	.07		
DAQ	.08	.06	.08	.28*	.05	.12	.28*	
WAU	-.17	.31*	.06	.11	-.13	-.19	.17	.04

**p<0.01, *p<0.05

AB: Attentional bias

AB.SI: Attentional bias calculated from Stroop interference

SMn: Sequential modulation on neutral stimuli

SMd: Sequential modulation on drug stimuli

AUDIT: Alcohol Use Disorder Invemtory Test

DAQ: Desire for Alcohol Questionnaire

WAU: Weekly Alcohol Use

Regression analysis

Multiple linear regression was employed to help determine which of the IVs could be used to predict attentional bias and sequential modulation. Since no a priori hypotheses had been made to determine the order of entry of the predictor variables, a direct method was used for the multiple linear regression analyses. Results showed weekly alcohol consumption predicts attentional bias (AB) ($\beta = .30, p<.05$). The overall model fit was not significant ($R^2= .11$) (see Table 3).

Table 3 Multiple regression analysis of self-report on attentional bias and sequential modulation

	ABvp				AB				AB.SI			
	B	*SE B*	β	*sr²*	B	SE B	β	*sr²*	*B*	*SE B*	β	*sr²*
Age	.02	.50	.01	.00	.13	.63	.03	.00	.18	1.39	.02	.00
AUDIT	-.17	.25	-.10	.01	.26	.32	.12	.01	-.19	.70	-.04	.00
DAQ	1.21	1.56	.11	.01	-.42	2.36	-.03	.00	2.73	5.24	.08	.01
WAU	-.19	.18	-.16	.02	.47	.23	.30*	.08	.21	.51	.06	.00
R^2	.05				.11				.01			
F	.59				1.47				.134			

	SMn				SMd			
	B	*SE B*	β	*sr²*	*B*	*SE B*	β	*sr²*
Age	2.19	1.93	.16	.03	-3.13	1.99	-.23	.05
AUDIT	.99	.98	.15	.02	1.37	1.00	.20	.04
DAQ	9.59	7.27	.19	.04	3.23	7.47	.06	.00
WAU	00.39	.70	.08	.01	-1.12	.72	-.23	.05
R^2	.11				.10			
F	1.39				1.35			

**p<0.01, *p<0.05

ABvp: Attentional bias calculated from Visual probe task

AB: Attentional bias calculated from subtracted reaction time of trials that preceded by neutral from alcohol image

AB.SI: Attentional bias calculated from Stroop interference

SMn: Sequential modulation on neutral stimuli

SMd: Sequential modulation on drug stimuli

AUDIT: Alcohol Use Disorder Invemtory Test

DAQ: Desire for Alcohol Questionnaire

WAU: Weekly Alcohol Use

3.1.3 Summary

Training effect: The study findings do not support our hypotheses, the training (a single session lab training, and a multisession online training) unable to change attentional bias. The result of a single session training was unlike previous studies (Field & Eastwood, 2005; Field et al. , 2007) that we have partially replicated. They found that one session of training attention away from alcohol-related image decreased alcohol attentional bias. However, the present study was consistent with the null finding of the study of a single attention retraining session using visual probe paradigm to train participants to attend away from the smoking stimuli (McHugh et.al., 2010). Although this study claimed that a single session is insufficient for reducing attentional bias, and might be due to "dose" of training not being enough. The present study contains a single lab session, and 4 sessions of online training, however, there was no change in attentional bias after the training was delivered. Therefore, number of training sessions might not explain the null findings or 5 training sessions in the current study might not be enough. Furthermore, the review by MacLeod and Clarke (2015) presented a number of attentional bias modification online training studies, which targeted anxiety and depression population, and they all were unsuccessful. Thus, it is still unclear what would support ABM online training success to alter attention.

Attentional bias was found in this sample, and presented under the condition of Stroop interference (SI) that an alcohol image produced Stroop interference larger than a neutral image. However, visual probe task and Stroop task did not show a significant reaction time difference between alcohol and neutral picture that represented attentional bias to alcohol. This may explain in the case of AB.vp and AB that participants had to shifting or disengage attention from one picture to another picture (e.g. from alcohol to neutral). Participants might be able to perform it, which represented no attentional bias

because cognitive resources were enough for this task. However, in the case of AB.SI, participants needed more cognitive resources to disengage attention from alcohol/neutral pictures, and inhibit attention on the word and attend to the gender in the picture (see Figure 18). Therefore, attentional bias was found in the condition of Stroop interference due to the task having more difficulty which needs more cognitive resources than only shifting or disengaging attention. Suggesting that it may be better to use both the Stroop and probe task to measure attentional bias as it may provide more viewpoints. Moreover, attentional bias (AB) was predicted by alcohol consumption. This finding supports the dual-processes model that drug use increases attentional bias due to sensitization, also could be explained in the incentive-sensitization theory that repeated drug use creates dopaminergic response that becomes sensitized.

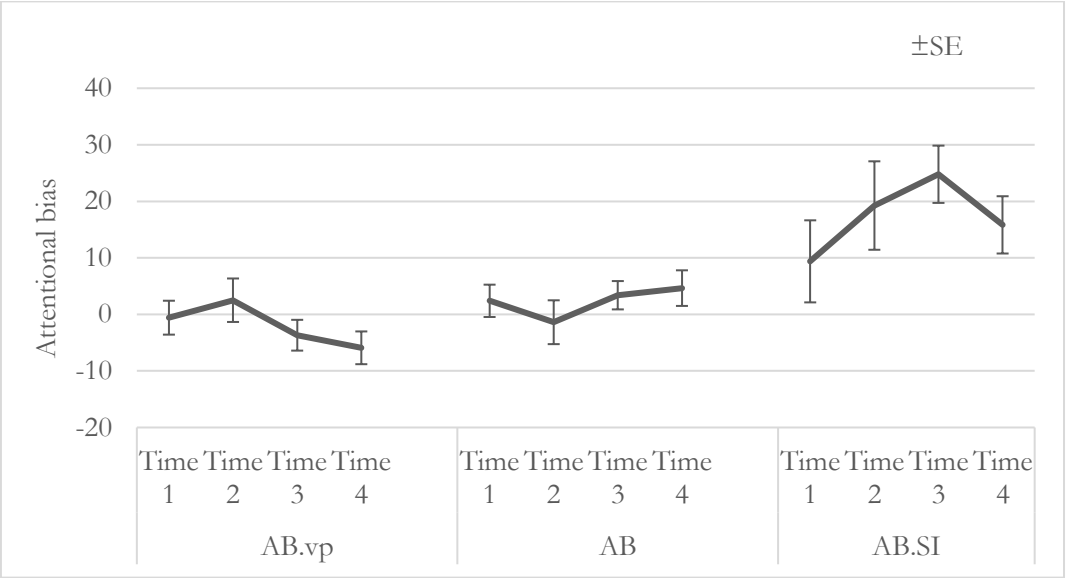


Figure 18. At baseline (Time 1), attentional bias was not found in AB.vp and AB, however it was found in AB.SI.

Cognitive control was found in this sample, represented by sequential modulation (RT of the current incongruent trial reduced when the previous trial was incongruent). This finding was consistent with a previous study where Sharma (2017) found cognitive control in young adult drinkers. Demonstrating top-down processes in individual who

are trying to overcome habitual responses. However, our training did not change cognitive control.

The current study revealed no *generalization* from visual probe task to Stroop task which is consistent with a previous study (Field et al., 2007) that attention training via probe detection paradigm was unable to generalise to the Stroop task. Additionally, no generalization was found on alcohol consumption and desire for alcohol, this was consistent with previous studies (Field et al., 2007; Field et al., 2009; Schoenmakers et al., 2007) whereas it was inconsistent with the study where McGeary et al. (2014) found that an 8 session computerized and home-based attention training decreased alcohol consumption.

Limitation of the study is that it did not measure affect. According to the observation of participants' behavior during the first session at the lab, the researcher saw negative emotions such as boredom and anger due to the length of the training session plus attentional measurement session. However, the present study did not measure affect before and after attentional testing, and attention training. Therefore, we might have missed the evidence to explain attentional bias and cognitive control. This issue is examined further in Study 3, which looked at affect before and after attentional testing and attentional training.

3.2 Study 2: Attentional bias in methamphetamine patients

Methamphetamine use has steeply increased in the past ten years as indicated by a global situation report from United Nations Office on Drug Crime (UNODC), particularly in Southeast Asia, which reported that methamphetamine is the main drug of concern in treatment (United Nation, 2019). The Drug Treatment Annual Report of Thailand showed the number of drug abusers who attended treatment at Princess Mother National Institute on Drug Abuse Treatment (PMNIDAT) in 2016 was 45,516 patients: 49.47 % were Methamphetamine abusers (PMNIDAT, 2016). In the past ten years, Thailand released a new law to send drug-related case suspects for mandated treatment. The treatment programs for methamphetamine patients was adapted from Therapeutic community and MATRIX program. The length of the program is 4 months in the hospital and follow up at least 6 months later.

Previous research has found that attentional bias is associated with craving, drug administration, and relapsing. Although studies of attentional bias in addiction have been conducted for two decades, none has been conducted in Thailand. Most of these studies were conducted in Western countries (Cox et al., 2014; Dean et al., 2019), with only a few in Asian countries (Kang et al., 2012; Kwak et al., 2007), and none being with methamphetamine abusers.

Study 2 aimed to investigate whether there is an attentional bias to methamphetamine stimuli in a group of inpatients and also investigate whether the attentional bias changes during the treatment. We had two hypotheses; 1) That there would be attentional bias in this inpatient group, and 2) attentional bias would decrease in a group who have been in treatment for a longer duration.

3.2.1 Method

Participants

One hundred and two participants were recruited from Thanyarak Chiang Mai Hospital, Thailand, through advertising by the researcher at the meeting in the ward. Participants were selected on the criteria that they were either native Thai speakers or fluent in spoken Thai and had visual acuity within normal limits, and were diagnosed with a Methamphetamine dependence. All participants were treated in accordance with the ethical standards of the British Psychological Association. In addition, ethical approval was obtained from the University of Kent at Canterbury's Department of Psychology ethics committee and permission from Thanyarak Chiang Mai Hospital before recruiting participants and proceeding with the experiment.

Materials

Face-word Stroop task

The face-word Stroop task was adopted from study 1, alcohol images were replaced with methamphetamine images, and words "male" and "female" in English letters were replaced with Thai letters.

Visual Probe task

Visual probe task was adopted from study 1, alcohol images were replaced with methamphetamine images, and the response key was changed from up arrow to Z button, and down arrow to M button due to this study using a laptop instead of a standard PC keyboard in which the arrow buttons on the laptop were half the size of a standard keyboard. The Z was covered with an up arrow image sticker, and the M key was covered with a down arrow image sticker.

Demography and Treatment history Record form

A record form contained demographic and treatment history from hospital records and self-reported. Hospital records: treatment duration (calculated from the date they were admitted for treatment until the date for testing). admission type (whether they came to the treatment by order of the court or voluntary by self-admission), and comorbidity (whether they were clinically diagnosed methamphetamine dependent alone or with other disorder). Participants self-reported: age, education, marital status, job employment, admissions number (Is this admission the first time of your drug treatment? If not, how many time have you been in drug treatment including this admission?).

Measures

Motivation to change

Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES 8D) (Miller & Tonigan, 1996): The SOCRATES is a 19-item, self-administered instrument designed to assess client motivation to change drug taking-related behaviour. It is made up of three scales: Problem Recognition (Re), Ambivalence (Am), and Taking Steps (TS). The three factors are scored separately. Each scale has items that are summed to derive the score for each factor.

Procedure

Testing took place in Thanyarak Chiang Mai Hospital, Thailand, in a quiet room. After participants signed a consent form, they then completed the SOCRATES-8D to measure motivation to change. This was followed by two computerized-based tasks: the visual probe task (56 trials) followed by the Stroop task (288 Trials). Both tasks provided a measure of attentional bias for methamphetamine-related cues. Participants provided demography data and received a debrief at the end of the session.

3.2.2 Results

Participant Characteristics

Descriptive statistics were used to describe participants in Age, Education, Employment, Marital status, Admission no., Admission type, Treatment duration, Comorbidity, and Motivation to Change (see Table 4)

Table 4 Descriptive statistic of participants.

	Mean	SD	Range
Age(years)	29.90	8.02	15-56
Admission no.	1.65	1.30	1-8
Treatment duration(days)	49.22	29.79	2-112
Motivation to Change			
Recognition (Re)	26.41	5.24	9-35
Ambivalence (Am)	13.93	3.19	6-20
Taking Steps (TS)	33.99	4.28	22-40

	%	N
Education		
Primary or lower	23.5	24
Secondary	50.0	51
High School	26.5	27
Job employment		
Unemployed	18.6	19
Employed	81.4	83
Marital status		
Single	41.2	42
Married	28.4	29
Separated/ Divorced/	30.4	31
Admission type		
Voluntary	22.5	23
Compulsory	77.5	79
Comorbidity		
Comorbidity	45.9	39
No comorbidity	54.1	46

Analysis of attentional bias and cognitive control

Stroop task

As in study 1 cleaning of data used the procedure by Sharma (2017). The first trial of each block, error trials, trials immediately following an error, trials with reaction time (RT) exceeding 3,000 ms and less than 300 ms, and 4 participants who had very high error rates (>30%) were treated as outliers and were removed. As a consequence, the analyses of Stroop data were conducted for 98 participants. To examine the presence of attentional bias and cognitive control, the mean correct reaction times were entered into a 2 x 2 x 2 mixed-design ANOVA with Image type (neutral, drug), Previous congruency (congruent, incongruent), and Current congruency (congruent, incongruent) as within-subject factors. Analyses revealed a significant main effect of Current congruency ($F(1, 97)=69.79$, $p<.001$, $\eta p^2 =.42$) that RT incongruent (M= 802.36, SE=22.48) greater than RT congruent (M= 741.35, SE=17.99), which indicated a Stroop interference. No other main effects or interaction were found.

To test whether attentional bias and sequential modulation varied with different group characteristics: comorbidity (comorbid, non-comorbid), admission type (voluntary, compulsory), education (primary or lower, secondary, college or higher), marital status (single, marriage, others), and job employment status (employed, unemployed). The previous ANOVA was employed adding one of the group variables as the between-group factor. The analysis revealed a significant three-way interaction, Previous congruency x Current congruency x comorbidity Group ($F(1,96)=7.25$, $p=.008$, $\eta p^2 =.070$) that RT current incongruent reduces when previous trial is incongruent in comorbidity group. This indicates cognitive control was found only in patients who had comorbidity (see Figure 19). There was no other significant main effect or interaction (all F's< 3.2, p>.06).

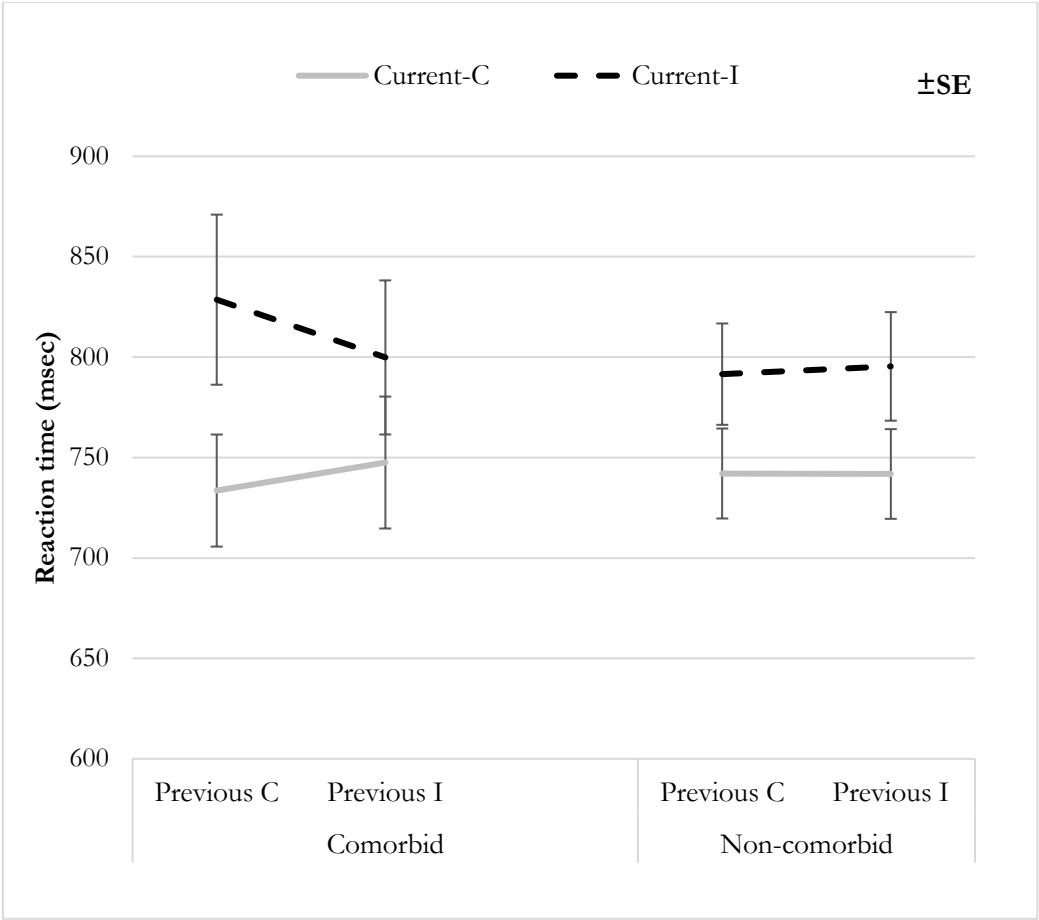


Figure 19. Interaction between Previous congruency and Current congruency in patients.

C: congruent, I: incongruent

Visual Probe task

The cleaning of data followed the procedure described by Field and Eastwood (2005). Reaction time data from practice and buffer trials, and from trials with errors were removed. To eliminate outliers, of these 102 participants, 17 participants were removed due to very high error rates (>30%). RTs were excluded if they were less than 300 ms. or greater than 3,000 ms, and then if they were ±2.5 SDs from the mean (12.16%). A total of 85 participants remained in the analysis. To test whether a whole sample has an attentional bias toward methamphetamine-related cues, ANOVA was employed with Probe Position (methamphetamine, neutral) as the within-group factor, and reaction time

as the dependent variable. No significant main effect of probe position was found ($F(1,84)=2.07$, $p=.15$, $\eta p^2=.024$), suggesting there was no attentional bias in this sample.

To test whether AB.vp is also affected by group conditions: admission type (voluntary, compulsory), comorbidity (comorbid, non-comorbid), education (primary or lower, secondary, college or higher), marital status (single, marriage, others), and job employment (employed, unemployed). ANOVA was employed as in the prior analysis with each group as the between-group factor. No significant main or interaction effect with position (all F's< .126, *p's*>.72) was observed.

Correlation analysis

Further exploratory analysis focused on examining the relationship between variables. The mean score of each variable was calculated and bivariate correlations were conducted. Analyses revealed a significant negative correlation between AB and SMd ($r=-.33$, $p=.001$), which indicated greater AB scores was related to a reduced level of cognitive control when preceded by methamphetamine pictures. A significant negative correlation between AB.SI and SMn ($r=-.27$, $p=.008$), which indicated greater AB.SI also reported smaller cognitive control when preceded by neutral pictures. SMn had a significant negative correlation with treatment duration ($r=-28$, $p=.012$), which indicated shorter treatment duration also reported greater cognitive control when preceded by neutral pictures. Moreover, admission number had a significant negative correlation with AB.vp ($r=-.23$, $p=0.36$), which indicated a greater number of admission also reported smaller AB.vp. A significant positive correlation with AB.SI ($r=.22$, $p=.047$), which indicated a greater number of admissions also reported greater AB.SI. Motivation to change did not associate to other variables (see Table 5).

Table 5 Correlations among variables of interest study 2

	AB.vp	AB	AB.SI	SMn	SMd	Age	Adm.no.	Duration	Re	Am
AB	.16									
AB.SI	.07	.04								
SMn	-.11	-.18	-.27**							
SMd	.03	-.33**	-.02	.11						
Age	.17	.14	.06	.01	-.11					
Adm. no.	-.23*	-.07	.22*	-.18	-.02	-.21				
Duration	.02	.13	.12	-.28*	-.15	.16	.14			
Re	.05	-.07	-.16	.05	.03	.02	.03	.06		
Am	.10	-.01	-.06	.04	.14	-.03	.13	.04	.72**	
TS	.08	-.01	-.12	.06	.00	.06	-.06	.18	.55**	.35**

*p<0.05, ** p<.01

Regression analysis

Multiple linear regression was employed to help determine which of the IVs could be used to predict attentional bias and sequential modulation in methamphetamine patients. Since no a priori hypotheses had been made to determine the order of entry of the predictor variables, a direct method was used for the multiple linear regression analyses. Results showed when AB.vp was predicted by admission number (β = -.23, *p<.05)*. The overall model fit was not significant (R^2= .09). Moreover, SMn was predicted by treatment duration (β = -.28, *p<.05)*. The overall model fit was not significant (R^2= .11) (see Table 6).

Table 6 Multiple regression analysis of demography, treatment history, and motivation to change on attentional bias and sequential modulation

	AB.vp				AB				AB.SI				SMn				SMd			
	B	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2
Age	.64	.61	.12	0.01	-.91	.53	-.20	0.04	1.06	1.16	.10	0.01	.46	1.92	.03	0.00	-1.15	1.54	-.09	0.01
Admission no.	-7.66	3.88	-.23*	0.05	3.43	3.39	.12	0.01	14.27	7.43	.22	0.05	-15.02	12.27	-.14	0.02	-3.90	9.85	-.05	0.00
Duration	.04	.17	.02	0.00	.03	.15	.02	0.00	.27	.33	.09	0.01	-1.31	.54	-.28*	0.07	-.49	.43	-.13	0.02
Recognition	-.93	1.41	-.12	0.01	-.71	1.23	-.10	0.00	-3.40	2.70	-.22	0.02	-.52	4.45	-.02	0.00	-2.95	3.58	-.15	0.01
Ambivalence	2.71	2.14	.20	0.02	-.27	1.87	-.02	0.00	2.33	4.10	.09	0.00	2.29	6.77	.05	0.00	8.39	5.44	.25	0.03
Taking Steps	.54	1.46	.05	0.00	.25	1.28	.03	0.00	-.91	2.81	-.04	0.00	3.26	4.63	.09	0.01	.37	3.72	.01	0.00
R^2	.09				.07				.10				.11				.06			
F	1.28				.99				1.44				1.55				.83			

**p<0.01, *p<0.05

3.2.3 Summary

The present study investigated attentional bias and cognitive control in Thai male methamphetamine inpatients in the residential treatment program. The findings showed the absence of *attentional bias* in this sample, however attentional bias (AB.vp) predicted by readmission such that less attentional bias in patients who had more readmission. Cognitive control, which was represented by changes in Stroop interference, was found in comorbid patients; cognitive control was predicted by treatment duration, that longer treatment duration produces smaller cognitive control when neutral picture was presented (SMn).

Attentional bias: The present study showed an absence of attentional bias in methamphetamine inpatients which is consistent with a number of addiction studies that have not found attentional bias in drug users who are seeking the treatment or currently in the treatment. For example, cigarette smokers who seeking treatment (Begh et al., 2015), alcohol abstinent (Noël et al., 2006), cannabis in-patients (Van Kampen et al., 2020). Although, there are also a number of addiction studies that show converse results: attentional bias in active drug-users; alcohol (Field et al., 2005), cigarette (Masiero et al., 2019), cannabis (Cousijn et al., 2013; Field, Mogg, & Bradley, 2004), cocaine (Cox, Hogan, Kristian, & Race, 2002), heroin (Marissen et al., 2006). This showed that the presence of attentional bias may be associated with a state of addiction, whether they are an abstinent or active user. The state of addiction might be related to motivation to change (their addiction) or being in the addiction treatment. However, the current study did not show any relationship between attentional bias and motivation to change from SOCRATES, and regression analyses showed that more admission number (readmission) produces less attentional bias. Suggesting that attentional bias associates with the addiction treatment, that the treatment reduces attentional bias.

Cognitive control (sequential modulation) was found in patients who had comorbidity. Demonstrating methamphetamine patients who had methamphetamine dependency problem with other health problems, such as have other addictions (cigarette, alcohol), affect disorder (depression, anxiety), physical problem (hypertension, diabetes, hepatitis), had greater cognitive control compared to patients who had an only methamphetamine dependency problem. This result might be explained in relation to affect that patients who have more issues, might have greater negative affect, and it effects cognitive control as the literature proposed that less-pleasure associated with more conflict-driven control (van Steenbergen, Band, & Hommel, 2010).

Furthermore, regression analysis revealed that cognitive control decreased by treatment duration. This might be explained in relation to the emotion that patients who just start the treatment in a residential program, where there was a new environment so that at the first period of staying with new people, new daily regulation, with strict rules that might cause stress and negative affect in them. Later on, when they are able to adjust to the new environment and the treatment program that provides both medical and psychological therapy also family support has been working for a while so that the negative affect decreases and positive affect increases, which is considered as good progress from the treatment objectives. These reasons support research finding that the conflict adaptation effect can be strongly reduced by reward contexts (Van Steenbergen et al., 2009).

The findings that cognitive control decreased with the duration of treatment, might also be explained as due to cognitive-depletion. Cognitive control is thought to require limited cognitive resources that could be depleted by increased task demands. One possibility is that patients in this study are in the residential program which is based on Therapeutic community model, where residents have to control themselves to follow the house rules (each ward in the rehabilitation phase is called a house). Everyone has to be

responsible for their own role in the house (for example, head of the kitchen team, worker in cleaning team). Also, there is a requirement to control their bahaviour/inhibit unwanted behavior: laziness, lying, irresponsibility. Whilst also promoting accepted behaviour: such as honesty, responsibility, and consistency. Apply behavioural shaping tools, which are called house tools (rewards, punishment) to help peers to stop unwanted behaviour and increase wanted behavior. These responsibilities consume cognitive resources almost all the time and every day, which could result in lowering the cognitive capacity available for other tasks. Therefore, patients who have a longer treatment duration might have greater mental and physical exhaustion than newcomers.

One important limitation of this study is that lack of craving measure and thus could not address whether craving is associated with attentional bias and cognitive control. This issue is examined further in Study 3, which looks at craving before and after the intervention.

Chapter 4

Experimental test of mindfulness-based intervention in drug addiction

This chapter contains four experiments (Study 3, 4, 5 and 6) in which the first two experiments examine the effects of a single session of mindfulness-based attention training and the other two experiments examine effects of daily mindfulness practice on attentional bias and cognitive control. As study 1 revealed a single session and multiple sessions of computerized-attention training had no impact on attentional bias and cognitive control in social drinkers. The training also created negative feedback in light of boredom because of hundreds of trials that participants had to look at, which induces a negative effect and reduces motivation to complete the tasks. Thus, mindfulness was combined in the later studies as Chapter 2, a literature review of mindfulness-based attention training in addiction showed mindfulness practice was integrated into treatment for various clinical conditioned population such as stress, cancer, depression, anxiety, as well as addiction, due to its effectiveness on well-being and cognitive improvements such as attention, emotion and executive function. Forms and length of mindfulness practice vary; brief and intensive practice, a single session and multiple sessions, and less equipment needed; this makes it practical to use, particularly in the hospital setting. Also, there is evidence showing that benefits deriving from mindfulness training could increase proportionally with daily practice (Pagnoni & Cekic, 2007; Jha et al., 2010).

Therefore, study 3 and 4 examined effects of a single session of mindfulness-based attention training in student social drinkers and methamphetamine inpatients, respectively. Because there is some limitation such as time and number of participants, therefore, the experiment used a single session of training and no control group who did not receive the training. Whereas, study 5 and 6 conducted in patients who stay in a longterm rehabilitation program and enough number for the control group, and aimed to

examine the effects of multiple session of mindfulness practice on attention and cognitive control.

4.1 Study 3: Effects of mindful-colouring on attention and cognitive control in social drinkers

According to Study 1 social drinkers' attentional bias did not change using a computer-based attentional bias training. In addition, there was negative feedback and lack of motivation regarding the length and repetitive nature of the hundreds of trials administered during the dot-probe task. The present study used a simplified version of the dot-probe task and combined it with a focused mindfulness attention meditation task, which is a mandala colouring. Study shows that colouring mandala enhances positive mood in adults (Babouchkina & Robbins, 2015), reduces anxiety in children, especially females. (Carsley et al., 2015), a 7-days mandala colouring reduce negative mood in female college students(Flett et al., 2017). In the focused mindfulness attention meditation, the individual would direct and sustain attention on a selected object, detect mind wandering and distractors (e.g. thoughts), disengage attention from distractors and shift attention back to the selected object, and reappraise distractors (e.g. 'just a thought', 'it is okay to be distracted'). Meditators would show improvements in selective attention and conflict monitoring (for a review, see Lutz, Slagter, Dunne, & Davidson, 2008). For mindful-colouring, the participant had to focus attention on each tiny space on a mandala pattern at the bottom of the page (in the booklet) and colour it. We expected that mindful-colouring would increase state mindfulness, resulting in strengthened awareness and cognitive control, and would induce positive emotion. Moreover, ignoring an alcohol picture at the top of the booklet, which is a similar idea as training using the dot-probe paradigm, aimed to train participants' attention to look away from alcohol pictures which would decrease attentional bias.

The current study examines attentional bias and cognitive control between experimental group, that were trained to look away from alcohol picture, and control

group, who were trained to look away from neutral picture during a mindful colouring task. Additionally, both groups are dividied into 5 minutes and 10 minutes colouring task.

The hypothesis is all groups show increasing of state mindfulness, and experimental groups would have reduction of attentional bias and increase of cognitive control, while control groups have no change in attentional bias and cognitive control. Moreover, the degree of change in 10 minutes group would be greater than 5 minutes group. The hypothesis regarding to the duration of colouring task is from the evidence that an experienced meditator shows a greater change than a naive meditator.

4.3.1 Method

Participants

One hundred and forty psychology undergraduates were recruited through the University of Kent's research participation scheme and were given 4-course credits. Participants were selected on the criteria that they were either native English speakers or fluent in spoken English and had visual acuity within normal limits. Participants were randomly allocated to 4 groups when they first completed questionnaires. Of these 140 participants, 18 were excluded from the final sample because of AUDIT score below 7 and/or incomplete data questionnaires. Therefore, the final sample consisted of 122 participants (24 male, 98 female; mean age = 19.28, SD=1.99, age range = 16). Of those who took part, 58 in control group (Intervention N, using a neutral distractor) and 64 in experimental group (Intervention A, using an alcohol distractor). All participants were treated in accordance with the ethical standards of the British Psychological Association. In addition, ethical approval was obtained from the University of Kent at Canterbury's Department of Psychology ethics committee before recruiting participants and proceeding with the experiment.

Materials

Face-word Stroop task

Same as adopted in Study 1

Visual Probe task

Same as adopted in Study 1

Mindful-colouring Intervention

There are 2 types of interventions; the intervention N is a mindful colouring with ignoring neutral picture, and the intervention A is a mindful colouring with ignoring alcohol picture. Both interventions use 1) A booklet which contains a coloured picture (Intervention-N uses a Nature picture, Intervention-A uses an Alcohol picture) and a blank Mandala (from google) for colouring, everyone uses the same pattern (see an appendix), 2) Coloured pencils and 3) The audio instruction (see an appendix).

Measures

Drinking severity

Alcohol Use Disorders Identification Test (AUDIT) (Babor et al. 2001): Adopted from study 1

Alcohol craving

Desire for Alcohol Questionnaire (DAQ) (Love et al. 1998): Adopted from study 1

Affect

Positive Affect and Negative Affect scales (PANAS) (Watson, Clark, & Tellegen, 1988): A self-report questionnaire that consisted of two 10-item scales to measure both positive and negative affect. Each item was rated on a 5-point scale of 1 (not at all) to 5 (very much) (see appendix). Positive Affect Score was calculated by adding the scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Higher scores represented higher levels of positive

affect. Negative Affect Score was calculated by adding the scores on items 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20. Lower scores represented lower levels of negative affect.

Affect grid (Russell, Weiss, & Mendelsohn, 1989): A single-item scale for assessing affect along the dimensions of pleasure–displeasure and arousal–sleepiness (or alert-calm). The participants were given several instructions beforehand to learn precisely how to respond using the affect grid (see Russell et al., 1989). The participant places a single mark in one of the 9 x 9 boxes of the grid. The pleasure score ranges from 1 to 9 in which the middle of the grid is anchored by the labels unpleasant feelings and pleasant feelings. The arousal score, which also ranges from 1 to 9, is anchored by the labels sleepiness and arousal.

Mindfulness

The Mindful Attention Awareness Scale – State version (MAAS-S) (Brown & Ryan, 2003): A short 5 item state mindful attention awareness questionnaire, was designed to measure mindfulness as present-centred attention-awareness in everyday experience, a state which varies within and between people. The five items are: I was finding it difficult to stay focused on what was happening. I was doing something without paying attention. I was preoccupied with the future or the past. I was doing something automatically, without being aware of what I was doing. 5. I was rushing through something without being really attentive to it. All items are rated on a 7 point scale: not at all (0), somewhat (3) and very much (6). The items are reversed scored and averaged to reflect higher scores for higher state mindfulness.

Procedure

All participants gave written consent to take part in this study and completed all the tasks in a quiet laboratory. They initially completed the questionnaires: PANAS, affect grid, MAAS, AUDIT, and desire for alcohol questionnaire (DAQ). They then followed

the first attentional bias (AB1) testing session that involved the Stroop task (288 trials) and the visual probe task (56 trials) to measure baseline levels of attentional bias for alcohol-related cues. In the Stroop task, participants responded to the gender of the face using a keyboard. The Stroop task and the visual probe task were the same as Study 1. Participants were asked to put headphones on to listen to the instructions of a mindful-colouring session then started colouring. After colouring, participants completed a second test session involving the Stroop and visual probe tasks (AB2) followed by completing the demographic and after-experiment-questionnaires. Participants received a debrief before leaving. (Figure 20).

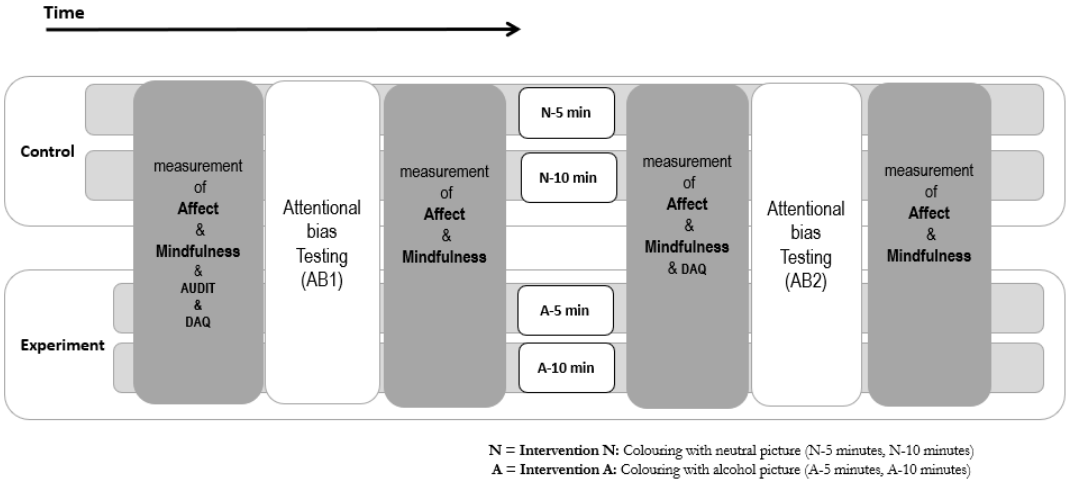


Figure 20. Timeline of testing and interventions of study 3

4.3.2 Result

Group Characteristics

A series of one-way ANOVAS were used to identify any differences in age, AUDIT, Desire for alcohol (DAQ), mindful attentional awareness (MAAS), affect (PANAS) and gender. Each ANOVA included Group (Control and experimental) as the independent variable and each measure as the dependent variable. There was no significant main effect of Group for any of these variables. Pearson Chi-square was

performed to identify any between-group differences in gender. These analyses revealed no significant difference (Table 7).

Table 7 Characteristics of participants allocated to the control and experimental group

	Control (n=58)						Experimental (n=64)					
	5 minutes (n=29)			10 minutes (n=29)			5 minutes (n=30)			10 minutes (n=34)		
	M	SD	Range	M	SD	Range	M	SD	Range	M	SD	Range
Age	19.52	2.89	16.00	19.21	1.18	4.00	19.60	2.36	11.00	18.85	1.05	4.00
AUDIT	12.10	5.05	22.00	12.55	4.81	19.00	12.63	5.70	19.00	11.53	3.80	13.00
DAQ1	2.87	.81	3.43	2.56	.73	2.79	2.74	.84	3.36	2.38	.96	5.14
MAAS1	4.43	.96	4.80	4.25	1.22	4.80	4.18	1.09	3.80	4.37	1.17	4.40
PA1	26.93	5.61	20.00	26.93	8.39	38.00	25.13	7.22	28.00	26.71	6.59	30.00
NA1	14.83	4.25	16.00	13.86	4.05	14.00	13.87	6.10	24.00	13.03	3.18	12.00
Pleasure1	5.62	1.66	6.00	5.83	1.81	6.00	5.93	2.16	6.00	6.26	1.75	7.00
Arousal1	5.28	1.79	7.00	4.86	1.66	6.00	4.53	1.94	6.00	5.29	1.85	7.00
Gender	n	%		n	%		n	%		n	%	
Male	4	13.8		8	27.6		5	16.7		7	20.6	
Female	25	86.2		21	72.4		25	83.3		27	79.4	

AUDIT: Alcohol Use Disorders Identification Test

DAQ: Desire for Alcohol Questionnaire

MAAS: Mindful Attention Awareness Scale

PA: Positive Affect

NA: Negative Affect

Analysis of attentional bias and cognitive control

Stroop task

Further cleaning of data used the procedure by Sharma (2017). The first trial of each block, error trials, trials immediately following an error, and trials with an RT exceeding 2,000 ms and less than 200 ms and if more than 2.5 SDs per condition and 2 participants who had no data recorded in both Time 1 and 2 because of software error were removed (19.50 % of data). 120 participants were used in the Stroop analysis.

To examine whether the intervention altered attentional bias and cognitive control, a mixed-design ANOVA was performed with intervention Group (control, experiment) and duration Group (5, 10 minutes) as between-subject factors, and Time (1, 2), Image type (neutral, alcohol), Previous congruency (congruent, incongruent), and Current congruency (congruent, incongruent) as within-subject factors. Mean correct reaction times was the dependent variable. The analysis revealed a significant main effect of Time ($F(1, 116)=39.46$, $p<.001$, $\eta p^2=.20$) that Time 1 (M= 594.13, SE=9.41) took longer than Time 2 (M= 564.25, SE=8.25) indicated a general practice effect. A significant main effect of Current congruency ($F(1,116)=153.15$, $p<.001$, $\eta p^2=.57$) which showed that incongruent trials (M= 599.60, SE=9.39) took longer than congruent trials (M= 558.77, SE=7.66), and provides further evidence for a Stroop interference. A significant main effect of Previous congruency ($F(1,116)=42.65$, $p<.001$, $\eta p^2=.27$) which showed that the previous incongruent trial (M= 573.72, SE=8.18) was shorter than the previous congruent trial response latencies (M= 584.65, SE=8.72). This indicated a sequential modulation effect that is independent of the current trial type. A significant 2-way interaction of Image x Current ($F(1,116)=3.96$, $p=.049$, $\eta p^2=.03$) showed that an alcohol image produced a larger Stroop interference than a neutral image (see Figure 21).

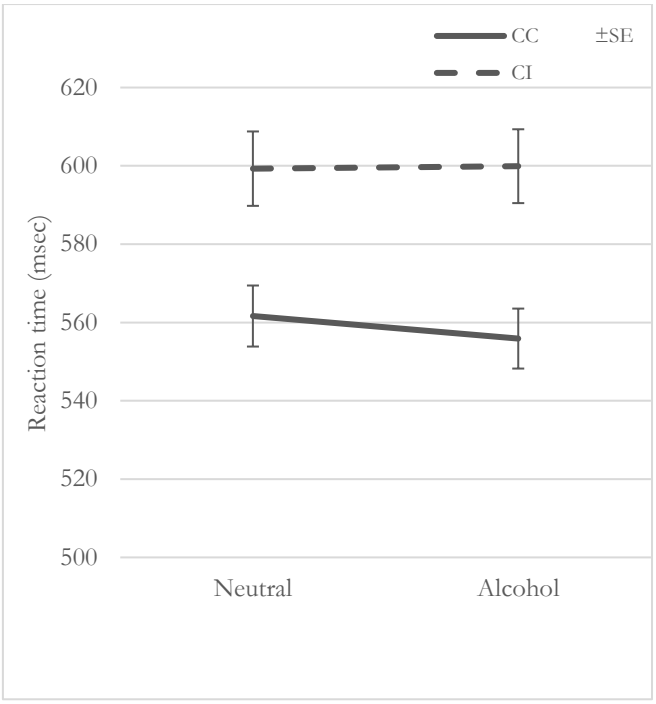


Figure 21. The interaction of Image type x Current congruency
CC: Current Congruent, CI: Current Incongruent

A significant 2-way interaction of Previous x Current ($F(1,116)=15.37$, $p<.001$, $\eta p^2=.12$), which showed RT of current incongruent trial, decreased when the previous trial was incongruent, this replicated the typical sequential modulation (SM) or cognitive control pattern found in the literature (see Figure 22).

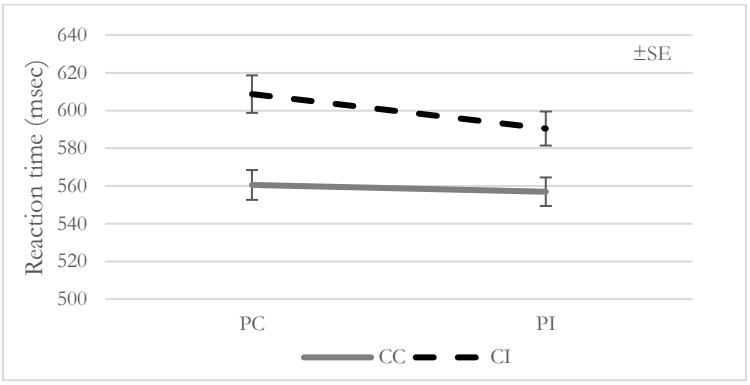


Figure 22. The interaction of Previous congruency x Current congruency
CC: Current Congruent, CI: Current Incongruent
PC: Previous Congruent, PI: Previous Incongruent

A significant 3-way interaction of Time x Previous x Current (F(1,116)=5.47, p=.021, ηp^2=.05), that sequential modulation at Time 1 (M= 23.61, SE= 5.71) was greater than Time 2 (M= 5.98, SE=4.77), t(119)=2.35, p=.021), showed SM reduced after the interventions (see Figure 23).

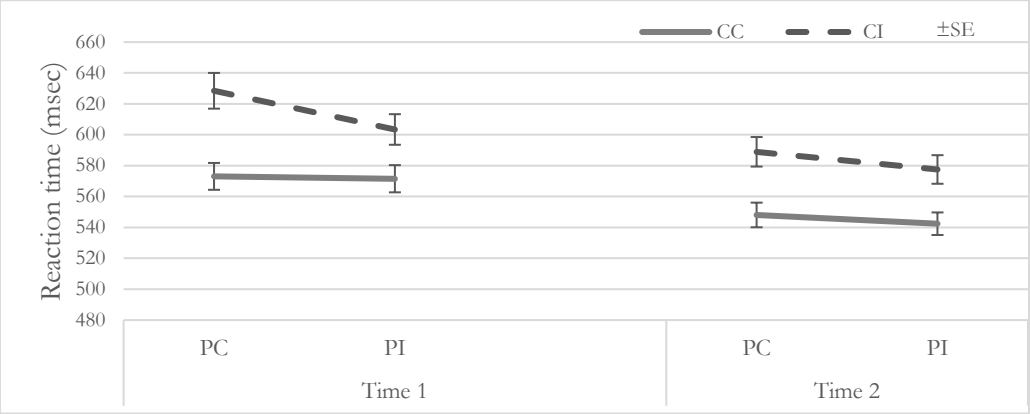


Figure 23. The interaction of Time x Previous x Current

CC: Current Congruent, CI: Current Incongruent

PC: Previous Congruent, PI: Previous Incongruent

Moreover, there was a significant interaction of Time x Image x Previous x Current x duration Group (5,10 min) (F(1, 116)=4.97, p=.028, ηp^2=.04) and a significant interaction of Time x Image x Previous x Current x intervention Group (control, experiment) (F(1, 116)=4.19, p=.043, ηp^2=.04). As the interaction between previous and current congruency represent top down cognitive control, SM scores were calculated to illustrate the interaction with Time and Image in each group: intervention (control, experiment), and duration (5 minutes, 10 minutes). Figure 24 shows SM which represents cognitive control (which was preceded by neutral image) was significantly decreased (t(55)=2.75, p=.008) in the control group, whereas there were no significant changes in the experimental group. Suggesting ignoring neutral picture training reduced cognitive control when there was the presence of a neutral image but had no effect for alcohol image. Training of ignoring alcohol picture did not affect cognitive control.

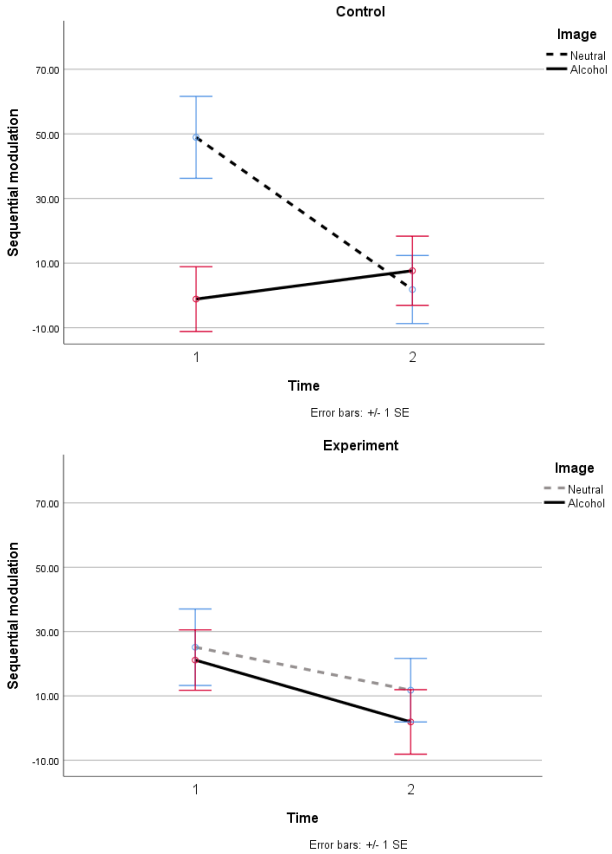


Figure 24. The control group (which trained to ignore the neutral picture) showed SM which was preceded by a neutral picture decreased after the intervention.

Additionally, figure 25 shows SM which was preceded by a neutral picture significantly decreased ($t(57)=2.86$, $p=.006$) only in the 5 minutes colouring group, and there were no significant changes in the 10 minutes group. Suggesting that the 5 minutes mindful-colouring (no matter whether they ignored neutral or alcohol picture during mindful colouring) decreased cognitive control which was preceded by neutral picture but not cognitive control which was precede by alcohol picture, and the 10 minutes colouring had no effect on cognitive control.

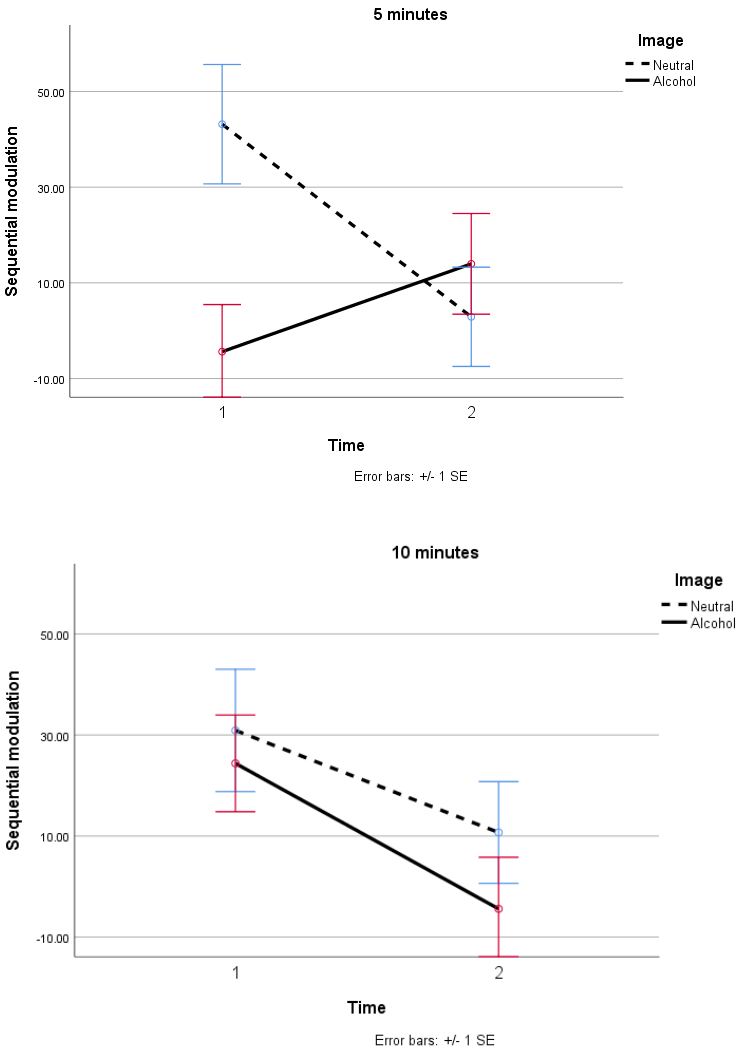


Figure 25. Sequential modulation which preceded by neutral picture decreased after 5 minutes mindful colouring.

Visual probe task

The cleaning of data followed the procedure described by Field and Eastwood (2005). From those 122 participants, 7 participants who had no data recorded in both Time 1 and 2 because of a software error, and 1 participant who had >30% incorrect answers was removed (2.13 % of data), total 114 participants in VP analysis. Reaction time data from practice and buffer trials, and from trials with errors were removed. To eliminate outliers, RTs were excluded if they were greater than 2,000 ms, and then if they were more than 2.5 SDs above the mean per condition.

To examine whether the intervention altered attentional bias, a mixed-design ANOVA was performed with intervention Group (control, experiment) and duration Group (5, 10 minutes) as a between-subject factor, Time (1, 2) and Probe position (alcohol, neutral) as within-subject factors and mean reaction time as a dependent variable. The analysis revealed a significant main effect of Time ($F(1, 110)=13.77$, $p=<.001$, $\eta p^2=.11$), indicating a general practice effect, with a faster reaction time at Time 2 (M= 457.47, SE=5.44) than Time 1 (M= 473.56, SE=4.54). There was a significant 2-way interaction of Time x Position ($F(1,110) = 5.76$, $p=.018$, $\eta p^2=.05$) which indicated a faster reaction time of probe when the arrow appeared at the same location of a neutral picture than an alcohol picture after the intervention (see Figure 26). Suggesting the presence of alcohol avoidance in this sample after the mindful-colouring task.

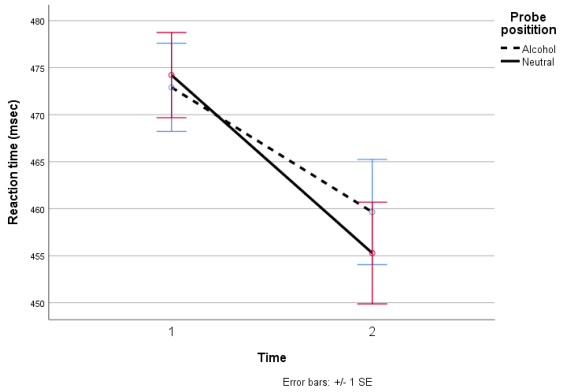


Figure 26. The interaction between Time and Position

Furthermore, the analyses revealed a significant interaction of Probe position x intervention Groups ($F(1, 110)=5.26$, $p=.024$, $\eta p^2=.046$) that the control group responded to probe which appeared in the same location of neutral picture faster than alcohol (M= -4.37, SD=12.33), this indicated alcohol avoidance. However, the experimental group had a smaller difference (M= 1.33, SD=13.86) between reaction time of probe to neutral and alcohol picture (see Figure 27). Suggesting the control group shows alcohol avoidance and no attentional bias to alcohol in the experimental group.

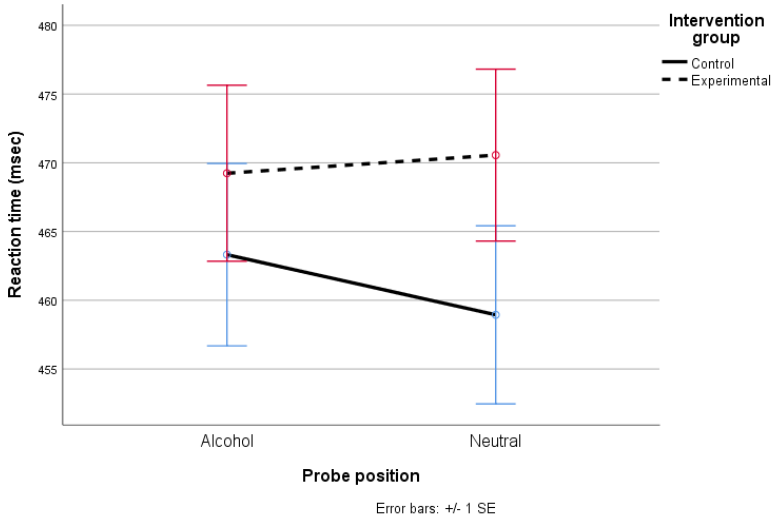


Figure 27. The interaction between Probe position and Intervention groups

Analysis of intervention effect on Mindfulness, Affect, and Craving

The main question is whether the intervention changed mindfulness, affect, and desire for alcohol. To answer this question, a 2x2 factorial design with Time (Time 2: before the intervention, Time 3: after the intervention) as a within-subject factor, and Group (control, experimental) as a between-subject factor was conducted, mean score of each variable was a dependent variable.

The analysis revealed *Mindfulness* had a significant main effect of Time ($F(1, 118)=16.16$, $p<.001$, $\eta p^2=.12$) as the state mindfulness score increased (Time 2, $M=4.10$, $S_2=.11$; Time 3, $M=4.57$, $SE=.12$). *Positive affect* (PA) had a significant main effect of Time ($F(1, 118)=7.55$, $p=.007$, $\eta p^2=.06$) that PA score increased (Time 2, $M=23.68$, $SE=.72$; Time 3, $M=25.26$, $SE=.81$). *Pleasant* had a significant main effect of Time ($F(1, 118)=103.08$, $p<.001$, $\eta p^2=.47$) that pleasant score increased (Time 2, $M= 5.82$, $SE=.16$; Time 3, $M= 7.26$, $SE=.12$). However, the analysis also found *Negative affect* (NA) had a significant main effect of Time ($F(1, 118)=18.08$, $p<.001$, $\eta p^2=.13$) that NA score decreased (Time 2, $M= 12.67$, $SE=.31$; Time 3, $M= 11.62$, $SE=.26$). *Arousal* had a main effect of Time ($F(1, 118)=9.97$, $p=.002$, $\eta p^2=.078$) that arousal score decreased (Time 2,

M=4.83, SE=.18; Time 3, M= 4.15, SE=.18). *DAQ* had a significant main effect of Time (F(1, 118)=17.42, p<.001, ηp^2=.129) that DAQ score decreased (Time 2, M=2.64, SE=.08; Time 3, M= 2.42, SE=.08). No other main effect or interaction were found to be statistically significant. This suggested that both interventions increased state mindfulness and positive affect, whereas decreased negative affect and craving for alcohol (Figure 28).

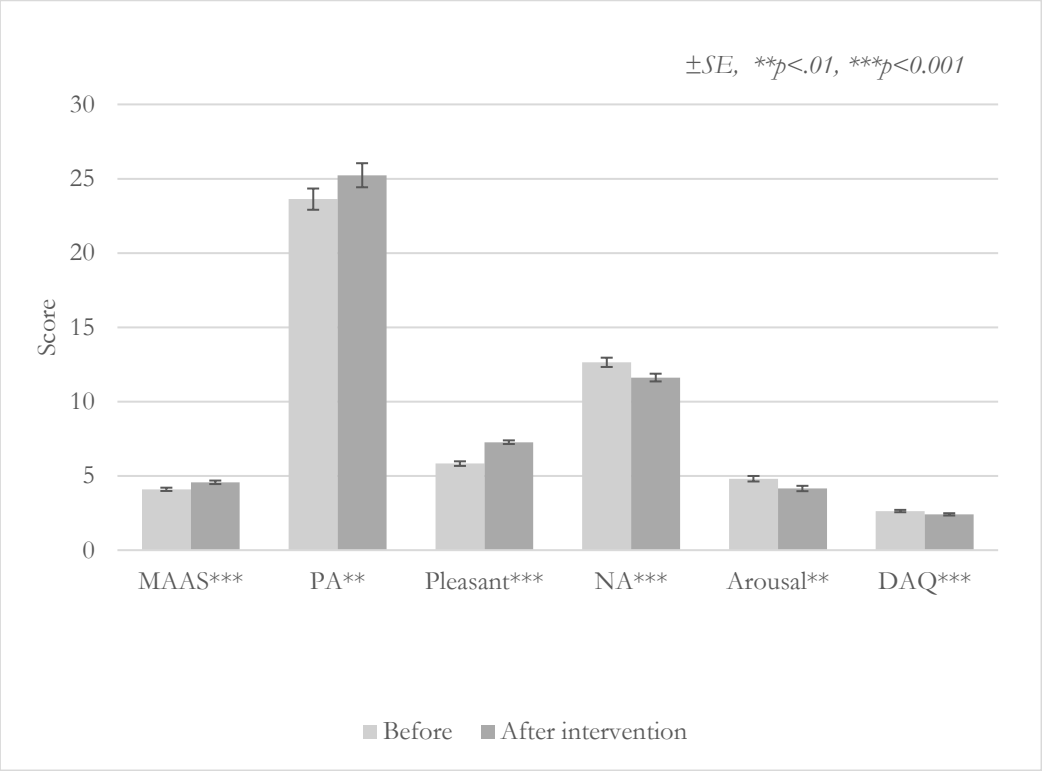


Figure 28. Effects of the mindful-colouring task on each variable.

Analysis of attentional tasks effect on mindfulness and affect

To test whether attention tasks (Stroop task and visual probe task) at Time 1 (AB1) effects mindfulness and affect, a mixed design 2 x 2 was conducted with Time (Time 1, Time 2) as a within-subject factor and Group (control, experiment) as a between-subject factor. Mean score of each variable (MAAS, PA, Pleasant, NA, Arousal) were the dependent variables.

The analysis revealed for PA there was a significant main effect of Time ($F(1,118)=35.17$, $p<.001$, $\eta p^2=.23$) that PA score decreased (Time 1, M= 26.50, SE=.64; Time 2, M= 23.68, SE=.72). NA scores showed a significant main effect of Time ($F(1,118)=23.13$, $p<.001$, $\eta p^2=.16$) that NA score decreased (Time 1, M= 13.92, SE=.41; Time 2, M= 12.67, SE=.31). No group difference and no main effect or intervention were found to be statistically significant in other variables. This suggested that attentional tasks, which tested attentional bias Time 1 reduced PA and NA.

To test whether attention testing at time 2 effects mindfulness and affect, a mixed design 2 x 2 ANOVA was conducted with Time (Time 3, Time 4) as a within-subject factor and Group (control, experiment) as a between-subject factor. Mean score of each variable (MAAS, PA, Pleasant, NA, Arousal) was a dependence variable. The analysis revealed for *MAAS* a statistically significant main effect of Time ($F(1,118)=59.76$, $p<.001$, $\eta p^2=.34$) that MAAS score decreased at Time 4 (Time 3, M= 4.57, SE=.12; Time 4, M= 3.60, SE=.15). PA had a statistically significant main effect of Time ($F(1,118)=62.88$, $p<.001$, $\eta p^2=.35$) that PA score decreased (Time 3, M= 25.26, SE=.81; Time 4, M= 20.71, SE=.75). Pleasant had a statistically significant main effect of Time ($F(1,118)=69.17$, $p<.001$, $\eta p^2=.37$) that Pleasant score decreased (Time 3, M= 7.26, SE=.12; Time 4, M= 5.81, SE=.16). No group difference and no main effect or intervention were found to be statistically significant in other variables. This suggested that attention tasks used in attentional bias testing Time 2 reduced MAAS, PA and Pleasant (Figure 29).

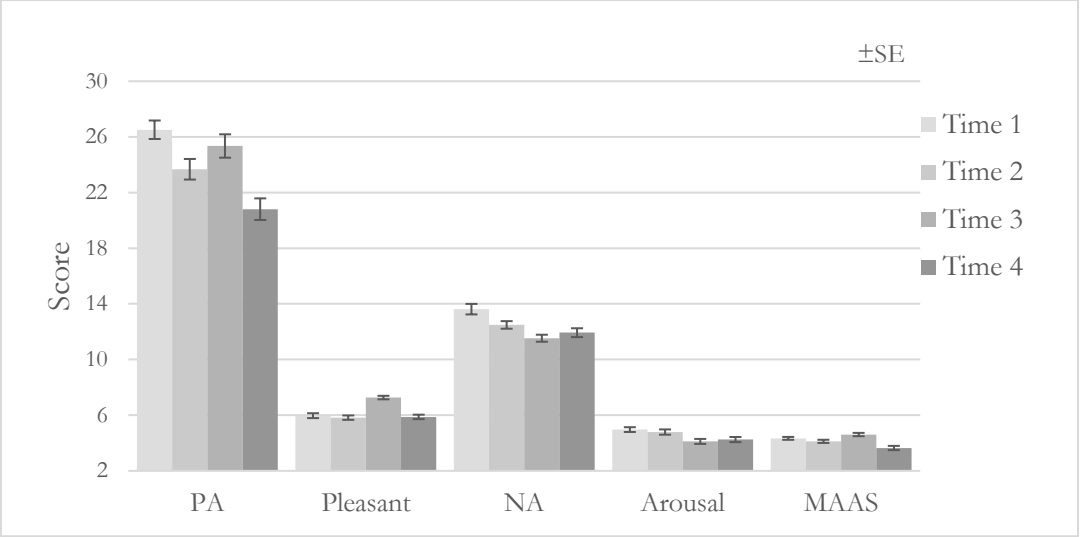


Figure 29. Attention task effects at testing before (Time 1and 2) and after (Time 3 and 4) the intervention

Correlation analysis

To examine the correlation between variables, a bivariate correlation analysis was conducted. Results showed cognitive control when preceded by neutral images had a statistically significant negative correlation with attentional bias (AB.SI) (r= -.38, p<.001), and cognitive control that were preceded by alcohol images had a negative correlation with severity of drinking (r=-.19, p=.044). Indicating greater cognitive control when preceded by neutral images also reported less alcohol attentional bias in Stroop interference condition; and greater cognitive control when preceded by alcohol images also reported less drinking severity respectively. MAAS had a statistically significant positive correlation with PA (r=.24, p=.009) and Arousal (r=.25, p=.008) indicating greater state mindfulness also reported greater positive affect and alertness. However, MAAS had a statistically significant negative correlation with NA (r=-.19, p=.046) and DAQ (r=-.21, p=.026), indicating greater state mindfulness also reported lower negative affect and desire for alcohol (see Table 8).

Table 8 Correlations among variables of interest study 3

	AB.vp	AB	AB.SI	SMn	SMd	AUDIT	DAQ	NA	Arousal	PA	Pleasant
AB	-.15										
AB.SI	-.01	-.14									
SMn	-.01	.06	-.38**								
SMd	.04	.01	.06	-.03							
AUDIT	.02	.05	.01	.07	-.19*						
DAQ	.03	-.10	-.13	.08	-.02	.08					
NA	-.05	.18	.02	-.05	.07	.37**	.30**				
Arousal	-.12	.06	-.02	-.11	-.04	-.11	.12	.04			
PA	-.02	-.01	-.02	-.02	-.11	.10	.10	.06	.51**		
Pleasant	-.04	-.06	-.08	.08	-.06	-.10	-.02	-.37**	.19*	.41**	
MAAS	.00	-.01	.10	.01	.15	-.16	-.21*	-.19*	.25**	.24**	.10

**p< 0.01 *p<.005

Regression analysis

To find predictors for attentional bias and sequential modulation, multiple regression was conducted. Results showed attentional bias (AB) could be predicted by NA (β =.24, p<.05). The overall model fit was not statistically significant (R^2= .07). SMd could be predicted by AUDIT (β =-.22, p<.05), and MAAS (β =.20, p<.05). The overall model fit was not statistically significant (R^2= .10). No other predictors were found (see Table 9).

Table 9 Multiple regression of self-report on attentional bias and sequential modulation

	AB.vp				AB				AB.SI				SMn				SMd			
	B	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	*β*	sr^2	*B*	*SE B*	*β*	*sr2*
AUDIT	.05	.30	.02	0.00	.00	.34	.00	0.00	.06	.80	.01	0.00	1.42	1.51	.10	0.01	-2.17	1.00	-.22*	0.04
DAQ	1.14	1.72	.07	0.00	-3.48	1.97	-.18	0.03	-5.20	4.57	-.12	0.01	10.88	8.62	.13	0.01	.08	5.72	.00	0.00
NA	-.49	.60	-.10	0.01	1.42	.68	.24*	0.04	.62	1.59	.05	0.00	-1.75	2.99	-.07	0.00	3.62	1.98	.21	0.03
Arousal	-1.50	1.16	-.15	0.02	1.26	1.33	.11	0.01	-.61	3.08	-.02	0.00	-7.15	5.81	-.14	0.01	-2.08	3.85	-.06	0.00
PA	.14	.24	.08	0.00	-.16	.28	-.07	0.00	.02	.64	.00	0.00	-.24	1.21	-.03	0.00	-.85	.80	-.13	0.01
Pleasant	-.80	1.26	-.08	0.00	.51	1.45	.04	0.00	-1.94	3.36	-.07	0.00	5.48	6.33	.10	0.01	1.58	4.20	.04	0.00
MAAS	.33	1.40	.03	0.00	-.17	1.61	-.01	0.00	3.52	3.73	.10	0.01	4.99	7.03	.07	0.00	9.08	4.66	.20*	0.03
R^2	.03				.07				.03				.05				.10			
F	.40				1.06				.49				.75				1.67			

*p<.05

4.3.3 Summary

The mindful-colouring task that simultaneously required ignoring a picture (alcohol or neutral) was designed by merging the dot probe attention training task with mindfulness practice. The main aim was to develop a shorter attention training task based on ignoring addiction related cues, as well as to increase the positive affect during training. Participants were instructed to ignore a coloured picture while doing mindful-colouring on a blank mandala. The hypotheses were that the brief mindful-colouring would increase state mindfulness, positive emotion and cognitive control, and decrease negative emotion and craving; and the experimental group who were trained to ignore a alcohol picture would have less alcohol attentional bias and more cognitive control than the control group who were trained to ignore a neutral picture.

As expected, the *mindful-colouring task* increased state mindfulness, positive emotion, and alertness; and decreased negative emotion and craving, this result is consistent with studies that found mindfulness practice decreased negative affect and increased positive affect (Farb et al., 2010; Goldin & Gross, 2010). It is interesting to note that the a*ttention tasks* (Stroop and visual probe task) at pre-intervention had the effect of decreasing positive affect and negative affect, and at post-intervention decreased state mindfulness, positive affect and pleasant. Suggesting that the attention tasks reduce positive affect as well as state mindfulness.

The study also showed a form of *attentional bias* to alcohol as the Stroop interference was larger when preceded by alcohol pictures than neutral pictures. This finding is consistent with previous research and indicates that alcohol pictures seen during the face-word Stroop task attracted more attentional resources than the neutral pictures in slowing down response latencies particularly for incongruent trials. In addition, attentional bias was predicted by negative affect, in particular that greater negative affect produces greater alcohol attentional bias.

Furthermore, the present study, although replicating the visual probe procedure from Field, Mogg, Zetteler, et al. (2004), produced contrary results. Rather than alcohol attentional bias we found avoidance to alcohol at post-intervention. It is not clear why there was avoidance to alcohol in the visual probe task even though we found an alcohol attentional bias in the Stroop task. This suggests that it is not always possible to generalize the findings from the visual probe to the Stroop tasks. This also suggests that multiple measurements of drug attentional bias should be used for stronger evidence.

Cognitive control was indicated by the main effect of previous congruency that faster RT incongruent trials than congruent trials; and the interaction between the previous and current congruency, that when the current trial is incongruent response latencies were faster when preceded by an incongruent trial than a congruent trial. This sequential modulation is thought to result from top down control processes triggered by the conflict on the previous trial. The main finding from study 3 is that sequential modulation is influenced by both the type of image (alcohol or neutral) during the Stroop task and by the type of mindful colouring (ignoring an alcohol or neutral picture).

In particular, SM was reduced with an alcohol image compared to a neutral image a finding that replicates Sharma (2017) in high social drinkers. In addition, SM (that was preceded by a neutral picture) decreased (from time 1 to time 2) in the control group (and the 5 minute mindful colouring group), whereas the experimental group showed a general reduction in SM which did not change across time. In general, this pattern of results suggests that SM was reduced in a group who carried out the mindful colouring task (but particularly reduced whilst ignoring an alcohol picture or when doing the mindful colouring task for 10 minutes). This pattern of results could suggest that the mindful colouring task reduces cognitive control because of an increase in positive affect or because of cognitive depletion.

The positive affect hypothesis is suggested by previous research (Van Steenbergen et al., 2009) which argues that the conflict adaptation effect can be strongly reduced by reward contexts, or less-pleasure associated with more conflict-driven control (van Steenbergen, Band, & Hommel, 2010). The current study did not show evidence of a relationship between SM and affect, but the regression analysis showed that SM was predicted by mindfulness, and that mindfulness had a positive correlation with positive affect and arousal. On the other hand, the *cognitive depletion hypothesis* suggests that completing simultaneous specific tasks causes depletion of attentional resources (Norman & Bobrow, 1975; Warm, Parasuraman, & Matthews, 2008). The present study, the mindful colouring task required participants to inhibit attention on a coloured picture (neutral/alcohol) at the top of the booklet, and maintain attention at the bottom of the booklet, on each tiny space in a blank mandala while mindfully colouring it. This task might have depleted cognitive resources and therefore reducing the ability for cognitive control in the face-word Stroop task at Time 2. However, the present study findings incongruent with Larson, Steffen, and Primosch (2013) who did not find cognitive control change from a 14 minutes audio clip focused on attending to their breathing and being mindful of the moment in students.

In addition, regression analyses revealed that cognitive control, especially when preceded by alcohol related stimuli, was predicted by drinking severity and state mindfulness, indicating that less drinking severity and more state mindfulness produce more cognitive control. Suggesting that cognitive control decreased might be because state mindfulness increased from the intervention.

Limitation of the study is lack of a control group that have not received any intervention. Therefore, we have no evidence to compare whether AB and cognitive control is different if participants have not received any intervention. This issue is examined further in Study 5 and 6.

4.2 Study 4: Effects of mindful-colouring on attentional bias and cognitive control in methamphetamine female inpatients

The previous study (Study 3) revealed a single session of mindful-colouring influenced alcohol avoidance, increased state mindfulness, positive affect; and decreased negative affect and alcohol craving. The current study replicated Study 3, aimed to investigate a group of methamphetamine inpatients, to see whether a single session of mindful-colouring could alter mindfulness, affect, craving, attention bias and cognitive control. Study 3 did not show significantdifferences between 5 and 10 minutes intervention duration. Therefore, in Study 4 we used the longer version as we expected that the longer duration might give more benefit.

4.2.1 Method

Participants

Forty-four participants were recruited from Thanyarak Chiang Mai Hospital, Thailand by the researcher who met the patients at the ward and invited the volunteer to take part in the research. Participants were selected on the criteria that they were either native Thai speakers or fluent in spoken Thai and had visual acuity within normal limits, and were diagnosed as having Methamphetamine dependence. They were randomly allocated into groups, every 6 participants were allocated to a control or experimental group respectively due to a limited number of laptops that were used in the experiment. Of these 44 participants, 3 were excluded from the final sample because 2 used other drugs as a major drug and 1 due to a software error, 41 participants were in the final analysis. All participants were treated in accordance with the ethical standards of the British Psychological Association. In addition, ethical approval was obtained from the University of Kent at Canterbury's Department of Psychology ethics committee and

permission from Thanyarak Chiang Mai Hospital before recruiting participants and proceeding with the experiment.

Materials

Face-word Stroop task

Adapted from Study 2

Visual Probe task

Adapted from Study 2. Response keys changed from X key and M key to arrow up key and arrow down key, due to the fact that the previous study showed a high percentage of error in answers, that might be due to participants confusing the position of the response keys.

Demography and Treatment history Record form

A record form contains demography and treatment history from hospital records (age, education, job employment, number of admissions, duration of treatment, admission type, and comorbidity).

Intervention: 10 minutes Mindful-colouring

Adapted from study 2, the audio instruction was translated to the Thai language, and picture in the booklet was changed from alcohol to methamphetamine (see appendix).

Measures

Mindfulness

The Mindful Attention Awareness Scale – State version (MAAS-S) (Brown & Ryan, 2003): Adopted from study 3 and translated to the Thai language by the researcher.

Toronto Mindfulness Scale – Trait version (TMS-T) (Davis, Lau, & Cairns, 2009): 13 items under a two-factor structure; curiosity (6 items) and decentering (7 items), was

designed to assess mindfulness as a quality maintained when attention is intentionally cultivated with open, non-judgmental orientation to experience, and measures mindfulness as a trait like quality. *Curiosity (TMSc)* reflects awareness of present moment experience with a quality of curiosity. *Decentering (TMSd)* reflects awareness of one's experience with some distance and disidentification rather than being carried away by one's thoughts and feelings. All the items are rated on a 5-point Likert scale, from 0 (not at all) to 4 (very much), translated to the Thai language by the researcher.

Affect

Affect grid (Russell, Weiss, & Mendelsohn, 1989): A single-item scale for assessing effect along the dimensions of pleasant-unpleasant and arousal–sleepiness, translated to the Thai language by the researcher.

Craving

Craving scale- Self-reported: A question, asking how much craving the participant is experiencing right now. Rating scale 0 to 10, 0 means no craving, 10 means a maximum craving.

Procedure

Testing took place in Thanyarak Chiang Mai Hospital, Thailand in a quiet room. After participants signed a consent form, they completed CEQ craving questionnaire and the affect grid before and after completing the two attention tasks: Stroop task (288 Trials) (Time 1) and the Visual probe task (56 trials) (Time1) to measure attentional bias for methamphetamine-related cues. They then completed MAAS and TMS to measure mindfulness state. Afterward, those participants were provided with headphones, a box of 12 colouring pencils and a booklet which contained a pattern of a mandala (everyone received the same pattern) and a photograph of nature (for control group) or a

photograph of methamphetamine (for experimental group). Participants were given 10 minutes during the mindful colouring session. After finishing the colouring session, participants completed MAAS, TMS, craving scale and affect grid. This was followed by the Stroop task (Time2), Visual probe task (Time2), followed by the affect grid and craving scale. They then provided demography data and received a debrief (Figure 30).

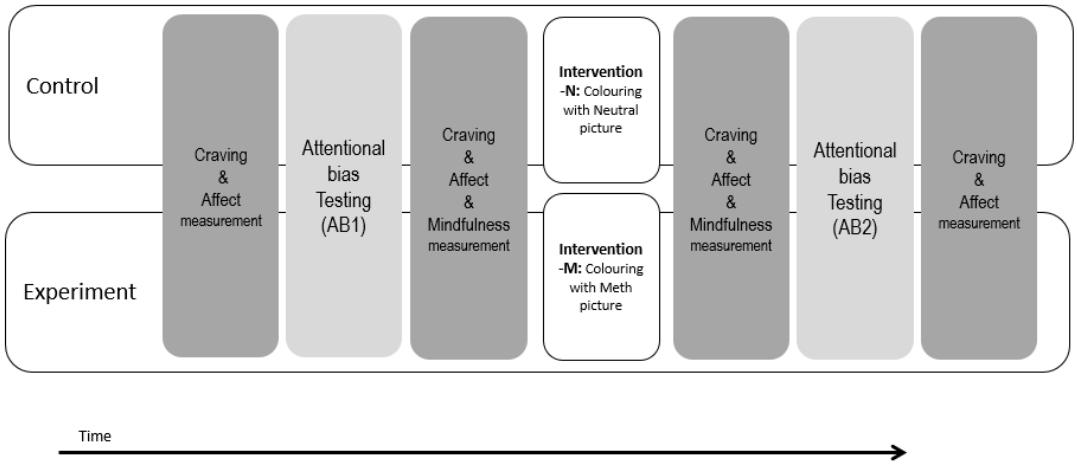


Figure 30. Timeline of testing and interventions of study 4

4.4.2 Result

Group Characteristics

A series of one-way ANOVAS were used to identify any between-group differences in age, the number of treatments, treatment duration, craving, affect, mindful attentional awareness (MAAS), TMS, Education, and job employment. Each ANOVA included Group (Control and experimental) as the independent variable and each measure as the dependent variable. There were no statistically significant differences between groups in these dependent variables. Pearson Chi-square was performed to identify any between-group differences in comorbidity. These analyses revealed no statistically significant differences (see Table 10).

Table 10 Comparison of pre-intervention measure data across each group

	Control (n=21)			Experimental (n=20)		
	Mean	SD	Range	Mean	SD	Range
Age	31.33	7.90	29	29.20	4.94	19
Admission no.	1.38	.74	2	1.40	.68	2
Treatment duration	24.57	17.87	59	21.10	12.32	43
Craving 1	1.90	2.74	8	2.35	2.06	7
Pleasant 1	6.38	1.88	7	6.90	2.15	8
Arousal 1	4.43	2.36	7	4.50	2.09	7
MAAS 1	4.75	1.18	4	4.19	1.27	4
TMSc 1	21.52	5.04	17	20.65	3.66	13
TMSd 1	21.71	5.51	19	21.15	3.91	15
	n	%		n	%	
Education						
Primary or lower	7	33.3		3	15	
Secondary	5	23.8		9	45	
High School	8	38.1		7	35	
College or higher	1	4.8		1	5	
Job employment						
Unemployed	7	33.3		7	35	
Retired/Studying	2	9.5		0	0	
Employed	12	57.1		13	65	
Comorbid						
Non-comorbid	18	85.7		19	95	
Comorbid	3	14.3		1	5	

Analysis of Attentional bias and Cognitive control

Stroop task

Further cleaning of data used the procedure by Sharma (2017). The first trial of each block, error trials, trials immediately following an error, and trials with an RT exceeding 3,000 ms and less than 300 ms and if more than 2.5 SDs per condition were removed. A mixed factorial was performed with Time (1, 2), Image type (neutral, alcohol), Previous congruency (congruent, incongruent), and Current congruency (congruent, incongruent) as within-subject factors and Group (control, experimental) as the between-subjects factor. Mean correct reaction time was the dependent variable.

The analysis of reaction time revealed a statistically significant main effect of Time ($F (1, 39) = 8.36$, $p<.05$, $\eta p^2 = .18$) that RT Time 2 (M=756.91, SE=25.26) was faster than Time 1 (M=811.67, SE=27.33) indicates a general practice effect. A statistically significant main effect of Current congruency ($F (1, 39) = 50.35$, $p<.001$, $\eta p^2 = .56$) showed RT of incongruent (Mean= 813.05, SE=26.66) was longer than congruent (Mean=755.53, SE=22.98) that represented the Stroop effect. A statistically significant 2-way interaction of Time x Previous ($F (1, 39) = 9.77$, $p<.05$, $\eta p^2 = .20$) showed RTs are faster after previous incongruent trials compared to previous congruent trials at time 2 than time 1. This is consistent with the previous incongruent trial triggering cognitive control to speed up RTs on the following trial at time 2 (Figure 31).

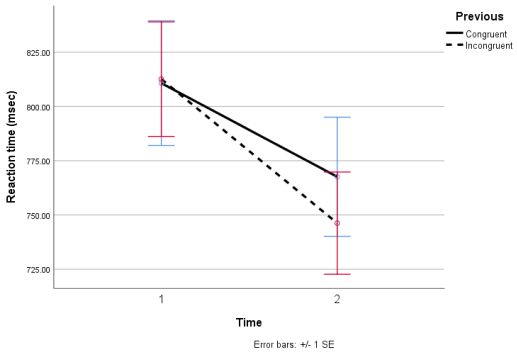


Figure 31. The interaction between Time and Previous congruency

The previous analysis did not show any statistically significant effects of Group, and thus no evidence that the colouring intervention used had any impact on performance. Therefore, we further explored the data to see if a different variable might show any effects. The prior analysis was continued with Comorbidity (comorbid, non-comorbid), Education (Primary or lower, Secondary, High school or higher), Job employment (Unemployed, Employed) as a between-subject factor. The analysis revealed no statistically significant main effects or interactions (all F's< 3.2, *p*'s>.05).

Visual probe task

The cleaning of data followed the procedure described by Field and Eastwood (2005). Reaction time data from practice and buffer trials, and from trials with errors were removed. To eliminate outliers, RTs were excluded if they were less than 300 ms or greater than 3,000 ms, and then if they were more than 2.5 SDs above the mean per condition. To examine the intervention effect, using a factorial design 2 x 2 x 2 with Time (1, 2) and Probe position (meth, neutral) as within-subject factors, and Group (control, experimental) as the between-subject factor. No statistically significant main effect or interaction was found (all F's<3.24, *p*'s>0.08). Suggesting that the mindful-colouring task was unable to change attention.

Analysis of Mindfulness, Affect and Craving

Mindfulness

To examine whether mindfulness changed throughout the study, each mean score of mindfulness (MAAS, TMSc and TMSd) was employed as a dependent variable into a factorial design 2 x 2 with Time (Time 2, Time 3) as within-subject, and Group (control, experimental) as the between-subject factor. Analyses revealed no statistically significant main effect or interaction (all F's<3.60, p's>0.06), which indicates mindfulness does not

change throughout the study. Suggesting that mindful-colouring task and the attention tasks were unable to change state and trait mindfulness.

Additionally, Comorbidity, New patient, were also employed as a between-group factor in each analysis, results showed no statistically significant main effect or interaction. Suggesting that the intervention had no effect on state mindfulness, and no difference between groups.

Affect

To examine whether affect changed throughout the study, each mean score of affect; Pleasant, and Arousal was employed as a dependent variable into a factorial design 4 x 2 with Time (Time 1, Time 2, Time 3, Time 4) as within-subject, and Group (control, experimental) as the between-subject factor. Analyses revealed no statistically significant main effect or interaction in Pleasant and Arousal (all F's<1.01, p>0.38). Suggesting that mindful-colouring task and attentional tasks were unable to change affect.

Craving

To examine whether craving changed throughout the study, mean score of craving was employed as a dependent variable into a factorial design 4 x 2 with Time (Time 1, Time 2, Time 3, Time 4) as within-subject, and Group (control, experimental) as the between-subject factor. Analyses revealed a statistically significant main effect of Time ($F(3,117)=3.41$, $p=.020$, $\eta p^2=.08$) that craving decreased (Time 1, M=2.13, SE=.38; Time 4, M=1.55, SE=.37) (see Figure 32). In addiction, post hoc t-test indicated significant differences between Time 1 and 2 compared to Time 4. No other differences were significant. There was not a statistically significant difference between control and experimental group, and between Time 1 and Time 2, Time 2 and Time 3, Time 3 and Time 4).

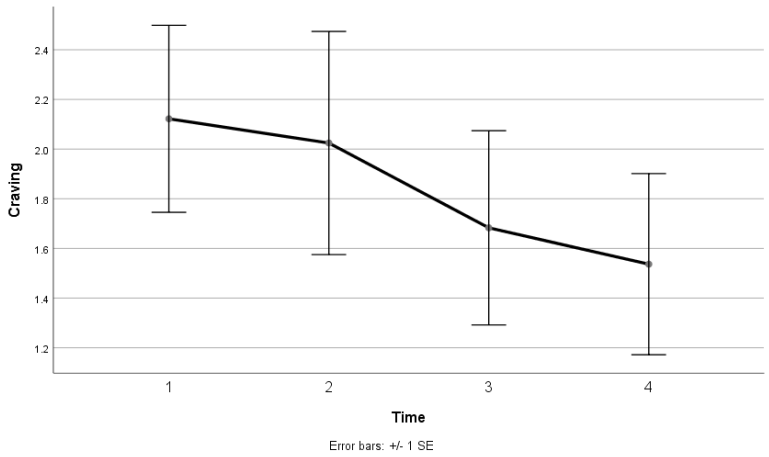


Figure 32. Craving decreased over time

Correlation analyses

To examine the correlation between variables, the mean score of each variable was calculated and bivariate correlation analysis was conducted. Analyses revealed AB.vp had a statistically significant positive correlation with AB.SI (r=41, *p* =.008), SMn (r=.38, *p* =.016), and SMd (r=.44, *p* =.004), this indicates that a greater attentional bias on visual probe task (AB.vp) also reported greater attentional bias on Stroop interference (AB.SI), cognitive control on both neutral and meth image. Additionally, AB.vp had a significant positive correlation with Pleasant (r=.37, *p*=.018), and Pleasant had a significant positive correlation with MAAS (r=.32, *p*=.043). This indicates greater attentional bias on visual probe also related to greater Pleasant scores, also greater Pleasant scores are related to greater state mindfulness. However, AB had a statistically significant negative correlation with SMn (r=-.34, *p*=.031) which indicates greater attentional bias on Stroop task also reported smaller cognitive control on neutral image. AB.SI had a statistically significant positive correlation with SMd (r=.39, *p*=.012) and TMSd (r=.38, *p*=.015) this indicates greater attentional bias on Stroop interference also reported greater cognitive control on meth image and decentering trait mindfulness. Moreover, AB.SI has a statistically

significant negative correlation with MAAS (r=-.36, *p*=.022), indicates greater attentional bias via Stroop interference also reported smaller state mindfulness (see Table 11).

Regression analysis

To find predictors for attentional bias and cognitive control, multiple linear regression was employed to determine which of the IVs could be used to predict attentional bias, and cognitive control in Methamphetamine female inpatients. A direct method was used for the multiple linear regression analyses. Analyses revealed AB.vp was predicted by Pleasant (β = .49, *p<.05)*. AB was predicted by Craving (β = -.50, *p<.05)* and Treatment duration (β = .49, *p<.05)*. The overall model fit was not statistically significant (R^2= .23). AB.SI was predicted by Pleasant (β = .42, *p<.05)*, and MAAS (β = -.39, *p<.05)*. The overall model fit was statistically significant (R^2= .46). Moreover, SMd was predicted by Pleasant (β = .38, *p<.05)*, the overall model fit was not statistically significant (R^2= .20). (see Table 12).

Table 11 Correlations among variables of interest study 4

	AB.vp	AB	AB.SI	SMn	SMd	MAAS	TMSc	TMSd	Pleasant	Arousal	Craving	Duration	Tx.No.
AB	.12												
AB.SI	.41**	.02											
SMn	.38*	-.34*	.29										
SMd	.44**	.20	.39*	.00									
MAAS	-.13	-.13	-.36*	-.05	-.11								
TMSc	-.02	.05	.25	-.21	.12	.00							
TMSd	.06	.01	.38*	.00	.13	-.22	.75**						
Pleasant	.37*	.02	.24	.20	.22	.32*	-.10	-.10					
Arousal	.03	.02	-.10	-.07	.12	-.02	-.09	-.12	-.07				
Craving	-.01	-.10	.28	.16	.00	-.24	-.03	-.03	.03	.34*			
Duration	.12	.28	.25	-.11	-.13	-.21	.02	.02	.14	.03	.56**		
Tx.No.	.08	.02	-.20	-.16	.10	.18	-.03	-.10	.02	.08	-.08	-.10	
Age	-.01	-.03	-.21	.06	.04	.01	-.10	-.13	.14	-.07	-.32*	-.24	-.06

*p<.05, **p<.01

Table 12 Multiple regression of self-report on attentional bias and sequential modulation

	AB.vp				AB				AB.SI				SMn				SMd			
	B	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2
MAAS	-10.79	6.39	-.32	0.08	-7.65	7.19	-.20	0.04	-27.49	11.30	-.39*	0.16	.38	14.32	.00	0.00	-22.15	14.32	-.30	0.07
TMS-c	-.23	2.17	-.03	0.00	1.41	2.44	.15	0.01	1.69	3.83	.09	0.01	-9.00	4.86	-.45	0.10	3.47	4.86	.18	0.02
TMS-d	.56	2.17	.07	0.00	-1.33	2.45	-.14	0.01	3.88	3.84	.22	0.03	6.87	4.87	.36	0.06	-.06	4.87	.00	0.00
Pleasant	10.89	3.87	.49*	0.20	1.31	4.36	.05	0.00	19.52	6.85	.42*	0.21	10.56	8.68	.21	0.05	18.30	8.68	.38*	0.13
Arousal	2.26	3.33	.12	0.01	3.54	3.75	.16	0.03	-3.89	5.89	-.10	0.01	-7.26	7.46	-.16	0.03	6.27	7.46	.15	0.02
Craving	-3.26	3.33	-.21	0.03	-8.66	3.75	-.50*	0.14	5.15	5.88	.16	0.03	14.69	7.46	.41	0.11	.16	7.46	.00	0.00
Duration	.19	.48	.08	0.01	1.33	.54	.49*	0.16	-.22	.85	-.04	0.00	-2.05	1.08	-.37	0.10	-1.35	1.08	-.25	0.05
Admission No.	5.96	8.53	.11	0.02	2.31	9.60	.04	0.00	-12.64	15.09	-.11	0.02	-16.93	19.12	-.14	0.02	13.03	19.12	.11	0.01
Age	-.60	.97	-.11	0.01	-.36	1.10	-.06	0.00	-2.41	1.72	-.20	0.06	.67	2.18	.05	0.00	-.42	2.18	-.03	0.00
R^2	.25				.23				.46				.28				.20			
F	1.15				1.02				2.92*				1.34				.86			

**p<0.01, *p<0.05

4.4.3 Summary

The current study is partly a replication of study 3 which employed a 10 minute mindful-colouring with ignoring drug or neutral picture, and aimed to examine whether the mindful-colouring affects attentional bias, cognitive control, state mindfulness, affect, and craving in methamphetamine female inpatients. The study findings showed at post - intervention, that the whole sample had increased cognitive control and decreased craving whereas other variables did not change.

Cognitive control did not show at pre-intervention, but it was found at post-intervention. Increased cognitive control was indicated by a significant interaction of Time by Previous congruency, that patients responded to current trial faster for previous incongruent trials than previous congruent trials. Demonstrating a strong top-down control process as patients are able to control attention to inhibit distractor and does not depend on the type of images (neutral or methamphetamine) that they have to ignore. This is evidence that the mindful-colouring task might induce cognitive control, with no difference between ignoring neutral or methamphetamine pictures during colouring. The increase in cognitive control might be explained by affect as the regression analysis showed that pleasant affect predicted cognitive control. The positive correlation with state mindfulness also suggests that mindfulness may have its effect by regulating positive affect.

It is interesting that there was an increase of cognitive control but no change in state *mindfulness*. A single session of 10 minutes mindful-colouring did not show a significant change on state mindfulness unlike study 3 with a student sample that used the same mindful colouring task. This finding is inconsistent with previous research such as Luberto and Mcleish (2018) that demonstrated in smokers that state mindfulness increased after a single session of 10 minutes sitting meditation with focusing attention

openly on the breath, body, sounds, and thoughts occurring in the present moment. This suggests that different meditation tasks have different effects on state mindfulness.

There were no experimentally induced changes on *affect* in study 4; however, there were a number of interesting correlational relationships. Pleasant had a positive correlation with state mindfulness; and arousal had a positive correlation with craving. This might provide another reason to explain no changes on mindfulness and affect in this sample. It might be because all patients had a daily chanting before bedtime (as a routine activity in the hospital treatment program) which might build up patient's mindfulness and positive affect. Thus, the effect of a single session of 10 minutes mindful-colouring task might have been too weak to alter mindfulness and affect.

In addition, the intervention requires participants to pay attention to the task which might have reduced the attention paid to craving. This would also be the case for the two visual probe and Stroop tasks, and thus, might explain why craving tended to decrease across all 4 times of testing, whether post-intervention or post-task. Furthermore, the attention tasks (Stroop and Visual probe) had no effect on affect and craving, unlike study 3. This shows that students are easier to change in their affect than patients.

Attentional bias was not found in this sample, which is consistent with Van Kampen et al. (2020) that have not found attentional bias in cannabis inpatients. However, it is inconsistent with other studies that found attentional bias in social drinkers (Field et al., 2005), cannabis smokers (Field, Mogg, & Bradley, 2004) and cigarette smokers (Attwood et al., 2008). This supports that attentional bias might not be present in abstinent or individuals who stay in a drug-free setting.

Moreover, attentional bias had a negative correlation with state mindfulness, and state mindfulness had a positive correlation with pleasant. In addition, regression analyses showed attentional bias (AB.SI) was predicted by state mindfulness and pleasant, that less

state mindfulness and greater pleasant predicts greater AB.SI. Suggesting that there are some links between attentional bias and state mindfulness and pleasant.

Limitation of the study is this study has no control group that does not receive any intervention. Therefore, we might miss the evidence to explain changes in each variable. This issue is examined further in Study 5, which provides the control group that participants would be in a waiting list group.

4.3 Study 5: Effects of mindfulness practising in alcohol in-patients

The mindfulness-based intervention was integrated into the treatment for pain, depression, anxiety and addiction. Most of the current interventions were based on Mindfulness-based stress reduction (MBSR) which was designed to reduce stress. To date, there are few models of mindfulness-based intervention for addicts, such as Mindfulness-Oriented Recovery Enhancement (MORE; integrated between cognitive behaviour therapy and mindfulness-based intervention, designed for specific addiction problem), and Mindfulness-Based Addiction Therapy (MBAT). Studies reveal effectiveness of multiple sessions of mindfulness-based practice on stress, emotion, craving, drug consumption and attention. For example, 10 sessions of MORE for alcohol abusers with 15 minutes daily mindfulness exercise reduces stress, thought suppression and modulated attentional bias to alcohol (Garland et al., 2010). A course of 3-sessions of mindfulness training reduces the relationship between motivation to drink and binge drinking behaviour in regular drinkers (Ostafin, Bauer, & Myxter, 2012). A course of 8 sessions of MORE for opioid misuse with chronic pain patients reduces pain severity, stress arousal, and opioid craving (Garland, Manusov, et al., 2014). An 8 week intervention where participants reported their state mindfulness in meditation after a brief mindful meditation, individuals varied significantly in their rates of change in state mindfulness in meditation during the intervention, and these individual trajectories predicted pre-post intervention changes in trait mindfulness and distress (Kiken et al., 2015). A course of 10 sessions of MORE with 15 minutes daily mindfulness practice in men with co-occurring substance use and psychiatric disorders revealed MORE enhanced mindful awareness in everyday life which induced trait mindfulness that mediated craving and post-traumatic stress (Garland et al., 2016). A course of 8 sessions of Mindfulness-Based Addiction Therapy (MBAT) where smokers practice sitting meditation or yoga for 30 to 45 minutes, and discuss in a counselling session once a week. Participants were also encouraged to

practice mindfulness formally 6 days per week. This revealed participants receiving MBAT perceived greater volitional control over smoking and evidenced lower volatility of anger than participants in CBT and treatment as usual, and reduction of attentional bias (Spears et al., 2017). Also, a course of 8 sessions of MORE for opioid patients revealed MORE was associated with decreased opioid cue-reactivity and enhanced capacity to regulate responses to neutral reward cues (Garland et al., 2019). Neuroimaging studies support those finding that practicing mindfulness meditation regularly affects neuroplasticity change over time in brain function and structure which would promote trait mindfulness which benefits psychological health (Tang et al., 2007; see reviews, Tang, Hölzel, & Posner, 2015; see reviews Fox et al., 2014).

As mentioned above that mindfulness-based intervention studies showed that positive outcomes such as reduced stress, craving, drug consumption, however, a few that measure mindfulness state, attentional bias and cognitive control which might be a variable to explain those changes. Moreover, most of the mindfulness-based intervention include CBT which might leads to those positive outcomes.The current study aimed to investigate the effects of multiple sessions of brief mindfulness practice on the attention bias and cognitive control in alcohol inpatients. Our hypothesis was 1) at post-intervention measurement, state mindfulness in mindfulness groups would be higher than control group, 2) attentional bias would reduce in mindfulness practice groups while control group would not change, and 3) cognitive control would increase in mindfulness practice groups and not change in control group.

4.3.1 Method

Participants

Fifty male participants, who were diagnosed as alcohol dependents (International Classification of Diseases (ICD-10): F 1024) were recruited from the alcohol ward at Thanyarak Chiang Mai Hospital via face to face advertisement. Selection criteria required participants to have passed detoxification phase, read Thai fluently, have hand ability to use a computer keyboard and have visual acuity within normal limits. Of these 50 participants, 1 dropped out during the experiment. Therefore, the final sample consisted of 49 participants (mean age = 40.51, SD = 8.48, range 28 - 59). All participants were treated in accordance with the ethical standards of the British Psychological Association. In addition, ethical approval was obtained from the University of Kent at Canterbury's Department of Psychology ethics committee before recruiting participants and proceeding with the experiment.

Materials

Face-word Stroop task

Stroop task was adopted from study 1. Alcohol images were replaced with alcohol beverage Thai brands (to reduce cultural biases) and global alcohol beverage brands (all images were taken from google), and the words "male" and "female" in English letters were replaced with Thai letters (same as study2).

Visual Probe task

Visual probe task was adopted from study 1, and the response keys were the same as study 2.

Demography and Treatment history Record form

A record form contains demography and treatment history from hospital records (age, education, marital status, job employment, number of admissions, duration of treatment, admission type, and comorbidity).

Mindful-movement video

The 10 minute video produced by the Thai government as part of a health promotion campaign and could be found through this link: https://www.youtube.com/watch?v=E-gEO12BVNU. It shows three men performing 10 simple body movements for participants to follow.

Mindful breathing and body scan audio

The 10 minutes audio adapted from the Inner observer of the enneagram personality system, the content of this audio is about letting the listener observe their current state of the body (postures, tensions) and current thoughts. (see the scripts in Appendix).

Measures

State mindfulness

The Mindful Attention Awareness Scale – State version (MAAS-S) (Brown & Ryan, 2003): Adopted from study 4.

Motivation to change

Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES 8A) (Miller, W.R. & Tonigan, J.S., 1996): The SOCRATES is a 19-item, self-administered instrument designed to assess motivation to change drinking behaviour. It is made up of three scales: Problem Recognition (Re), Ambivalence (Am), and Taking Steps (TS). The three scores

are scored separately, and each scale has items that are summed to derive the scale score, translated into Thai by a researcher.

Procedure

Figure 33 shows timeline of the study that Day 1: In a quiet room, after providing signed consent and demographics information, participants were seated in front of a computer laptop and started the visual probe to test attentional bias. This was then followed by Stroop, which also aimed to measure attentional bias. Participants then completed SOCRATES to indicate stage of change and MAAS to indicate mindfulness state. Participants were allocated to 3 groups; initially a cohort of 20 patients were assigned to the control group. In a second cohort, 30 patients were randomly assigned to either the mindful-movement or body scan groups.

Day 2 – 6: Participants attended 4 sessions of a 10 minutes mindfulness training in a quiet room. The movement group had mindful-movement practice by following the video, the body scan group: practiced body scan by sitting, eyes closed and listening to the audio. Participants in the control group were on a waiting list.

Day 7: Participants returned to a quiet room after training testing. Attentional bias was measured by using the visual probe and Stroop, followed by SOCRATES and MAAS for stage of change and state of mindfulness respectively. Finally, they were debriefed and thanked.

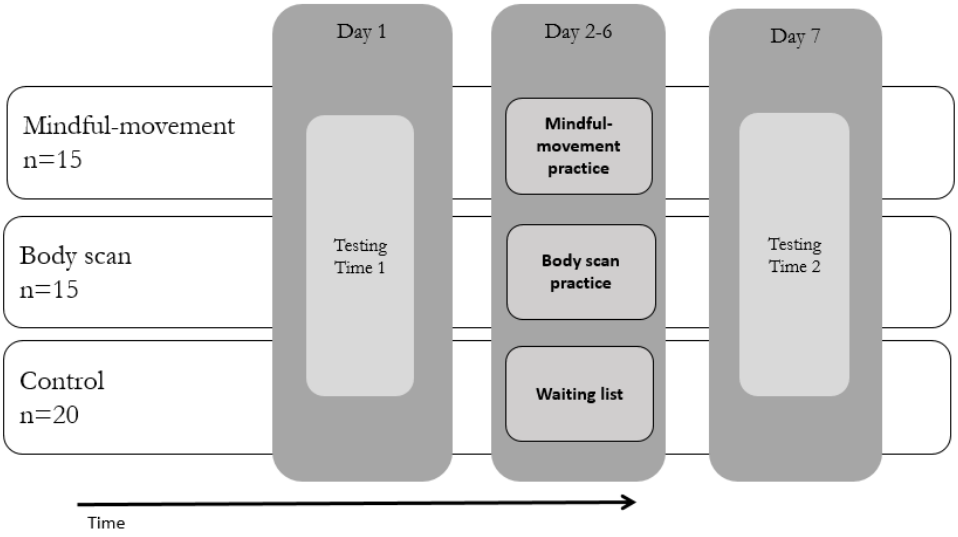


Figure 33. Timeline of study 5

Testing includes Visual probe task, Stroop task, SOCRATES, and MAAS

4.3.2 Result

Group Characteristics

A series of one-way ANOVA was used to identify any between-group difference in age, number of admissions, mindful attentional awareness (MAAS) and motivation to change from SOCRATES. Each ANOVA included Group (Movement, Breathing, and Control) as the independent variable and each measure as the dependent variable. There were no statistically significant differences between groups in age, number of admissions, mindful attentional awareness (MAAS), motivation to change, education, and marital status. Pearson Chi-square was performed to identify any between-group differences in employment, and co-morbidity. These analyses revealed a statistically significantly difference in employment (X^2 *(2, N = 49) = 7.68, p < .05)* and comorbidity (X^2 *(2, N = 49) = 7.99, p < .05)* (see Table 13).

Table 13 Comparison of pre-training measure data across each group

	Training Condition								
	Movement (n=14)			Breathing and Body scan (n=15)			Control (n=20)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Age	37.71	6.09	23	42.67	10.01	30	40.85	8.52	28
Admission no.	4.79	4.95	13	5.67	8.49	28	3.25	3.42	10
MAAS1	3.04	.77	2.60	2.77	.58	2	2.81	1.23	4.40
Motivation to Change									
Recognition 1 (Re)	29.50	3.03	10	24.47	6.55	22	28.70	5.05	21
Ambivalence 1 (Am)	16.43	2.03	8	13.27	4.03	14	14.85	2.54	9
Taking Steps 1 (TS)	34.14	2.66	9	28.20	6.05	22	31.30	4.54	15
	n	%		n	%		n	%	
Education									
Primary or lower	2	14.3		4	26.7		5	25	
Secondary	5	35.7		2	13.3		5	25	
High school	7	50		8	53.3		10	50	
Undergrad				1	6.7				
Marital status									
single	4	28.6		6	40		5	25	
coupled	5	35.7		8	53.3		10	50	
widow, separate	5	35.7		1	6.7		5	25	
Job employment									
unemployed	6	42.9		1	6.7		10	50	
employed	8	57.1		14	93.3		10	50	
Comorbidity									
comorbid	9	64.3		11	73.3		20	100	
no comorbid	5	35.7		4	26.7				

Analysis of Attentional bias and Cognitive control

Stroop task

Further cleaning of data used the procedure by Sharma (2017). Of these 49 participants, 3 were excluded from the final sample; 1 due to a software error, and another 2 were excluded as outliers as they were >2.5 standard deviations from the mean. Therefore, the final sample consisted of 46 participants. The first trial of each block, error trials, trials immediately following an error, and trials with an RT exceeding 2,500 ms and less than 200 ms and if more than 2.5 SDs per condition were removed.

To examine attentional bias and cognitive control, a mixed-design ANOVA 3 x 2 x 2 x 2 was performed with Time (1, 2), Previous congruency (congruent, incongruent), Current congruency (congruent, incongruent) and Image type (neutral, alcohol) as within-subject factors, and Group (movement, breathing, control) as the between-subject factor. Mean correct reaction times was the dependent variable. Analyses revealed a statistically significant main effect Current ($F(1,43) = 50.09$, $p<.001$, $\eta p^2 = .54$) that latencies of congruent (M= 861.05, SE=35.59) were shorter than incongruent trials (M= 949.53, SE=39.41) which indicated Stroop interference, the ability to control attention from distractor. A statistically significant main effect of Image ($F(1,43) = 24.99$, $p<.001$, $\eta p^2 = .37$), which showed RT to neutral image (M= 917.73, SE=38.06) was longer than alcohol image (M= 892.85, SE=36.14). This indicates attentional bias to neutral image. A statistically significant main effect of Previous ($F(1,43) = 5.89$, $p < .05$, $\eta p^2 = .12$) that indicates latencies of incongruent (M=892.85, SE=36.14) were shorter than congruent trials (M= 917.73, SE=38.06), indicates cognitive control. Additionally, a statistically significant 4-way interaction of Image x Previous x Current x Group ($F(2, 43) = 3.39$, $p=.04$, $\eta p^2 = .14$) that the movement group has a larger sequential modulation when

preceded by alcohol than neutral image (t(13)=2.53, *p*=.025) (see Figure 34). No other statistically significant main effect and interactions were found (all F's<3.03, p's >.089).

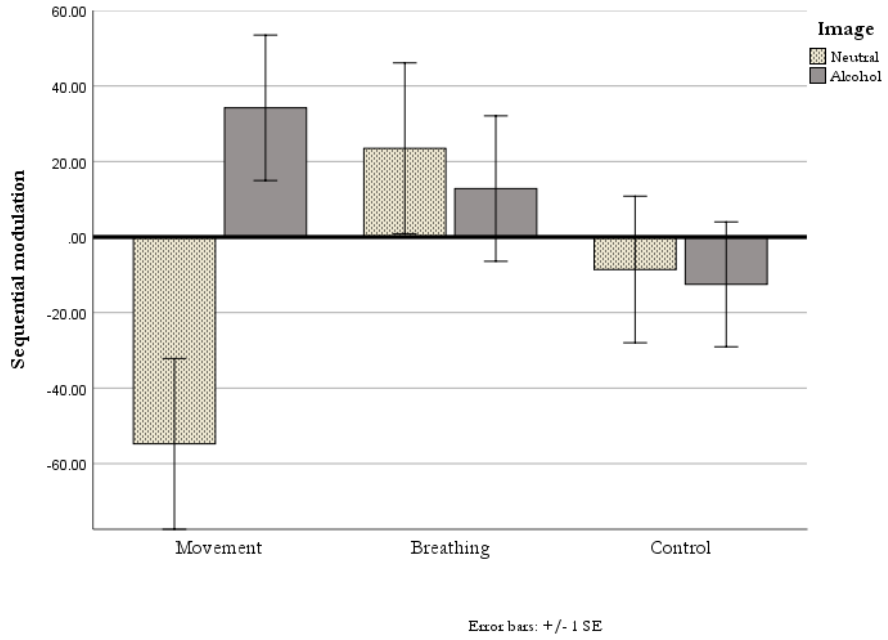


Figure 34. Movement group had SM preceded by alcohol picture larger than neutral picture.

Visual probe task

Of these 49 participants, 5 were excluded from the final sample because of 1 software error and 4 with an error rate in their answers of >30%. The final sample consisted of 44 participants. Reaction time data from practice and buffer trials, and from trials with errors were removed. To eliminate outliers, RTs were excluded if they were greater than 2,000 ms, and then if they were more than 2.5 SDs above the mean per condition.

To examine the effects of attentional bias, using a factorial design 3 x 2 x 2 with Group (movement, breathing, control) as the between-subject factor, Time (1, 2) and Probe position (alcohol, neutral) as within-subject factors. Mean correct reaction time was the dependent variable. Analyses revealed a statistically significant main effect of

Time (F(1,41) = 5.55, p<.05, ηp^2 =.12) that RT reduced (Time 1, M= 804.50, SE=39.80; Time 2, M= 745.73, SE=29.67), which indicates a general practice effect. No other main effect or interaction was found (all F's<2.60, p's >.121).

Analysis of mindfulness

To examine state mindfulness, a factorial design 3 x 2 with Group (movement, breathing, control) as the between-subject factor, Time (1, 2) as within-subject factors, and MAAS score as a dependent variable was conducted. Analyses revealed a statistically significant main effect of Time (F(1, 45)=4.48, p<.05, ηp^2=.091) that MAAS score decreased (Time 1: M= 2.89, SE=.14; Time 2: M=2.54, SE=.15). Indicating a whole sample showed reduction of state mindfulness, which was not related to the interventions.

Analysis of Motivation to change

To identify whether the intervention changed motivation, a paired t-test was conducted to compare each subscale score of motivation to change (Recognition, Ambivalence, and Taking Steps), before and after the intervention in each group. Analyses revealed the mindful-breathing and body scan group had a statistically significant increase in all subscales: Recognition (Time 1: M= 23.71, SD=6.08; Time 2: M=29.57, SD=3.39, t(13)=3.57, p=.003), Ambivalence (Time 1: M= 12.93, SD=3.95; Time 2 :M= 16.29, SD=2.02, t(13)=2.55, p=.024), and Taking Steps (Time 1: M= 27.86, SD=6.13; Time 2: M= 34.07, SD=2.20, (t(13)=4.08, p=.001). Suggesting that the mindful-breathing and body scan practice increased motivation to change (Figure 35). There were no motivation changes in other groups.

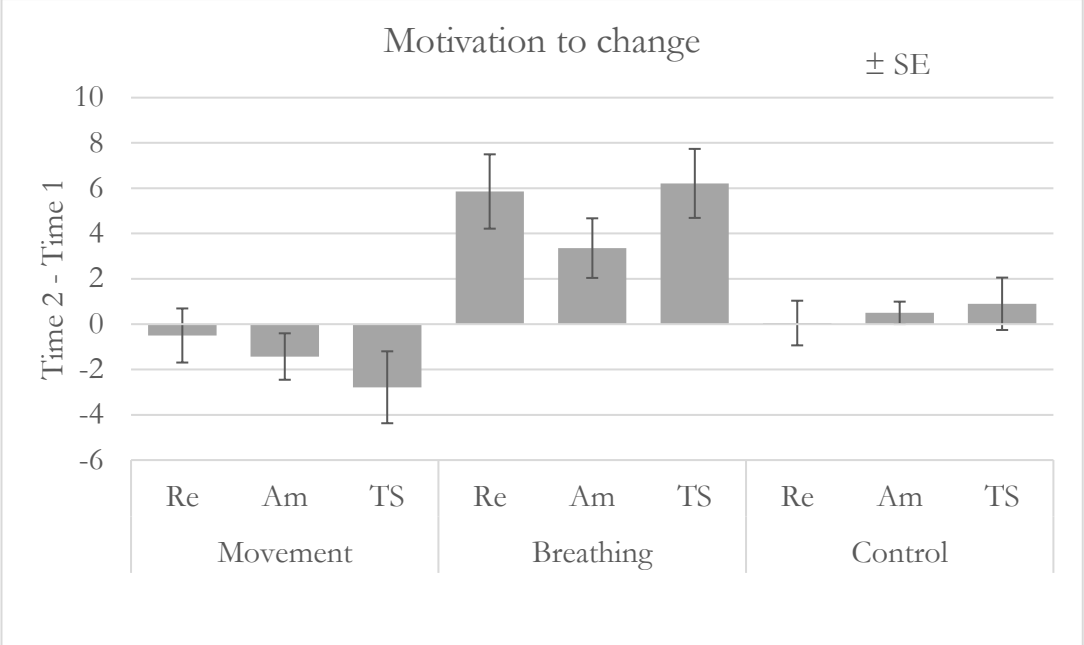


Figure 35. Motivation changes in each group

Correlation analysis

To explore the relationship between variables, the mean score of each variable was calculated. Bivariate correlation analysis revealed AB.SI had a negative correlation with SMn (r=-.34, p<.05), that more attentional bias also reported less cognitive control when neutral cues presented); AB.SI had a negative correlation with Re (r=-.29, p<.05) that more attentional bias also reported less problem recognition; whereas AB.SI had a positive correlation with Age (r=.42, p<.01) that greater attentional bias in older than younger age. MAAS had a negative correlation with Re (r=-.33, p<.05), that more state mindfulness also reported less problem recognition. In addition, Age had a positive correlation with AB.SI (r=.42, p<.01), that older age also reported greater attentional bias. However, age had a negative correlation with SMd (r=-.37, p<.01)., Re (r=-.37, p<.01) and Am (r=-.31, p<.05), that older age also reported less cognitive control after the presence of alcohol, less problem recognition, and less ambivalence in stop drinking (see Table 14).

Table 14 Correlations among variables of interest study 5

	ABvp	AB	AB.SI	SMn	SMd	MAAS	Re	Am	TS	Admission no.
AB	.03									
AB.SI	.08	.02								
SMn	-.08	.2	-.34*							
SMd	-.1	.16	-.17	-.1						
MAAS	-.09	.03	.07	-.05	.04					
Re	.02	-.15	-.29*	.07	-.05	-.33*				
Am	.08	-.11	-.06	.05	.02	-.28	.76**			
TS	-.04	-.16	-.05	-.14	.08	.13	.53**	.49**		
Admission no.	-.08	-.14	-.11	.16	-.01	-.23	.34*	.29*	0	
Age	-.13	-.21	.42**	-.25	-.37**	-.03	-.37**	-.31*	-.1	-.06

**p<.01, *p<.05

Regression analysis

Multiple linear regression was employed to help determine which of the IVs could be used to predict attentional bias and sequential modulation in alcohol dependent patients. A direct method was used for the multiple linear regression analyses. Results showed AB.SI was predicted by Age (β = .37, p=.018), that older age produces greater attentional bias. The overall model fit was statistically significant. Moreover, SMd was predicted by Age (β = -.49, p=.002), that older age produces less cognitive control (when alcohol picture was presented) (see Table 15).

Table 15 Multiple regression of self-report on attentional bias and sequential modulation

	AB.vp					AB					AB.SI					SMn					SMd				
	B	*SE B*	β	sr^2	*00*	*B*	*SE B*	β	sr^2	*0*	*B*	*SE B*	β	sr^2	*00*	*B*	*SE B*	β	sr^2	*00*	*B*	*SE B*	β	sr^2
MAAS	-7.84	14.63	-.10	0.01		-2.93	7.12	-.07	0.00		1.32	14.45	.01	0.00		2.92	19.60	.03	0.00		-13.34	15.17	-.15	0.02
Re	-1.71	4.73	-.11	0.00		-1.81	2.27	-.21	0.01		-8.28	4.56	-.44	0.08		.95	6.19	.04	0.00		-9.29	4.79	-.48	0.09
Am	4.35	7.40	.15	0.01		-.11	3.63	-.01	0.00		12.31	7.43	.35	0.06		1.46	10.08	.03	0.00		1.43	7.80	.04	0.00
TS	-.96	4.26	-.05	0.00		-.59	1.96	-.06	0.00		.75	4.22	.03	0.00		-5.78	5.73	-.21	0.02		6.94	4.44	.30	0.06
Admission no.	-1.15	1.82	-.11	0.01		-.56	.90	-.10	0.01		-.47	1.82	-.04	0.00		2.18	2.47	.14	0.02		.95	1.91	.08	0.01
Age	-.86	1.35	-.12	0.01		-1.17	.63	-.30	0.08		3.16	1.28	.37*	0.13		-2.50	1.74	-.23	0.05		-4.34	1.34	-.49*	0.21
R^2	.05					.12					.26					.11					.23				
F	.29					.93					2.37*					.86					1.97				

**p<0.01, *p<0.05

4.4.3 Summary

Our hypotheses were 1) at post-intervention measurement, state mindfulness in two mindfulness groups would be higher than control group, 2) unlike the control group, attentional bias would decrease in two mindfulness groups, and 3) cognitive control would be increased in mindfulness practice groups and no change in control group.

The current study revealed findings opposing these hypotheses: movement group showed SM was higher after alcohol image than neutral image; there was a reduction of state mindfulness in all groups; the mindful-breathing and body scan group showed motivation increased whereas other groups did not show any change; there was no significant change on attentional bias and cognitive control. Moreover, regression showed age is associate with attentional bias (AB.SI) and cognitive control (SMd) when alcohol image was presented. Suggesting that the hospital treatment programme reduces state mindfulness; the mindfulness-based interventions were unable to alter attentional bias and cognitive control, however, mindful-breathing and body scan practice induces motivation to change; more attentional bias (AB.SI) in older than younger age; and more cognitive control when alcohol presented in younger than older age.

The Stroop task demonstrated that alcohol inpatients did not show *attentional bias* to alcohol but an avoidance of alcohol cues (participants responded faster to disengage from alcohol than neutral picture), which is consistent with Field et al. (2013) who found that alcohol patients who have low levels of craving showed alcohol avoidance. However, this result was not present in the visual probe task which did not show attentional bias toward alcohol. These findings were unlike the studies that we replicated (Field, Mogg, Zetteler, et al., 2004), it might be because Field and colleagues studied active drinkers (undergrad student), whereas our sample are patients who are currently abstinent in a drug free setting. Thus, active social drinkers and patients might have a different motivation stage in alcohol use, which might affect attentional bias.

Cognitive control was found through the main effect of Previous congruency, that RTs for the current trial speeds up when the previous trial is incongruent than congruent. This indicates a strong level of top-down control indicating that the participants are able to filter out the distractors on the current trial after conflict is triggered from the previous trial. It is interesting to also note that the regression analysis showed that older age produces less cognitive control (when alcohol picture was presented), this is consistent with Persson, Lustig, Nelson, and Reuter-Lorenz (2007) who suggested that age differences are most noticeable in cognitive control ability.

State mindfulness decreased in the whole sample, this finding goes against our expectation and may be due to the interventions are not strong enough to increase mindfulness. One explanation for the decrease in state mindfulness is indicated by the negative correlation with problem recognition. This may be due to the hospital treatment programme which focuses on exploring one's problem with drug addiction. This exploration necessarily involves not being in the present moment but recalling the past or future memories. It may also be the case that doing mindfulness practice increases the awareness of a lack of mindfulness attention.

Additionally, only the mindful-breathing and body scan group had increased all scales in *motivation to change*, whereas the other groups did not have any changes on motivation. The meaning of each subscale: *problem recognition scale* reflects that participants acknowledge that they are having problems related to their drinking, tending to express a desire for change and to perceive that harm will continue if they do not change. *Ambivalence scale* reflects that they sometimes wonder if they are in control of their drinking, are drinking too much, are hurting other people, and/or are alcoholic, reflects some openness to reflection, as might be particularly expected in the contemplation stage of change. *Taking steps* reflects that they are already doing things to make a positive change in their drinking. Motivation to change increased might be because the mindful-breathing

and body scan practice is an open monitoring meditation that meditators practice continues to include observation and disengagement from emerging thoughts and feelings while also reflexively turning attention back on itself to attend to the field of awareness in which mental contents arise. In addition, the audio scripts asked participants to scan body and the mind thus might have cued participants to reflect on personal concerns related to drinking consequences, resulting in influencing motivation to change. (Example from the audio scripts: ……*After watching out the external body, then now start to observe in your body whether it is in the normal state? Is there any pain on any part? Observe it for a while, if it is still painful, more or less?)*. Whereas, the mindful-movement practice requires participants to focus their attention on the video clip and control their body movement. This practice did not relate to problem recognition or thoughts related to drinking. This is potentially an important finding as it suggests that focusing on the breath and mind could be an important addition to any addiction therapy.

Limitation of the study: The present study did not measure mindfulness immediately after each session on each day. Thus, we were not able to see the immediate effect of the intervention every day. As our training was a very brief session it is possible that the effects of the meditation may also be brief and therefore not last until testing Time 2.

Moreover, there was no measurement for the desire for alcohol, which is the variable that might be able to explain attentional bias. Previous research by Field, Munafò, and et al. (2009) conclude that attentional bias and craving are related phenomena, and the magnitude of the attentional bias is generally proportional to the amount of alcohol that people habitually consume (Cox et al., 2006).

4.4 Study 6: Mindfulness practising in Methamphetamine Patients

The previous studies (study 5) showed the mindful-breathing and body scan practice increased motivation to change in alcohol inpatients; however, they were unable to change attentional bias and cognitive control. The current study replicated study 5 in methamphetamine inpatients with hypotheses: 1) the experimental group who practice mindful-breathing and body scan daily would have a significant increase in motivation to change whereas no change in control group; 2) state mindfulness, positive affect, and cognitive control would be increased in an experimental group, whereas the control group would not have any significant changes; and 3) the experimental group would have a reduction of methamphetamine attentional bias, negative affect and craving, whereas the control group would not have any significant changes.

4.4.1 Method

Participants

Ninety participants were recruited at Thanyarak Chiang Mai Hospital, Thailand, through an announcement by a researcher at the morning meeting group. Participants were selected on the criteria that they were either native Thai speakers or fluent in spoken Thai, had visual acuity within normal limits and were diagnosed as a Methamphetamine dependent. Two wards were used to recruit participants with one ward randomly assigned to the experimental group and the other to the control group. This was done to avoid priming of different interventions between participants within the same ward. Of these 90 participants, 7 were excluded from the final sample because 3 used methamphetamine as a second drug and another 4 were discharged before testing time 2, leaving a total of 83 participants in the final analysis. All participants were treated in accordance with the ethical standards of the British Psychological Association. In addition, ethical approval

was obtained from the University of Kent at Canterbury's Department of Psychology ethics committee and permission from Thanyarak Chiang Mai Hospital before recruiting participants and proceeding with the experiment.

Materials

Face-word Stroop task

Adopted in Study 2

Visual Probe task

Adapted from Study 2. Response keys changed from X and M keys to up and down arrow keys, due to the previous study having shown a high percentage of incorrect answers due to participants possibly confusing the position of the response keys.

Intervention: mindful breathing and body scan

Audio instruction of mindful breathing and body scan, adopted from study 5 (See Appendix B15)

Measures

Mindfulness

The Mindful Attention Awareness Scale – State version (MAAS-S) (Brown & Ryan, 2003): Adopted from study 3.

Toronto Mindfulness Scale - trait version (TMS-T) (Davis, et al., 2009): Adopted from study 4.

Craving

Craving Experience Questionnaire (CEQ) (May et.al. 2014): A 22 item questionnaire to measure sensory aspects of craving (imagining taste, smell or sensations of drinking and intrusive cognitions associated with craving) when craving was maximal during the

previous week (CEQs), and to assess frequency of desire-related thoughts in the past week (CEQf).

Craving scale- Self-reported: Adopted from study 4.

Affect

Affect grid (Russell, Weiss, & Mendelsohn, 1989): Adopted from study 4.

Motivation to change

Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES 8D) (Miller & Tonigan, 1996): Adopted from study 2.

Procedure

Day 1: Testing took place in Thanyarak Chiang Mai Hospital, Thailand, in a quiet room. After participants signed a consent form they completed MAAS and TMS to mindfulness state, CEQ and craving scale to measure craving, and affect grid of measuring the effect before and after completing the Stroop task (288 Trials) and the Visual probe task (56 trials) to measure attentional bias for methamphetamine-related cues. They then completed SOCRATES 8D, a 19 item questionnaire to measure motivation to change, and demography.

Day 2-16: Participants were taught how to follow the audio of mindfulness practice once before the start of the first session of a mindfulness practice group (mindful-breathing and body scan). This daily practice (14 days), took place before participants started the routine in the morning at the meeting room and in a participant's bedroom before going to bed at night.

Day 17: Participants had a measurement of mindfulness state, craving, affect, motivation to change and attentional bias on Day 1, and were given a debrief (Figure 36)

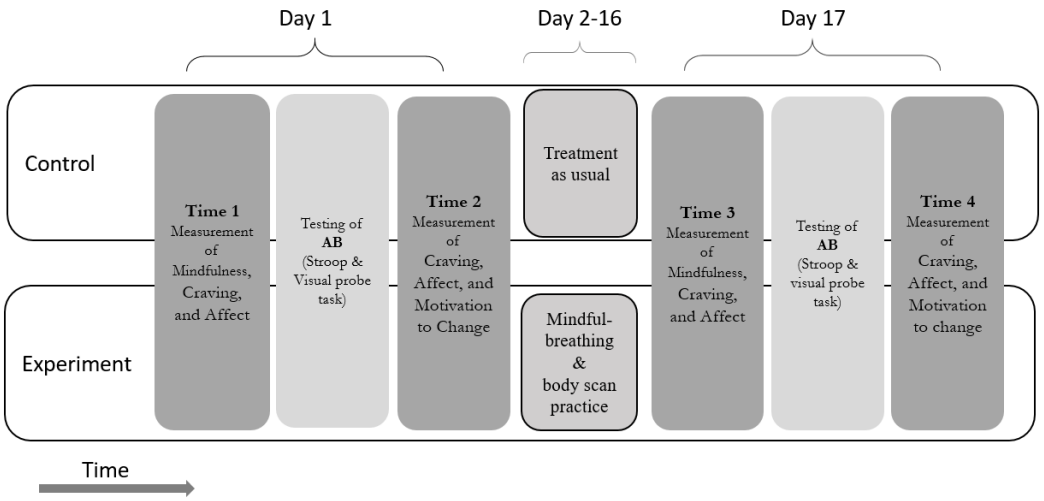


Figure 36. Procedure and Timeline of study 6

4.4.2 Result

Participant Characteristics

A series of one-way ANOVAs were used to identify any between-group difference in Age, Admission number, Duration of treatment, Craving, Affect, Mindfulness, and Motivation to change. Each ANOVA included Group (Control and Experimental) as the independent variable (IV) and each measure as the dependent variable. Analyses revealed a main effect of Group for Arousal on the Affect grid ($F(1,82) = 8.65$, $p < .05$) and Taking Steps ($F(1,82) = 4.50$, $p < .05$). There were no other main effects or interaction found. Pearson Chi-square was performed to identify any between-group difference in comorbidity. These analyses revealed no significant differences (see Table 16).

Table 16 Comparison of pre-intervention measure data across each group

	Control (n=42)			Experimental (n=41)		
	Mean	SD	Range	Mean	SD	Range
Age	31.98	8.23	40	31.22	8.58	37
Admission no.	1.67	0.82	2	1.85	0.79	2
Treatment duration (day)	31.4	24.99	86	42.05	31.79	111
Craving						
Craving1	1.5	1.99	9	1.44	1.79	5
CEQ-Strength1	3.82	2.5	8	3.87	2.4	10
CEQ-Frequency1	3.81	2.03	8	3.56	2.07	8
Affect						
Pleasant1	6.98	1.91	8	7.27	1.92	7
Arousal1*	5.55	2.32	8	4.15	2.01	8
Mindfulness						
MAAS1	3.95	1.2	5	3.97	0.96	4
TMS-Curiosity1	20.52	5.41	20	21.88	4.56	18
TMS-Decentering1	22.79	4.36	20	22.46	3.59	18
Motivation to change						
Recognition1	20.67	4.92	24	21.88	4.43	17
Ambivalence1	13.14	3.11	14	13.51	3.27	13
Taking Steps1*	26.74	5.73	28	29.02	3.9	14
		n	%		n	%
Comorbid						
Comorbid		9	21.4		10	24.4
Non-comorbid		33	78.6		31	75.6

*p<.05

Analysis of Attentional bias and Cognitive control

Stroop task

Further cleaning of data used the procedure by Sharma (2017). The first trial of each block, error trials, trials immediately following an error, trials with an RT exceeding 3,000 ms and less than 300 ms, and then if they were less than -2.5 SDs or more than 2.5 SDs from the mean were removed.

A mixed-design ANOVA was performed with Group (control, experimental) as the between-subject factor and Time (1, 2), Image type (neutral, alcohol), Previous congruency (congruent, incongruent), and Current congruency (congruent, incongruent) as within-subject factors. Mean correct reaction times was the dependent variable. The analysis of reaction time revealed a statistically significant main effect of Current congruency ($F (1, 81) = 92.44$, $p<.001$, $\eta p^2 = .53$) that latencies of incongruent trials (M=778.83, SE=20.32) were greater than congruent trials (M=729.04, SE=17.56), indicating a Stroop effect; a significant main effect of Time ($F (1, 81) = 7.25$, $p=.009$, $\eta p^2 = .082$), that Time 2 (M=731.45, SE=18.73) was shorter than Time 1 (M=776.42, SE=22.29), indicating a general practice effect; a significant main effect of Previous congruency ($F (1, 81) = 6.21$, $p=.015$, $\eta p^2 = .07$) that latencies of incongruent trials (M=749.82, SE=18.52) were shorter than congruent trials (M=758.05, SE=19.25) indicating a sequential modulation effect that is independent of the current trial type. A significant two-way interaction of Image x Previous congruency ($F (1, 81) = 5.77$, $p= .019$, $\eta p^2 = .07$) that latencies of incongruent (M=761.36, SE=21.40) were shorter than congruent trials (M=778.63, SE=23.23) (Figure 37), indicating top-down cognitive control when preceded by neutral cues. No other statistically significant main effect or interaction were found (all F's <2.21, $p>.14$).

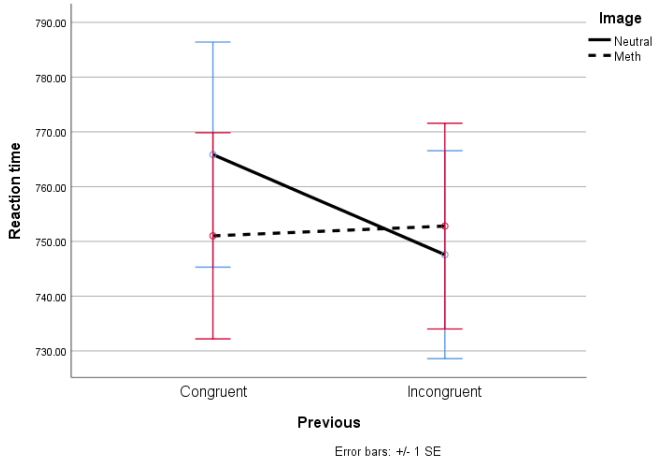


Figure 37. The interaction between Image and Previous

Visual probe

To identify any between group and between condition differences, reaction time data from practice and buffer trials and from trials with errors were removed. To eliminate outliers, RTs were excluded if they were less than 300 and greater than 3,000 ms, and then if they were more than 2.5 SDs above the mean per condition. A factorial design with Group (control, experimental) as the between-subject factor, Time (1 and 2) and Probe position (same, different) as within-subject factors were conducted. Analyses revealed no statistically significant main effect or interaction (all F's <2.49, p>.11). This indicates there was no attentional bias changes and no differences between groups.

Analysis of Mindfulness, Affect, Craving, and Motivation to change

Mindfulness

To examine state mindfulness, using a factorial design 2 x 2 with Group (control, experimental) as the between-subject factor, and Time (1, 3) as within-subject. MAAS score was the dependent variable. Analyses revealed a statistically significant main effect of Time (F(1, 81)=12.30, p=.001, ηp^2=.132) that MAAS increased (Time1, M= 3.96, SE=.12; Time 3, M= 4.35, SE=.12), however, no statistically significant interactions with Group. This indicates state mindfulness increased but was not related to the intervention.

To examine trait mindfulness-curiosity (TMSc) using a factorial design 2 x 2 with Group (control, experimental) as the between-subject factor, and Time (1, 3) as within-subject. TMSc score was the dependent variable. Analyses reveal a statistically significant main effect of Time ($F(1, 81)=5.25$, $p=.024$, $\eta p^2=.061$) that TMSc increased (Time1, M= 21.20, SE=.55; Time 3, M= 22.34, SE=.53). There was no statistically significant interaction with Group. Suggesting awareness of present moment experience with a quality of curiosity increased in this sample but was not related to the intervention (Figure 38).

To examine trait mindfulness-decentering (TMSd), analyses revealed no statistically significant main effect or interactions (all $F's<3.35$, $p>0.16$). Suggesting no changes in awareness of individual's experience with some distance and disidentification rather than being carried away by individual's thoughts and feelings (see Figure 38).

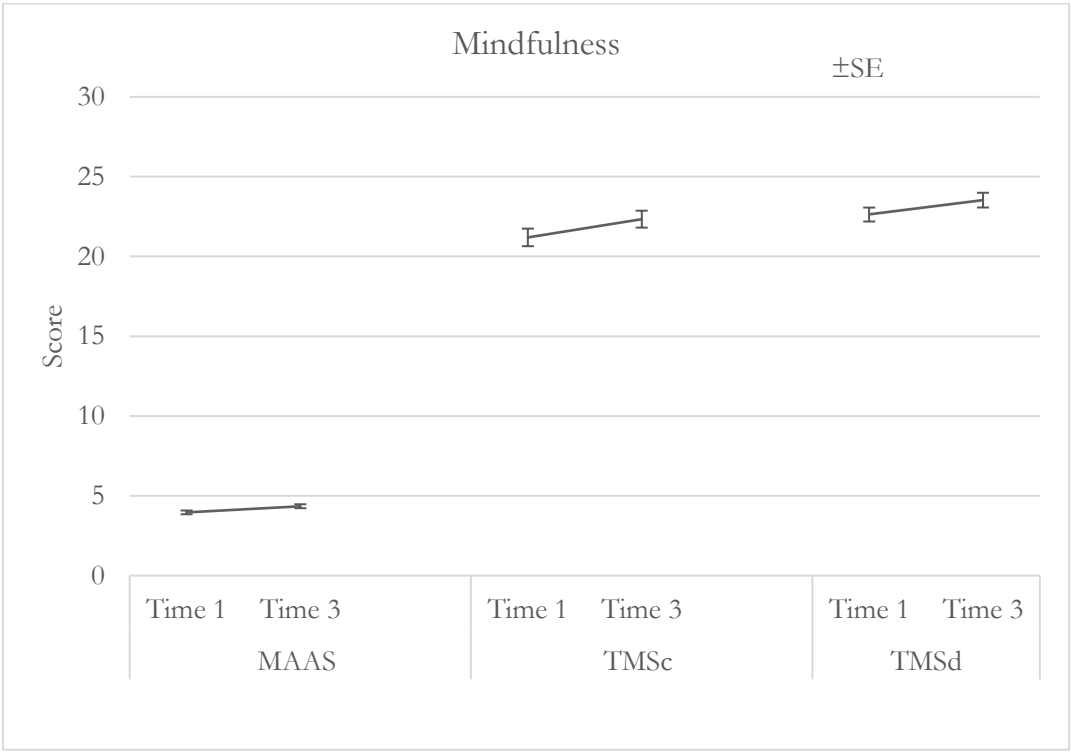


Figure 38. State mindfulness and curiosity increased after the intervention.

Affect

Pleasant: To examine Pleasant, using a factorial design 2 x 4 with Group (control, experimental) as the between-subject factor, and Time (1, 2, 3, 4) as within-subject. Pleasant score was a dependent variable. Analyses revealed no statistically significant main effect or interaction (all F's<1.4, p>.28). Indicating attentional tasks (Visual probe task and Stroop task) had no effect on Pleasant, as well as the intervention had no effect on Pleasant (Figure 39).

Arousal: To examine Arousal, using a factorial design 2 x 4 with Group (control, experimental) as the between-subject factor, and Time (1, 2, 3, 4) as within-subject. Arousal score was a dependent variable. Analyses revealed no statistically significant main effect or interaction (all F's<1.74, p>.17). Suggesting attentional tasks (Visual probe task and Stroop task) had no effect on Arousal, as well as the intervention had no effect on Arousal (Figure 39).

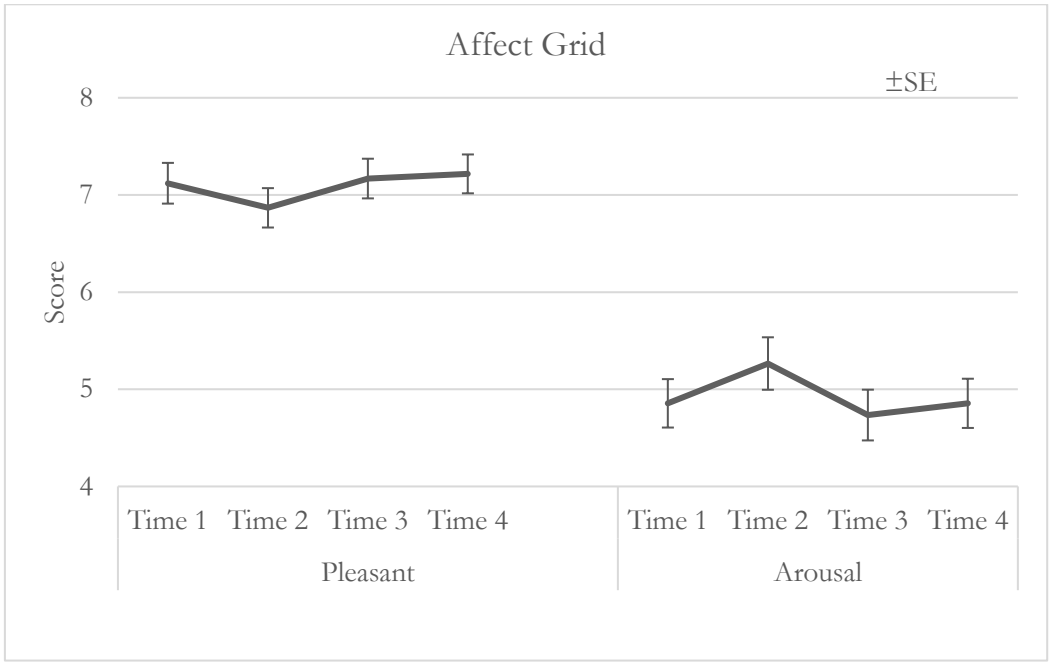


Figure 39. Pleasant and Arousal were not changed from attentional tasks (Stroop task and Visual probe task) (Time 1 and 2, and Time 3 and 4) and the intervention (Time 2 and 3).

Craving

A factorial design 2 x 4 with Group (control, experimental) as the between-subject factor, and Time (1, 3) as within-subject, and *CEQ-Strength* score was the dependent variable. The analyses revealed no statistically significant main effect or interaction (all F's<2.6, p>.12), indicating craving strength does not change. However, factorial analyses of *CEQ-Frequency*, revealed a statistically significant main effect of Time (F(1,81) =9.43, p=.003, ηp^2=.104), indicating craving frequency decreased (Time1, M=. 3.68, SE=.22, Time 3, M= 3.08, SE=.22). Suggesting craving strength has no changes throughout the study, but craving frequency decreased but this was not related to the intervention.

To examine *craving scale* ("how much do you feel craving right now?, rating scale 0 to 10), using a factorial design 2 x 4 with Group (control, experimental) as the between-subject factor, and Time (1, 2, 3, 4) as within-subject. Craving score was a dependent variable. Analyses revealed no statistically significant main effect or interaction (all F's<2.10, p>.12) (see Figure 40). Suggesting no craving changes before and after attention tasks (Time 1 and 2, Time 3 and 4), and at pre- and post-intervention (Time 1 and 3) in the whole sample.

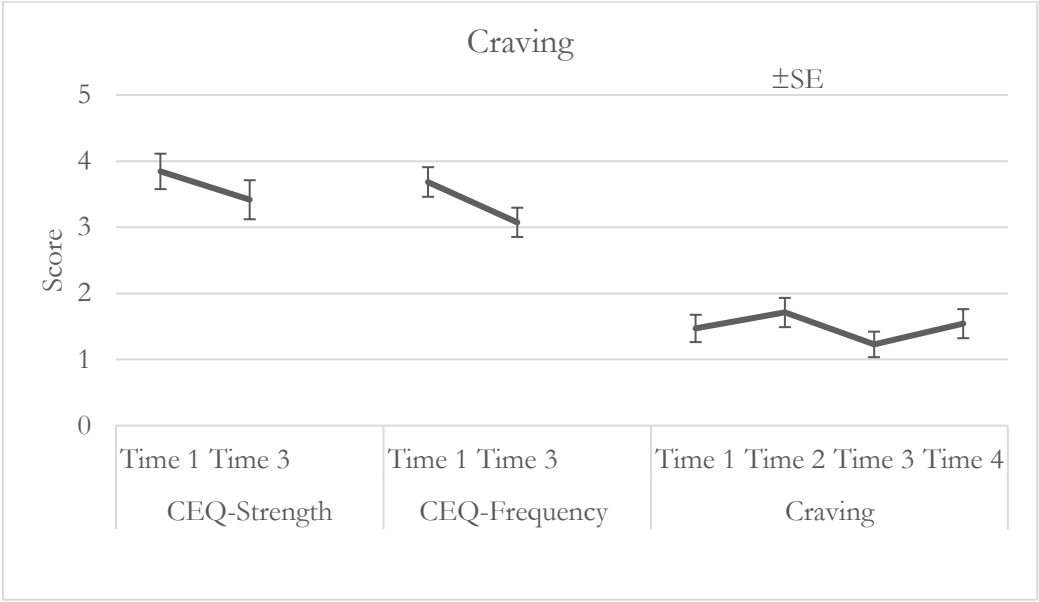


Figure 40. Craving scores at pre- and post-intervention

Motivation to change

To examine whether the intervention alters motivation to change in drug-related behaviour, each subscale (Re, Am, TS) score was employed as a dependent variable in a factorial design 2 x 4 with Group (control, experimental) as the between-subject factor, and Time (2, 4) as within-subject factor. Analyses revealed no statistically significant main effect or interaction (all F's<2.15, p>.14). Indicating the intervention has no effect on stages of change, readiness and treatment eagerness, and no difference between groups.

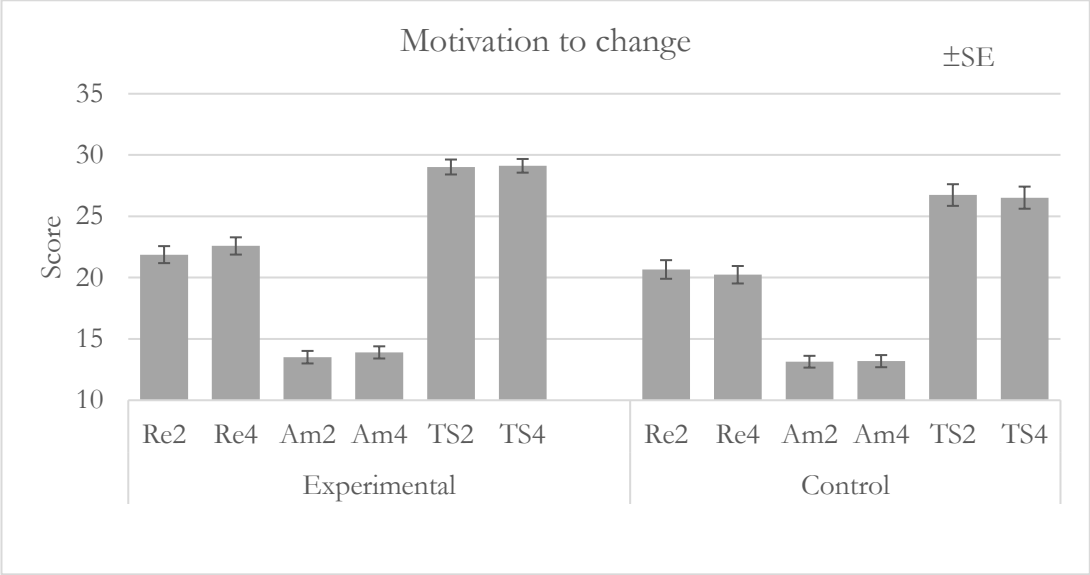


Figure 41 Shows the interaction between Group (experimental, control) and Time (2, 4) for all subscales in motivation to change (problem Recognition, Ambivalence, Taking Steps).

Correlation analysis

To examine the correlation between variables, the mean score of each variable was calculated, ANOVA revealed no statistically significant differences between before and after the intervention, although mindfulness and craving had changes but not related to the intervention. Bivariate correlations were performed, results showed in Table 17.

Attentional bias (calculated from latency of disengaging attention), AB.vp and AB had a statistically significant positive correlation (r=.27, p= .015). This indicates greater AB also reported greater AB.vp. Additionally, AB had a negative correlation with age (r=-.31, p=.004) which indicates younger participants had greater attentional bias (AB). However, AB.vp had a statistically significant negative correlation with AB.SI (attentional bias calculated from effect of image on Stroop interference) (r=-.24, p=.026). This indicates greater AB from visual probe task would report smaller attentional bias from Stroop interference.

Cognitive control (when preceded by methamphetamine image: SMd) had a statistically significant positive correlation with AB (r=.22, p= .042), indicates greater cognitive control also reported a greater attentional bias (AB). However, SMd had a statistically significant negative correlation with AB.SI (r=-.24, p=.028), which indicates greater cognitive control also reported smaller attentional bias (AB.SI). This demonstrates that cognitive resources still exist for cognitive control if subject only disengages attention (from AB score), but not when the subject had to disengage plus inhibit attention (from AB.SI), which causes no cognitive resources left for cognitive control.

Additionally, state mindfulness (MAAS) had statistically significant negative correlations with arousal (r= -.22, p=.049), and craving (r's >-34, p's <.05). This indicates greater state mindfulness also reported greater calmness, and less craving. Furthermore, trait mindfulness (TMS) had positive correlations with motivation to change (r's >.25, p's <.05). This indicates greater trait mindfulness also reported greater motivation to change

drug-related behaviour. Age also had a statistically significant positive correlation with curiosity on trait mindfulness (r=.23, $p<.01$), that greater trait mindfulness in older age compared to younger age.

Regression analysis

To determine which of the IVs could be used to predict attentional bias and sequential modulation in methamphetamine inpatients, multiple linear regression was employed. A direct method analysis revealed AB.vp could be predicted by ambivalence ($\beta = -.43$, $p<.05$). The overall model fit was not statistically significant. Moreover, AB could be predicted by TMSc ($\beta = .33$, $p<.05$), CEQs ($\beta = .60$, $p<.05$), CEQf ($\beta = -.50$, $p<.05$), ambivalence ($\beta = .51$, $p<.05$), and age ($\beta = -.37$, $p<.05$). The overall model fit was not statistically significant (see Table 18).

Table 17 Correlations among variables of interest study 6

	AB.vp	AB	AB.SI	SMn	SMd	MAAS	TMSd	TMSc	Pleasant	Arousal	Craving	CEQs	CEQf	Re	Am	TS	Adm.no.	Duration
AB	.27*																	
AB.SI	-.24*	-.01																
SMn	-.07	.11	-.19															
SMd	.09	.22*	-.24*	-.08														
MAAS	-.02	.11	.07	-.09	.01													
TMSd	.01	-.12	.04	-.01	-.02	-.28**												
TMSc	.08	.01	.03	-.15	.01	-.11	.63**											
Pleasant	-.16	-.01	-.06	-.01	.07	.19	-.08	-.04										
Arousal	-.01	-.07	-.10	-.02	.04	-.22*	-.02	.06	-.20									
Craving	.00	.03	-.07	.02	.16	-.40**	.14	-.02	-.09	.25*								
CEQs	-.03	.10	.13	-.01	-.02	-.34**	.14	.02	-.16	.09	.64**							
CEQf	-.12	.03	.09	-.04	.10	-.36**	.12	.10	-.08	.18	.70**	.88**						
Re	.02	-.03	.03	.04	-.10	.02	.27*	.30**	-.14	-.13	-.04	-.02	-.06					
Am	-.10	.11	.09	.06	.02	-.07	.26*	.25*	-.10	-.18	.08	.08	.06	.85**				
TS	.06	.04	.16	-.09	-.03	.27*	.18	.36**	.11	-.26*	-.21	-.14	-.20	.71**	.61**			
Adm.no	.02	.02	-.14	.03	.07	-.02	.01	-.05	-.01	.19	.37**	.23*	.24*	.11	.09	-.05		
Duration	.04	.01	.16	.00	.09	-.11	.08	.01	-.01	-.02	-.05	-.03	-.04	-.03	.01	.05	.05	
Age	.01	-.31**	-.02	-.07	.05	-.19	.21	.23*	.09	.07	-.08	.09	.04	.02	-.02	-.02	.07	.20

*p<0.05, **p<0.01

Table 18 Multiple regression of self-report on attentional bias and sequential modulation

	AB.vp				AB				AB.SI				SMn				SMd			
	B	*SE B*	β	sr^2	B	SE B	β	sr2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2	*B*	*SE B*	β	sr^2
MAAS	-2.08	3.64	-.08	0.00	2.73	4.83	.07	0.00	5.68	8.32	.10	0.01	-7.73	13.27	-.09	0.00	8.90	11.40	.11	0.01
TMSd	-.96	1.18	-.13	0.01	-2.53	1.57	-.24	0.04	1.47	2.70	.09	0.00	2.13	4.31	.08	0.00	-.65	3.70	-.03	0.00
TMSc	1.12	.98	.20	0.02	2.71	1.30	.33*	0.06	-1.26	2.23	-.10	0.00	-3.52	3.56	-.18	0.01	-.09	3.05	-.01	0.00
Pleasant	-2.87	2.10	-.17	0.03	1.18	2.79	.05	0.00	-3.88	4.80	-.10	0.01	3.28	7.65	.06	0.00	-1.69	6.57	-.03	0.00
Arousal	-1.27	1.70	-.10	0.01	.25	2.26	.01	0.00	.17	3.88	.01	0.00	-.47	6.20	-.01	0.00	-.32	5.32	-.01	0.00
Craving	3.61	2.91	.22	0.02	-1.61	3.86	-.07	0.00	-7.27	6.64	-.20	0.02	-1.92	10.59	-.03	0.00	13.19	9.10	.26	0.03
CEQs	2.51	2.87	.23	0.01	9.58	3.81	.60*	0.09	4.58	6.56	.18	0.01	1.72	10.46	.04	0.00	-16.22	8.99	-.47	0.05
CEQf	-6.15	3.85	-.44	0.04	-9.81	5.11	-.50*	0.05	5.02	8.79	.16	0.00	-4.81	14.03	-.10	0.00	14.65	12.05	.34	0.02
Re	1.29	1.49	.22	0.01	-3.75	1.98	-.45	0.05	-4.15	3.41	-.31	0.02	3.30	5.44	.16	0.01	-7.13	4.67	-.40	0.03
Am	-3.73	1.93	-.43*	0.05	6.26	2.56	.51*	0.08	3.86	4.41	.19	0.01	1.90	7.04	.06	0.00	7.77	6.04	.29	0.02
TS	.68	1.05	.13	0.01	-.61	1.39	-.08	0.00	3.35	2.39	.27	0.03	-3.77	3.82	-.20	0.01	1.80	3.28	.11	0.00
Tx.No.	.46	1.49	.04	0.00	1.27	1.97	.08	0.01	-3.40	3.40	-.13	0.01	.65	5.42	.02	0.00	.32	4.66	.01	0.00
Duration	.03	.10	.04	0.00	.11	.14	.09	0.01	.31	.24	.16	0.03	.03	.38	.01	0.00	.19	.32	.07	0.01
Age	.01	.38	.00	0.00	-1.59	.51	-.37*	0.13	-.22	.87	-.03	0.00	-.77	1.39	-.07	0.00	1.17	1.20	.12	0.01
R^2	.15				.27				.16				.07				.14			
F	.84				1.76				.94				.36				.77			

**p<0.01, *p<0.05

4.4.3 Summary

This study adopted the 10 minutes mindful-breathing and body scan practice from Study 5, and extended practice duration from 4 days to 14 days, twice a day. There were three hypotheses: 1) the experimental group who practice mindful-breathing and body scan daily would have a significant increase in motivation to change whereas no change in control group; 2) state mindfulness, positive affect, and cognitive control would be increased in an experimental group, whereas the control group would not have any significant changes; and 3) the experimental group would have a reduction of methamphetamine attentional bias, negative affect and craving, whereas the control group would not have any significant changes.

The study findings showed both groups had an increase in state mindfulness and trait mindfulness (curiosity), and a decrease in craving frequency. However, there were no changes in attentional bias, cognitive control, motivation to change or craving strength.

Mindfulness increased: Increasing of state mindfulness and trait mindfulness-curiosity in both groups might be the result of the hospital treatment programme, which encourages patients to do chanting before bedtime every day, and/or the intervention might not have an affect on methamphetamine patients unlike alcohol patients. As the correlation showed that state mindfulness had a negative correlation with craving, it may be that the increase in state mindfulness at post-intervention might be because patients had a reduction of craving. This reduction might be from being in the hospital where there is a lack of drug-related stimuli to arouse their craving. Moreover, as trait mindfulness had a positive correlation with motivation to change and age, this might be from the hospital treatment programme which induces motivation to change through a therapeutic environment such as therapy groups and individual psychotherapy. However,

the findings did not show a significant change in motivation to change due to the intervention (see Figure 41).

Craving frequency decreased, the study measured craving in strength and frequency of craving. At post-intervention, both groups showed statistically significant decrease on craving frequency, but no changes on craving strength. This might be because patients had less chance to be exposed to drug-related cues due to staying in a drug-free setting, and patients were so busy with the hospital treatment program that their attention had to focus on those activities, thus, the craving frequency reduced. However, the fact that craving strength did not change might be because the score of craving strength was very low at the beginning (score between 1 to 2 from 10), therefore, it might be a floor effect.

Additionally, this might be because mindfulness increased. As the correlation showed that craving had a negative correlation with state mindfulness, also mindfulness had a negative correlation with arousal, thus state mindfulness might reduce arousal and induces an awareness of the nature of craving as impermanent, if a person has no attachment to a craving, they could be free and able to maintain their treatment goal (drug-free). This finding support Garland and Roberts-Lewis (2013) who suggest that trait mindfulness seems to be a buffer to protect individual from post-traumatic stress and craving.

Attentional bias was not found in this sample, this is consistent with Begh et al. (2015); Noël et al. (2006); Van Kampen et al. (2020) did not find attentional bias in drug abusers. In addition, regression showed attentional bias associates with trait mindfulness, craving, and motivation to change. As mindfulness practice induces curiosity, which makes a person more open to the perception of the environment including drug cues this might lead to attentional bias to drug. Craving also has a strong association with attentional bias, however, the direction of the relationship between attentional bias and craving strength was different, opposite to the relationship between attentional bias and

craving frequency. Thus, it is difficult to conclude whether craving predicts attentional bias in a positive or negative direction. However, it is consistent with a meta-analysis (Field, Munafò, et al., 2009) which concludes that attentional bias and craving are related phenomena.

Furthermore, *motivation to change* associates with attentional bias, particularly ambivalence that more ambivalence produces more attentional bias. This could be explained in the light of *stage of change model* (Prochaska, & Norcross, 2001), that since ambivalence refers to the stage between pre-contemplation and contemplation when drug abusers are considering between pros and cons, but have not yet decided whether they should stop or continue drug use. Thus, attentional bias still exists.

Cognitive control was found in this sample and was presented via the main effect of Previous congruency that RT incongruent faster than congruent trials, and the interaction of Previous congruency and Image that RT incongruent faster than congruent trials when preceded by natural cues. This indicated top-down process that methamphetamine patients were able to disengage and filter out the distractor, especially when preceded by neutral cues. However, in the context of a methamphetamine picture, top-down cognitive control did not occur. Furthermore, cognitive control had a relationship with attentional bias, but the direction was inconclusive.

Trait Mindfulness and Motivation: Trait mindfulness-curiosity had a statistically significant positive correlation with all subscales of motivation to change, this showed that more curiosity is also more motivation to change, which consists of three subscales: *problem recognition* (it will be worse if I continue drug), *ambivalence* (whether it is better if I stop drug), and *taking step* (action in stopping drug use). This is the evidence that mindfulness might affect participants' current concern that their current concern has changed from positive to negative to drug-use, which refers to a person's cognitive reappraisal. This finding inconsistent with Garland, Roberts-Lewis, Kelley, Tronnier, and

Hanley (2014) who found that motivation to change did not mediate trait mindfulness and craving, unlike negative affect and cognitive reappraisal.

State Mindfulness and Affect: The affect has not changed at the post-intervention in both groups; however, state mindfulness had a statistically significant negative correlation with arousal in which the individual would be calmer with greater state mindfulness. This finding is consistent with Brown and Ryan (2003) who found that trait and state mindfulness predict positive emotional states and self-regulated behavior, as well as Basso, McHale, Ende, Oberlin, and Suzuki (2019) who report 8 weeks of 13 minutes daily meditation decreased negative mood state in non-experienced meditators, compared to the control group, and Goyal et al. (2014) who found mindfulness-based intervention produces a significant decrease in negative affect.

Furthermore, age was associated with attentional bias, and trait mindfulness, that older participants had greater trait mindfulness-curiosity and less attentional bias. To explain these associations, it might be that older adults are more reflective in their thinking style which could increase mindfulness and decrease attentional bias. This would also be consistent with Shook, Ford, Strough, Delaney, and Barker (2017) who found that mindfulness mediated the relation between age and positive affect. However, further research is required as some research Prakash, Hussain, and Schirda (2015) does not find an effect of age on trait mindfulness, emotion regulation, and perceived stress in both older adults and young adults.

Limitation of the study: This study did not provide a control group that did not receive the treatment. A control group is needed to make sure that the treatment effect observed are due to treatment and not due to other confounding variables (such as, placebo effect, practice effect.)

Also mindfulness measurement during practicing every day which might have revealed some changes. Future research could investigate how much practice is needed before any change is observed as well as how long any benefit lasts.

Chapter 5 General discussion

5.1 Key findings of the present research

This thesis aimed to investigate attention and mindfulness training on attentional bias and cognitive control in drug addiction. The thesis consists of 6 studies, of which two studies were conducted in the UK with undergraduate students who are social drinkers, and four studies were conducted on alcohol, and methamphetamine inpatients in Thailand. The attentional bias modification training (ABM), and the mindfulness-based attention training were used in the thesis. This chapter will discuss the key findings that stem from attentional bias, followed by cognitive control in relation to the effects of ABM training and mindfulness-based training, then other factors that are related to attentional bias and cognitive control, and their limitations.

Attentional bias

a. ABM training unable to alter attentional bias in social drinkers

The thesis used the probe paradigm in ABM training to manipulate attention to look away from drug-related stimuli (study 1), the results showed the training was unable to change attentional bias, which is inconsistent with Field and Eastwood (2005) study even though we used the same stimuli and methods. Their findings showed attentional bias could be manipulated in one training session at the lab, whereas our study did not show changes on attentional bias from a single lab session, and multiple online sessions. This occurred even though our sample consisted of undergraduate students who were of a similar age, weekly unit drink, drinking severity (AUDIT), and desire for alcohol (DAQ). Moreover, our investigation found participants experienced boredom and negative emotions during the lab session, due to the large number of trials and/or the length of

the training. Thus, more research replication is needed to identify which conditions could support ABM training to alter attention.

One explanation for ABM training having no effect could be because ABM training was not strong enough to overcome the attentional bias. Attentional bias might be a stronger bottom-up process than our training effect. This may be due to strong conditioning in addicts who have suffered with addiction for a long time as well as the reinforcement from positive emotion memory, whereas ABM training has no positive reinforcement. Therefore, developing a new automatic process which is in the opposite direction to the attentional bias might need more supportive factors such as a longer training duration, the pattern of training (that does not create boredom), and induces motivation to continue the training.

b. Mindful-colouring task modulates attentional bias in social drinkers but not in methamphetamine patients

Studies 3 and 4 used a novel adapted probe-like paradigm, that asked participants to ignore a coloured picture (which is a drug-related picture for the experimental group and the neutral picture for the control group) whist mindfully colouring a blank mandala. Result showed attentional bias changes only in students (Study 3). The specific pattern of results was that training on the mindful-colouring task (alcohol or neutral) reduced attentional bias to alcohol in the visual probe task. In patients (Study 4) there was no effect of the colouring task on attentional bias. This may be due to the participants ignoring the alcohol or distractor picture or paying equal attention to the distractor picture (drug or neutral) in the colouring task. Future research might add the antisaccade task to support evidence in attentional bias and inhibition ability. The antisaccade task requires subjects to make a saccadic eye movement away from the target, rather than towards it. It is used to investigate the top-down inhibition of a reflexive, automatic saccade. In

addition, it may be possible that in patient groups a longer duration of training is required before any effects are observable.

c. Daily mindfulness practice unable to alter attentional bias

Findings from study 5 and 6 which tested the effects of daily mindfulness practice in alcohol and methamphetamine patients respectively showed that there was no intervention effect on attentional bias. The study hypothesized that daily mindfulness practice would increase mindfulness, and the increased mindfulness would result in weakened AB as Garland, Bryan, Hanley, and Howard (2020) state that mindfulness regulates craving and cue reactivity. Alcohol patients (study 5) showed the relationship between attentional bias and age, but did not show the relationship with mindfulness. Additionally, methamphetamine patients (study 6) showed attentional bias had a relationship with curiosity trait mindfulness, and age.

Although there were some demographic differences between alcohol and methamphetamine patients which might lead to different direction of mindfulness at post-intervention such as age (late 30/early 30), duration of the treatment course (30 days/120 days), number of sessions of mindful practice (4/28), number of admissions (<2/>3). However, both studies had the same result that there were no attentional bias changes, although mindfulness decreased in alcohol patients and increased in methamphetamine patients at post-intervention. This might be because mindfulness might not have a direct effect on attentional bias but there might be a mediating variable between mindfulness and attentional bias, such as age.

d. Attentional bias might not be found in patients but social drinkers.

The thesis revealed attentional bias was found in social drinkers (study 1 and 3), whereas it was not found in patients: alcohol (study 5) and methamphetamine (study 2, 4

and 6). These findings are consistent with previous studies which have reported an absence of attentional bias in patients or people who are seeking treatment (Van Kampen et al., 2020), and support the review by Cox and Field (2008) who suggest that attentional bias might be found in active drug users but not in individuals who are seeking treatment. Moreover, each study in the thesis showed association between attentional bias and various interested variables, therefore, the thesis findings support a meta-analysis (Field, Munafò, et al., 2009) which suggest that attentional bias and cravings are related phenomena, and the relationship is moderated by many factors.

Additionally, the thesis revealed attentional tasks (the Stroop task and the visual probe task) sometimes did not show congruent results. Suggesting that it may be better to use both the Stroop and probe task to measure attentional bias as may provide more viewpoints.

Cognitive control

a. Daily brief mindfulness practice unable to alter cognitive control

The thesis tested the effect of daily brief mindfulness practice on cognitive control in alcohol inpatients (study5), and methamphetamine inpatients (study 6). These studies did not show cognitive control changes at post-intervention. Moreover, correlation analysis did not show a relationship between mindfulness and cognitive control. Daily mindfulness practice aimed to increase state mindfulness which we hypothesised might strengthen cognitive control and decrease arousal from drug-related cues and thus reduce attentional bias. However, alcohol inpatients (study 5), and methamphetamine inpatients (study 6) did not show cognitive control changes at post-intervention. The findings of both studies showed cognitive control has a relationship with attentional bias. Methamphetamine patients showed cognitive control had relationships with craving and motivation to change, whereas alcohol patients showed cognitive control had

relationships with age and motivation to change. Suggesting that mindfulness practice might not have a direct effect on cognitive control but there might be a mediating variable between mindfulness and cognitive control such as craving, age, and motivation to change.

b. A single session of mindful-colouring modulates cognitive control

The thesis demonstrated cognitive control was not changed by daily mindfulness practice, however, a single session of 10 minutes mindful-colouring decreased cognitive control in student social drinkers (study 3) and increased cognitive control in female methamphetamine inpatients (study 4).

Mindful-colouring task decreases cognitive control in student social drinkers; this might be because the task either creates positive affect, which previous research has shown to reduce cognitive control, and/or depletes cognitive resources to reduce top-down control. Although this result is inconsistent with Larson, Steffen, and Primosch (2013) who used a 14 minutes audio clip focused on attending to their breathing and being mindful of the moment in students, and found that there were no changes on cognitive control from the Flanker task. However, it might be concluded that in students brief mindfulness-based activities might not be able to increase cognitive control .

Mindful-colouring task increases cognitive control in patients. The mindful-colouring task has two important features. One is to complete the task in a mindful way, and the second is to inhibit irrelevant cues (controlling attention from distractors). Our findings showed no changes in state mindfulness, affect, or motivation to change. This might be because patients had practiced focused attention every day, by daily chanting before bedtime, as a routine activity of the treatment programme, therefore one session of a very brief mindful-colouring task might not have been enough to alter patients' mindfulness, affect, and motivation to change. This therefore suggests that mindfulness is unlikely to have

produced the change in cognitive control. It also suggests that the inhibitory control feature of the colouring task may have increased cognitive control on the Stroop task. Thus, it might be concluded that ten minutes of mindful-colouring whilst ignoring a distractor picture is able to induce an increase in cognitive control and therefore may be a useful simple intervention alongside other treatment programs. It is possible that these effects are facilitated in those individuals who also practice mindfulness as this was the case for all patients in our group, although further research is required to confirm this suggestion. This finding supports new theoretical developments in dual-process models of addictive behaviours (e.g. Wiers and Stacy, 2006) that state that addictive behaviour is the result from an imbalance between automatic and controlled processing. Although it is not clear that ABM training is able to alter attentional bias or cognitive control, our findings do suggest an alternative way to strengthen inhibitory ability (in our research using a mindful-colouring task with an inhibitory element) that could be a promising way to increase cognitive control for the treatment of drug addiction.

c. Cognitive control: social drinker students vs. methamphetamine inpatients

Cognitive control in this thesis is presented in two forms: 1) sequential modulation (SM): an interaction of Previous congruency and Current congruency that current incongruent trial was speeding up when previous trial was incongruent, represented cognitive adaptation that participant improves performance by learning from conflict from the previous trial; 2) the main effect of Previous congruency, that RT on current trial is faster when the previous trial is incongruent than congruent. The main effect of Previous congruency indicates a stronger level of cognitive control than SM, as participants responded to a previous incongruent trial by responding faster to both incongruent and congruent stimuli on the current trial.

All studies in this thesis showed cognitive control in the whole sample. For students, both SM and the main effect of Previous congruency were found, whereas for patients, only the main effect of Previous was found. This showed that patients had a stronger cognitive control than students as the main effect of Previous congruency represents cognitive adaptation on both current incongruent and current congruent trials. This might be because patients who are receiving the treatment have more motivation to change than students who are active social drinkers, and/or patients have more mindfulness due to daily chanting in the regular treatment programme. This view is supported by Hodgins and Adair (2010) who found that regular mindfulness meditators have stronger attention capacity than naïve individuals, as well as Jha, A., Krompinger, J., Baime (2007) who report that alerting and attentional orienting and cognitive control is enhanced by intensive mindfulness practice.

In conclusion, cognitive control as a conflict adaptation would be found in the individuals, however, in drug addiction, individuals who have more motivation to change or have more experience with mindfulness practice might show stronger cognitive control. Moreover, cognitive control could be manipulated by mindfulness practice, with affect as a mediator.

d. No generalization of the effect of mindful-colouring task from lab experiments to the clinical setting.

The effect of mindful-colouring task on cognitive control was investigated with students in the lab (study 3), and the methods replicated with patients in the clinical setting (study 4). The intervention effect was different for students and patients; students showed a decrease in cognitive control after mindful-colouring, whereas patients showed an increase in cognitive control. Therefore, this highlights the difficulty in generalizing the effects of the mindful-colouring task on cognitive control from student social drinkers to

methamphetamine patients. Our research suggests that affect may be an important meditating variable.

Other factors: Craving, Affect, Mindfulness, and Motivation

a. Craving

Craving was not changed from a lab session of ABM, also a multiple session of online ABM among student social drinkers (study 1). However, a single session of 10 minutes mindful-colouring task reduced craving in student social drinkers (study 3) and female methamphetamine inpatients (study 4). This might be because 1) mindfulness-based intervention increases state mindfulness resulting in reduced negative affect, supported by the correlation analysis that being more mindful was related to reduced craving, and having more negative affect would increase craving, and/or 2) during a mindful-colouring task, participants paid most of their attention on the task. The focus on the colouring task may have distracted participants from paying attention to craving. Moreover, study 6 showed craving frequency was reduced in the methamphetamine inpatients. This might be an effect from staying in a drug-free place without drug-related cues, which might reduce craving, also treatment, as usual, encourages all patients to do chanting before bedtime every day, which might induce mindfulness, resulting in a reduction of arousal which can also reduce craving. In addition, the treatment programme is based on the Therapeutic community that every resident is responsible for various groups which keeps everyone busy all day. This may take up additional cognitive resources that may reduce the time to think about drugs.

In conclusion, craving could be reduced by mindfulness-based intervention, opposed to attentional bias modification training. The mindfulness-based intervention induces mindfulness which may reduce arousal and negative affect, resulting in decreasing

craving. Also, being in drug-free environment may help to turn attention to other thoughts which are not drug-related and therefore might also reduce craving.

b. Affect

Affect was investigated in one study among students (study 3) and two studies among methamphetamine inpatients (study 4 and 6). Students showed affect has changed as expected, that mindfulness-based intervention induces positive affect and pleasantness, and reduces negative affect and arousal. In addition, the attention tasks reduced positive affect. However, these effects did not show among our patient studies. Additionally, all these three studies showed affect had a significant correlation with mindfulness, and craving. Suggesting that affect change is easier for students than patients, and it might be because of patients in this setting had mindfulness practice involving regular daily chanting before bedtime. Therefore, during the treatment, patients might develop state mindfulness that functions as a buffer to protect emotion change easily. Moreover, female patients (study 4) showed a very strong association between affect and attentional bias, whereas, these association did not show in male patients (study 6). Suggesting that, in female patients affect may be an important factor that manipulates attentional bias.

c. Mindfulness

The thesis investigated the effects of a mindfulness-based intervention on attentional bias and cognitive control in four studies: two were a single session of mindful-colouring (study 3 and 4), and the other two were daily mindfulness practice (study 5 and 6). The findings of mindfulness changes are:

1) A single session of mindful-colouring increased state mindfulness in students (study3), whereas, there were no changes in state and trait mindfulness in patients (study 4). It might be because the effect of a single session of mindful-colouring might not be

strong enough for patients who already had daily chanting or experienced mindfulness meditation (as chanting and meditation is a part of the Thai culture), and/or due to the intervention did not change affect in patients unlike in students, as affect had a correlation with mindfulness.

2) The daily brief mindfulness practice: the alcohol patients (study 5) showed mindfulness decreased for all groups after 4 days of mindfulness practice, whereas the methamphetamine patients (study 6) showed that mindfulness increased for all groups after 14 days of mindfulness practice. These changes are the effect of treatment as usual, not the effect of the research intervention. The correlation analyses in alcohol patient study revealed state mindfulness had a significant negative correlation with problem recognition (subscale in motivation to change). However, in the methamphetamine patient study, state mindfulness had a significant negative correlation with craving and arousal, and trait mindfulness had a significant positive correlation with motivation to change.

The differences between alcohol patients and methamphetamine patients might be explained in relation to *addiction severity*, *the dosage of the routine mindfulness activity*, and *affect* before discharge. Assuming that readmission numbers might represent addiction severity, therefore alcohol patients had higher addiction severity (readmission mean = 4.43±5.78) than methamphetamine patients (1.76± .81). Additionally, all patients were encouraged to do chanting or praying (depends on their religion) every day before bedtime, and the treatment programme for alcohol patients (30 days) was shorter than methamphetamine patients (120 days). Therefore, alcohol patients had more addiction severity and less dosage of the routine mindfulness activity than methamphetamine patients. Furthermore, their affect may be related to time left on the treatment programme before discharge, for alcohol patients they attended the study during the last week before discharge from the hospital. At this stage, it is possible that patients might show more negative affect and

arousal due to thoughts related to their personal problems such as returning to their career, relationship with significant persons, and financial problems. However, there was no affect measure in study 5 to support this explanation so further research is required to investigate how affect may be affected by these other variables.

In conclusion, it is not clear whether a brief mindfulness-based intervention is able to alter mindfulness in alcohol and methamphetamine Thai patients. The studies did not find mindfulness changes from the research intervention but the treatment as usual, this might be because the intervention dosage was not enough for participants who had previous experience with mindfulness practice. Moreover, affect, age, and motivation to change, might mediate mindfulness changes in patients.

d. Motivation to change

There are three studies that measure motivation to change (study 2, 5, and 6). Two of those studies were conducted in methamphetamine patients (study 2 and 6), both studies showed similar scores of motivation to change. Other two studies that had mindfulness intervention conducted in alcohol patients (study 5) and methamphetamine patients (study 6). Study 5 showed alcohol patients who attended mindful-breathing and body scan showed an increase in motivation to change, whereas the mindful-movement group and the waiting list group did not show these changes. Study 6 replicated study 5 by adopted the mindful-breathing and body scan to methamphetamine patients, but the results were unlike study 5. There were no changes of motivation to change in methamphetamine patients.

There are several differences between the two groups that might explain these findings. As noted earlier alcohol patients have a greater number of readmissions (4.43±5.78) than methamphetamine patients (1.76± .81), which might indicate alcohol patient have a higher motivation to stop their addiction than methamphetamine patient.

Additionally, the mindful-breathing and body scan practice starts from focusing attention to their breathing then expanding attention to all over their body, then the audio scripts asked the participant to identify if any part of the body that they have a concern with or feel unwell. This might have increased their current concern related to drinking consequences and their desire to stop drinking.

Moreover, alcohol patients' average *age* 40.51 (±8.48) years old and, whereas methamphetamine patients' average age is younger 31.60 (±8.36) years old. In this point, might explained in relation to *"Hitting rock bottom",* a phrase from the 12 steps-based treatment. Alcohol patients who are in the late adult and had several readmissions might have thought that they are hitting rock bottom, which referred to a person who is in the worst scenario (the lowest possible point in their lives). At this stage, addicts are faced with the consequences from addiction. This raises their motivation to stop their addiction cycle, which motivates them to stop drinking.

The correlation analyses in alcohol patients showed motivation to change had a negative correlation with state mindfulness, age, and attentional bias (AB.SI), whereas in methamphetamine patients, motivation to change had a positive correlation with state and trait mindfulness, and age; and a negative correlation with arousal. This showed the opposite direction of the relationship between motivation and mindfulness of alcohol and methamphetamine patients. Thus, this might be another reason for different results from mindful-breathing between alcohol and methamphetamine patients.

In conclusion, the 4 sessions of mindful-breathing and body scan practice could promote motivation to change for alcohol patients in a clinical setting. Additionally, mindfulness and age associates with motivation to change in both alcohol and methamphetamine patients. However, there was no generalization of the effects of mindful-breathing and body scan practice from alcohol patients to methamphetamine patients.

Limitation and suggestions

Although the thesis had both experimental study in the lab and in the clinical setting, however, the effects found are complex and suggest a number of limitations:

(1) Difficult to generalize findings from student social drinkers in the UK to those patients in Thailand. There are some differences between these samples such as age, education, culture background, addiction severity, and motivation to change that require further controlled investigation. However, our research provided some benefits. In particular, participants' negative reactions in study 1 led the researcher to modify attentional bias modification training to one using a mindfulness-based approach to reduce boredom and negative affect.

(2) Using the same task but still not getting the same effect in the same sample, this is difficult to reconcile. It might be because there are other factors which were not measured but may have impacted on attentional bias and cognitive control.

(3) Park, T., Reilly-Spong, M., and Gross (2013) suggested that current mindfulness scales have important conceptual differences, and none can be strongly recommended based solely on superior psychometric properties. Thus, further study in non-Western and non-English speaking should use mindfulness scale which are developed for specific populations. This thesis used the original version which was developed for Western population, thus, it might have an error that is related to language differences, although the Thai translated version was validated by experts who are a psychiatrist and clinical psychologists. However, more research needs to be done across cultures and across tasks.

5.2 General conclusions

The thesis investigated the effects of attention and mindfulness training on attentional bias and cognitive control in drug addiction. Overall, the thesis has highlighted a number of key findings:

i) The attentional bias modification (ABM) training was unable to change attentional bias in a group of student social drinkers either by training in a lab session or by multiple online sessions. This particular form of attention training using a visual probe task may be potentially unsuitable in practice as participants have to complete the task over a long duration and without positive reinforcement.

ii) Mindfulness-based intervention (MBI) has a tendency to alter cognitive control but not attentional bias. MBI also showed clear evidence in altering state mindfulness, affect, craving, and motivation to change. However, more research is needed to reveal the specific dose, activity in a specific population.

iii) Attentional bias might not be found in patients but is found in non-patients. This may be related to the environmental setting that patients and non-patients find themselves in. Addiction treatment programmes often use a drug-free environment that may reduce cueing from drug related stimuli as well as reduce arousal and craving.

iv) Not able to generalize the attentional bias findings from the visual probe to the Stroop tasks. Multiple measurements of drug attentional bias should be used for stronger evidence. Several measures of attentional bias were recorded. Two from the face-word Stroop task (AB and AB.SI), and one from the visual probe task (AB). The differing pattern of results from each of these measures suggests further work is required to understand the underlying mechanisms for attentional bias.

iv) Our research indicates differences in cognitive control that is related to patient/non-patient status and positive affect. Patients seem to have stronger cognitive control than students, which might be because patients have greater motivation to change

than students. Cognitive control was also changed by a single session of mindful-colouring task but not the daily mindfulness practice. It was thought that this may be because the mindful-colouring practice produces an immediate effect on inducing positive affect which declines over time. Moreover, the inhibitory control feature of the colouring task may have increased cognitive control on the Stroop task, and therefore the 10 minutes mindful-colouring with ignoring picture may be a useful simple intervention alongside other treatment programs, especially in patients who have daily mindfulness practice.

v. This thesis highlighted two important avenues for further development. First, our novel mindful-colouring task has the potential to increase inhibitory control. Second, a mindful-breathing and body scan intervention could increase the focus on current concerns related to addictive behaviour. Both aspects suggest that they may be successfully used in conjunction with other treatment programs.

5.3 Theory Implication

As the dual-process model state that the automatic processing can be moderated or inhibited by emotion regulation if sufficient motivation and cognitive resources are available to do so, however, Study 1 which fail in altering AB through ABM and it might because of the probe detection task increases negative affect such as tiring and boredom from hundreds of trials in the training. This showed that when emotion regulation is disturbed, its effectiveness is weakened. Thus, this seems to support the dual-process model that emotion regulation could alter the automatic processing.

Additionally, the thesis (Study 3, 4, 5, and 6) integrates mindfulness training, which aimed to induce positive affect and enhance executive function through attentional awareness and expected to increase cognitive control and reduce AB. The findings demonstrated that AB has a relationship with cognitive control, however, it was unclear

in the direction of the relationship and whether there is a mediator between them. Thus, this seems to support the dual-process model that cognitive control which is part of the reflective processes has a relationship with AB which is impulsive processes in addictive behaviour.

5.4 Future research

The thesis has two studies conducted among social drinker students in the UK, and four studies conducted among alcohol or drug inpatients in Thailand. Experimental tools were invented in the UK and tryout in students in the UK then replicated in patients in Thailand. Limitations, such as experiment duration (which affects training duration) and a number of participants (which effects to control group), are concerned. As well as, lack of evidence to support whether AB changed because of ignoring the alcohol or distractor picture or paying equal attention to the distractor picture (drug or neutral) in the colouring task (Study 3 and 4) which the antisaccade task could provide the evidence. Thus, future research may manage this limitation. However, the strength of this thesis is using a visual probe task along with the Stroop task to demonstrated attentional bias in vary perspective. Thus, this methodology might apply to future research.

Reference

American Society of Addiction Medicine. (2019). Retrieved from https://www.asam.org/quality-practice/definition-of-addiction

Albery, I. P., Sharma, D., Niazi, A., & Moss, A. C. (2005). Theoretical perspectives and approaches. In M. Munafò & I. P. Albery (Eds.), *Cognition and Addiction* (pp.12-14). Oxford: Oxford University Press.

Alcorn, J. L., Marks, K. R., Stoops, W. W., Rush, C. R., & Lile, J. A. (2019). Attentional bias to cannabis cues in cannabis users but not cocaine users. *Addictive Behaviors*, *88*(July 2018), 129–136. https://doi.org/10.1016/j.addbeh.2018.08.023

Alcorn, J. L., Strickland, J. C., Lile, J. A., Stoops, W. W., & Rush, C. R. (2020). Acute methylphenidate administration reduces cocaine-cue attentional bias. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *103*(December 2019), 109974. https://doi.org/10.1016/j.pnpbp.2020.109974

Anderson, N. D., Lau, M. A., Segal, Z. V., & Bishop, S. R. (2007). Mindfulness-based stress reduction and attentional control. *Clinical Psychology and Psychotherapy*, *14*(6), 449–463. https://doi.org/10.1002/cpp.544

Ataya, A. F., Adams, S., Mullings, E., Cooper, R. M., Attwood, A. S., & Munafò, M. R. (2012). Internal reliability of measures of substance-related cognitive bias. *Drug and Alcohol Dependence*, *121*(1–2), 148–151. https://doi.org/10.1016/j.drugalcdep.2011.08.023

Attwood, A. S., O'Sullivan, H., Leonards, U., Mackintosh, B., & Munafò, M. R. (2008). Attentional bias training and cue reactivity in cigarette smokers. *Addiction*, *103*(11), 1875–1882. https://doi.org/10.1111/j.1360-0443.2008.02335.x

Babouchkina, A., & Robbins, S. J. (2015). Reducing negative mood through mandala creation: A randomized controlled trial. *Art Therapy*, *32*(1), 34–39. https://doi.org/10.1080/07421656.2015.994428

Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological Review*, *111*(1), 33–51. https://doi.org/10.1037/0033-295X.111.1.33

Basso, J. C., McHale, A., Ende, V., Oberlin, D. J., & Suzuki, W. A. (2019). Brief, daily meditation enhances attention, memory, mood, and emotional regulation in non-experienced meditators. In *Behavioural Brain Research* (Vol. 356, pp. 208–220). https://doi.org/10.1016/j.bbr.2018.08.023

Bauer, D., & Cox, W. M. (1998). Alcohol-related words are distracting to both alcohol abusers and non-abusers in the Stroop colour-naming task. *Addiction*, *93*(10), 1539. https://doi.org/10.1046/j.1360-0443.1998.9310153910.x

Begh, R., Munafò, M. R., Shiffman, S., Ferguson, S. G., Nichols, L., Mohammed, M. A., Holder, R. L., Sutton, S., & Aveyard, P. (2015). Lack of attentional retraining effects in cigarette smokers attempting cessation: A proof of concept double-blind randomised controlled trial. *Drug and Alcohol Dependence*, *149*, 158–165. https://doi.org/10.1016/j.drugalcdep.2015.01.041

Bindra, D. (1974). A motivational view of learning perfomance, and behavior modification. *Psychological Review*, *81*(3), 199–213. https://doi.org/10.1037/h0036330

Botvinick, M. M., Carter, C. S., Braver, T. S., Barch, D. M., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review*, *108*(3), 624–652. https://doi.org/10.1037/0033-295X.108.3.624

Bowen, S., Witkiewitz, K., Dillworth, T. M., Chawla, N., Simpson, T. L., Ostafin, B. D., Larimer, M. E., Blume, A. W., Parks, G. A., & Marlatt, G. A. (2006). Mindfulness meditation and substance use in an incarcerated population. *Psychology of Addictive Behaviors*, *20*(3), 343–347. https://doi.org/10.1037/0893-164X.20.3.343

Brewer, J. A., Ruf, A., Beccia, A. L., Essien, G. I., Finn, L. M., van Lutterveld, R., & Mason, A. E. (2018). Can mindfulness address maladaptive eating behaviors? Why traditional diet plans fail and how new mechanistic insights may lead to novel interventions. *Frontiers in Psychology*, *9*(SEP), 1–11. https://doi.org/10.3389/fpsyg.2018.01418

Brown, K. W., & Ryan, R. M. (2003). The Benefits of Being Present: Mindfulness and Its Role in Psychological Well-Being. *Journal of Personality and Social Psychology*, *84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Browning, M., Holmes, E. A., Murphy, S. E., Goodwin, G. M., & Harmer, C. J. (2010). Lateral Prefrontal Cortex Mediates the Cognitive Modification of Attentional Bias. *Biological Psychiatry*, *67*(10), 919–925. https://doi.org/10.1016/j.biopsych.2009.10.031

Carsley, D., Heath, N. L., & Fajnerova, S. (2015). Effectiveness of a Classroom Mindfulness Coloring Activity for Test Anxiety in Children. *Journal of Applied School Psychology*, *31*(3), 239–255. https://doi.org/10.1080/15377903.2015.1056925

Chambers, R., Lo, B. C. Y., & Allen, N. B. (2008). The impact of intensive mindfulness training on attentional control, cognitive style, and affect. *Cognitive Therapy and Research*, *32*(3), 303–322. https://doi.org/10.1007/s10608-007-9119-0

Chiesa, A., Calati, R., & Serretti, A. (2011). Does mindfulness training improve cognitive abilities? A systematic review of neuropsychological findings. *Clinical Psychology Review*, *31*(3), 449–464. https://doi.org/10.1016/j.cpr.2010.11.003

Christiansen, P., Schoenmakers, T. M., & Field, M. (2015). Less than meets the eye: Reappraising the clinical relevance of attentional bias in addiction. *Addictive Behaviors*, *44*, 43–50. https://doi.org/10.1016/j.addbeh.2014.10.005

Clarke, P. J. F., Browning, M., Hammond, G., Notebaert, L., & MacLeod, C. (2014). The causal role of the dorsolateral prefrontal cortex in the modification of

attentional bias: Evidence from transcranial direct current stimulation. *Biological Psychiatry*, *76*(12), 946–952. https://doi.org/10.1016/j.biopsych.2014.03.003

Colzato, L. S., van der Wel, P., Sellaro, R., & Hommel, B. (2016). A single bout of meditation biases cognitive control but not attentional focusing: Evidence from the global-local task. *Consciousness and Cognition*, *39*, 1–7. https://doi.org/10.1016/j.concog.2015.11.003

Cousijn, J., Watson, P., Koenders, L., Vingerhoets, W. A. M., Goudriaan, A. E., & Wiers, R. W. (2013). Cannabis dependence, cognitive control and attentional bias for cannabis words. *Addictive Behaviors*, *38*(12), 2825–2832. https://doi.org/10.1016/j.addbeh.2013.08.011

Cox, W. M., Hogan, L. M., Kristian, M. R., & Race, J. H. (2002). Alcohol attentional bias as a predictor of alcohol abusers' treatment outcome. *Drug and Alcohol Dependence*, *68*(3), 237–243. https://doi.org/10.1016/j.drugalcdep.2005.07.002

Cox, W. M., Fadardi, J. S., Intriligator, J. M., & Klinger, E. (2014). Attentional bias modification for addictive behaviors: Clinical implications. *CNS Spectrums*, *19*(3), 215–224. https://doi.org/10.1017/S1092852914000091

Cox, W. M., Fadardi, J. S., & Pothos, E. M. (2006). The addiction-stroop test: Theoretical considerations and procedural recommendations. *Psychological Bulletin*, *132*(3), 443–476. https://doi.org/10.1037/0033-2909.132.3.443

Cox, W. M., Hogan, L. M., Kristian, M. R., & Race, J. H. (2002). Alcohol attentional bias as a predictor of alcohol abusers' treatment outcome. *Drug and Alcohol Dependence*, *68*(3), 237–243. https://doi.org/10.1016/S0376-8716(02)00219-3

Cox, W. M., & Klinger, E. (1988). A Motivational Model of Alcohol Use. *Journal of Abnormal Psychology*, *97*(2), 168–180. https://doi.org/10.1037/0021-843X.97.2.168

Cox, W. M., Klinger, E., & Fadardi, J. S. (2015). The motivational basis of cognitive determinants of addictive behaviors. *Addictive Behaviors*, *44*, 16–22.

https://doi.org/10.1016/j.addbeh.2014.11.019

Cox, W. M., Yeates, G. N., & Regan, C. M. (1999). Effects of alcohol cues on cognitive processing in heavy and light drinkers. *Drug and Alcohol Dependence*, *55*(1–2), 85–89. https://doi.org/10.1016/S0376-8716(98)00186-0

Dean, A. C., Nurmi, E. L., Moeller, S. J., Amir, N., Rozenman, M., Ghahremani, D. G., Johnson, M., Berberyan, R., Hellemann, G., Zhang, Z., & London, E. D. (2019). No effect of attentional bias modification training in methamphetamine users receiving residential treatment. *Psychopharmacology*, *236*(2), 709–721. https://doi.org/10.1007/s00213-018-5100-8

DeVito, E. E., Kiluk, B. D., Nich, C., Mouratidis, M., & Carroll, K. M. (2018). Drug Stroop: Mechanisms of response to computerized cognitive behavioral therapy for cocaine dependence in a randomized clinical trial. *Drug and Alcohol Dependence*, *183*(May 2017), 162–168. https://doi.org/10.1016/j.drugalcdep.2017.10.022

Eberl, C., Wiers, R. W., Pawelczack, S., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2013). Approach bias modification in alcohol dependence: Do clinical effects replicate and for whom does it work best? *Developmental Cognitive Neuroscience*, *4*, 38–51. https://doi.org/10.1016/j.dcn.2012.11.002

Eberl, C., Wiers, R. W., Pawelczack, S., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2014). Implementation of Approach Bias Re-Training in Alcoholism-How Many Sessions are Needed? *Alcoholism: Clinical and Experimental Research*, *38*(2), 587–594. https://doi.org/10.1111/acer.12281

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, *16*(1), 143–149. https://doi.org/10.3989/arbor.2000.i650.965

Everaert, J., Mogoaşe, C., David, D., & Koster, E. H. W. (2014). Attention bias modification via single-session dot-probe training: Failures to replicate. *Journal of*

Behavior Therapy and Experimental Psychiatry, *49*(Pt A), 1–8. https://doi.org/10.1016/j.jbtep.2014.10.011

Fadardi, J. S., & Cox, W. M. (2009). Reversing the sequence: Reducing alcohol consumption by overcoming alcohol attentional bias. *Drug and Alcohol Dependence*, *101*(3), 137–145. https://doi.org/10.1016/j.drugalcdep.2008.11.015

Farb, N. A. S., Segal, Z. V., & Anderson, A. K. (2013). Mindfulness meditation training alters cortical representations of interoceptive attention. *Social Cognitive and Affective Neuroscience*, *8*(1), 15–26. https://doi.org/10.1093/scan/nss066

Field, M., Duka, T., Eastwood, B., Child, R., Santarcangelo, M., & Gayton, M. (2007). Experimental manipulation of attentional biases in heavy drinkers: Do the effects generalise? *Psychopharmacology*, *192*(4), 593–608. https://doi.org/10.1007/s00213-007-0760-9

Field, M., Duka, T., Tyler, E., & Schoenmakers, T. (2009). Attentional bias modification in tobacco smokers. *Nicotine and Tobacco Research*, *11*(7), 812–822. https://doi.org/10.1093/ntr/ntp067

Field, M., & Eastwood, B. (2005). Experimental manipulation of attentional bias increases the motivation to drink alcohol. *Psychopharmacology*, *183*(3), 350–357. https://doi.org/10.1007/s00213-005-0202-5

Field, M., Kiernan, A., Eastwood, B., & Child, R. (2008). Rapid approach responses to alcohol cues in heavy drinkers. *Journal of Behavior Therapy and Experimental Psychiatry*, *39*(3), 209–218. https://doi.org/10.1016/j.jbtep.2007.06.001

Field, M., Mogg, K., & Bradley, B. P. (2004). Cognitive bias and drug craving in recreational cannabis users. *Drug and Alcohol Dependence*, *74*(1), 105–111. https://doi.org/10.1016/j.drugalcdep.2003.12.005

Field, M., Mogg, K., & Bradley, B. P. (2005). Craving and cognitive biases for alcohol cues in social drinkers. *Alcohol and Alcoholism*, *40*(6), 504–510.

https://doi.org/10.1093/alcalc/agh213

Field, M., Mogg, K., Mann, B., Bennett, G. A., & Bradley, B. P. (2013). Attentional biases in abstinent alcoholics and their association with craving. *Psychology of Addictive Behaviors*, *27*(1), 71–80. https://doi.org/10.1037/a0029626

Field, M., Mogg, K., Zetteler, J., & Bradley, B. P. (2004). Attentional biases for alcohol cues in heavy and light social drinkers: The roles of initial orienting and maintained attention. *Psychopharmacology*, *176*(1), 88–93. https://doi.org/10.1007/s00213-004-1855-1

Field, M., Munafò, M. R., & Franken, I. H. A. (2009). A Meta-Analytic Investigation of the Relationship Between Attentional Bias and Subjective Craving in Substance Abuse. *Psychological Bulletin*, *135*(4), 589–607. https://doi.org/10.1037/a0015843

Field, M., Werthmann, J., Franken, I., Hofmann, W., Hogarth, L., & Roefs, A. (2016). The role of attentional bias in obesity and addiction. *Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association*, *35*(8), 767–780. https://doi.org/10.1037/hea0000405

Flett, J. A. M., Lie, C., Riordan, B. C., Thompson, L. M., Conner, T. S., & Hayne, H. (2017). Sharpen Your Pencils: Preliminary Evidence that Adult Coloring Reduces Depressive Symptoms and Anxiety. *Creativity Research Journal*, *29*(4), 409–416. https://doi.org/10.1080/10400419.2017.1376505

Fox, K. C. R., Nijeboer, S., Dixon, M. L., Floman, J. L., Ellamil, M., Rumak, S. P., Sedlmeier, P., & Christoff, K. (2014). Is meditation associated with altered brain structure? A systematic review and meta-analysis of morphometric neuroimaging in meditation practitioners. *Neuroscience and Biobehavioral Reviews*, *43*, 48–73. https://doi.org/10.1016/j.neubiorev.2014.03.016

Friese, M., Hofmann, W., & Wiers, R. W. (2011). On taming horses and strengthening riders: Recent developments in research on interventions to improve self-control

in health behaviors. *Self and Identity*, *10*(3), 336–351. https://doi.org/10.1080/15298868.2010.536417

Garland, E. L., Atchley, R. M., Hanley, A. W., Zubieta, J. K., & Froeliger, B. (2019). Mindfulness-Oriented Recovery Enhancement remediates hedonic dysregulation in opioid users: Neural and affective evidence of target engagement. *Science Advances*, *5*(10), 1–13. https://doi.org/10.1126/sciadv.aax1569

Garland, E. L., Bryan, M. A., Hanley, A. W., & Howard, M. O. (2020). Neurocognitive mechanisms of mindfulness-based interventions for addiction. In *Cognition and Addiction*. Elsevier Inc. https://doi.org/10.1016/b978-0-12-815298-0.00021-6

Garland, E. L., Froeliger, B., & Howard, M. O. (2014). Mindfulness training targets neurocognitive mechanisms of addiction at the attention-appraisal-emotion interface. *Frontiers in Psychiatry*, *4*(JAN), 1–16. https://doi.org/10.3389/fpsyt.2013.00173

Garland, E. L., Gaylord, S. A., Boettiger, C. A., & Howard, M. O. (2010). Mindfulness training modifies cognitive, affective, and physiological mechanisms implicated in alcohol dependence: Results of a randomized controlled pilot trial. *Journal of Psychoactive Drugs*, *42*(2), 177–192. https://doi.org/10.1080/02791072.2010.10400690

Garland, E. L., Manusov, E. G., Froeliger, B., Kelly, A., Williams, J. M., & Howard, M. O. (2014). Mindfulness-oriented recovery enhancement for chronic pain and prescription opioid misuse: Results from an early-stage randomized controlled trial. *Journal of Consulting and Clinical Psychology*, *82*(3), 448–459. https://doi.org/10.1037/a0035798

Garland, E. L., & Roberts-Lewis, A. (2013). Differential roles of thought suppression and dispositional mindfulness in posttraumatic stress symptoms and craving. *Addictive Behaviors*, *38*(2), 1555–1562.

https://doi.org/10.1016/j.addbeh.2012.02.004

Garland, E. L., Roberts-Lewis, A., Kelley, K., Tronnier, C., & Hanley, A. (2014). Cognitive and affective mechanisms linking trait mindfulness to craving among individuals in addiction recovery. *Substance Use and Misuse*, *49*(5), 525–535. https://doi.org/10.3109/10826084.2014.850309

Garland, E. L., Roberts-Lewis, A., Tronnier, C. D., Graves, R., & Kelley, K. (2016). Mindfulness-Oriented Recovery Enhancement versus CBT for co-occurring substance dependence, traumatic stress, and psychiatric disorders: Proximal outcomes from a pragmatic randomized trial. *Behaviour Research and Therapy*, *77*, 7–16. https://doi.org/10.1016/j.brat.2015.11.012

Gladwin, T. E. (2019). Spatial anticipatory attentional bias for alcohol: A preliminary report on reliability and associations with risky drinking. *Alcoholism and Drug Addiction*, *32*(1), 63–70. https://doi.org/10.5114/ain.2019.85769

Glautier, S. (2004). Measures and models of nicotine dependence: Positive reinforcement. *Addiction*, *99*(SUPPL. 1), 30–50. https://doi.org/10.1111/j.1360-0443.2004.00736.x

Hasin, D. S., O'Brien, C. P., Auriacombe, M., Borges, G., Bucholz, K., Budney, A., … Grant, B. F. (2013). DSM-5 criteria for substance use disorders: recommendations and rationale. *The American Journal of Psychiatry*, *170*(8), 834–851. https://doi.org/10.1176/appi.ajp.2013.12060782

Heather, N., Best, D., Kawalek, A., Field, M., Lewis, M., Rotgers, F., Wiers, R. W., & Heim, D. (2018). Challenging the brain disease model of addiction: European launch of the addiction theory network. *Addiction Research and Theory*, *26*(4), 249–255. https://doi.org/10.1080/16066359.2017.1399659

Heeren, A., Van Broeck, N., & Philippot, P. (2009). The effects of mindfulness on executive processes and autobiographical memory specificity. *Behaviour Research and*

Therapy, *47*(5), 403–409. https://doi.org/10.1016/j.brat.2009.01.017

Heitmann, J., Bennik, E. C., Van Hemel-Ruiter, M. E., & De Jong, P. J. (2018). The effectiveness of attentional bias modification for substance use disorder symptoms in adults: A systematic review. *Systematic Reviews*, *7*(1), 1–21. https://doi.org/10.1186/s13643-018-0822-6

Heitmann, J., van Hemel-Ruiter, M. E., Vermeulen, K. M., Ostafin, B. D., MacLeod, C., Wiers, R. W., DeFuentes-Merillas, L., Fledderus, M., Markus, W., & de Jong, P. J. (2017). Internet-based attentional bias modification training as add-on to regular treatment in alcohol and cannabis dependent outpatients: A study protocol of a randomized control trial. *BMC Psychiatry*, *17*(1), 1–13. https://doi.org/10.1186/s12888-017-1359-2

Hodgins, H. S., & Adair, K. C. (2010). Attentional processes and meditation. *Consciousness and Cognition*, *19*(4), 872–878. https://doi.org/10.1016/j.concog.2010.04.002

Houben, K., Nederkoorn, C., Wiers, R. W., & Jansen, A. (2011). Resisting temptation: Decreasing alcohol-related affect and drinking behavior by training response inhibition. *Drug and Alcohol Dependence*, *116*(1–3), 132–136. https://doi.org/10.1016/j.drugalcdep.2010.12.011

Jha, A., Krompinger, J., B. (2007). Mindfulness training modifies. *Cognitive, Affective, & Behavioral Neuroscience*, *7*(2), 109–119.

Jha, A. P., Stanley, E. A., Kiyonaga, A., Wong, L., & Gelfand, L. (2010). Examining the Protective Effects of Mindfulness Training on Working Memory Capacity and Affective Experience. *Emotion*, *10*(1), 54–64. https://doi.org/10.1037/a0018438

Jones, A., Christiansen, P., & Field, M. (2018). Failed Attempts to Improve the Reliability of the Alcohol Visual Probe Task Following Empirical Recommendations. *Psychology of Addictive Behaviors*, *32*(8), 922–932.

https://doi.org/10.1037/adb0000414

Jones, B. T., Jones, B. C., Smith, H., & Copley, N. (2003). A flicker paradigm for inducing change blindness reveals alcohol and cannabis information processing biases in social users. *Addiction*, *98*(2), 235–244. https://doi.org/10.1046/j.1360-0443.2003.00270.x

Kang, Y., Gruber, J., & Gray, J. R. (2013). Mindfulness and de-automatization. *Emotion Review*, *5*(2), 192–201. https://doi.org/10.1177/1754073912451629

Kerst, W. F., & Waters, A. J. (2014). Attentional retraining administered in the field reduces smokers' attentional bias and craving. *Health Psychology*, *33*(10), 1232–1240. https://doi.org/10.1037/a0035708

Kiken, L. G., Garland, E. L., Bluth, K., Palsson, O. S., & Gaylord, S. A. (2015). From a state to a trait: Trajectories of state mindfulness in meditation during intervention predict changes in trait mindfulness. *Personality and Individual Differences*, *81*, 41–46. https://doi.org/10.1016/j.paid.2014.12.044

Kisacik, E., & Çakir, Z. (2020). The development study of smoking stroop test on a turkish sample. *Noropsikiyatri Arsivi*, *57*(3), 234–240. https://doi.org/10.29399/npa.23509

Koob, G. F. (1996). Drug addiction: The Yin and Yang of hedonic homeostasis. *Neuron*, *16*(5), 893–896. https://doi.org/10.1016/S0896-6273(00)80109-9

Larson, M. J., Steffen, P. R., & Primosch, M. (2013). The impact of a brief mindfulness meditation intervention on cognitive control and error-related performance monitoring. *Frontiers in Human Neuroscience*, *7*(JUN), 1–12. https://doi.org/10.3389/fnhum.2013.00308

Lewis, M. (2017). Addiction and the Brain: Development, Not Disease. *Neuroethics*, *10*(1), 7–18. https://doi.org/10.1007/s12152-016-9293-4

Liang, Q., Yuan, T., Cao, X., He, H., Yang, J., & Yuan, J. (2019). Assessing the severity

of methamphetamine use disorder beyond the subjective craving report: The role of an attention bias test. *General Psychiatry*, *32*(2). https://doi.org/10.1136/gpsych-2018-100019

Lippelt, D. P., Hommel, B., & Colzato, L. S. (2014). Focused attention, open monitoring and loving kindness meditation: Effects on attention, conflict monitoring, and creativity - A review. *Frontiers in Psychology*, *5*(SEP), 1–5. https://doi.org/10.3389/fpsyg.2014.01083

Lopes, F. M., Pires, A. V., & Bizarro, L. (2014). Attentional bias modification in smokers trying to quit: A longitudinal study about the effects of number of sessions. *Journal of Substance Abuse Treatment*, *47*(1), 50–57. https://doi.org/10.1016/j.jsat.2014.03.002

Love, A., James, D., & Willner, P. (1998). *A comparison of two alcohol craving questionnaires*. *93*(June), 1091–1102.

Luberto, C. M., & Mcleish, A. C. (2018). Addictive Behaviors The e ff ects of a brief mindfulness exercise on state mindfulness and a ff ective outcomes among adult daily smokers. *Addictive Behaviors*, *77*(May 2017), 73–80. https://doi.org/10.1016/j.addbeh.2017.09.013

Luberto, C. M., & McLeish, A. C. (2018). The effects of a brief mindfulness exercise on state mindfulness and affective outcomes among adult daily smokers. *Addictive Behaviors*, *77*(May 2017), 73–80. https://doi.org/10.1016/j.addbeh.2017.09.013

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*, *12*(4), 163–169. https://doi.org/10.1016/j.tics.2008.01.005

MacLeod, C., & Clarke, P. J. F. (2015). The attentional bias modification approach to anxiety intervention. *Clinical Psychological Science*, *3*(1), 58–78. https://doi.org/10.1177/2167702614560749

MacLeod, C. M., & MacDonald, P. A. (2000). Interdimensional interference in the Stroop effect: Uncovering the cognitive and neural anatomy of attention. *Trends in Cognitive Sciences*, *4*(10), 383–391. https://doi.org/10.1016/S1364-6613(00)01530-8

Masiero, M., Lucchiari, C., Maisonneuve, P., Pravettoni, G., Veronesi, G., & Mazzocco, K. (2019). The Attentional Bias in Current and Former Smokers. *Frontiers in Behavioral Neuroscience*, *13*(July), 1–11. https://doi.org/10.3389/fnbeh.2019.00154

Mayer, A. R., Wilcox, C. E., Dodd, A. B., Klimaj, S. D., Dekonenko, C. J., Claus, E. D., & Bogenschutz, M. (2016). The efficacy of attention bias modification therapy in cocaine use disorders. *The American Journal of Drug and Alcohol Abuse*, *42*(4), 459–468. https://doi.org/10.3109/00952990.2016.1151523

McGeary, J. E., Meadows, S. P., Amir, N., & Gibb, B. E. (2014). Computer-delivered, home-based, attentional retraining reduces drinking behavior in heavy drinkers. *Psychology of Addictive Behaviors*, *28*(2), 559–562. https://doi.org/10.1037/a0036086

McHugh, R. K., Murray, H. W., Hearon, B. A., Calkins, A. W., & Otto, M. W. (2010). Attentional bias and craving in smokers: The impact of a single attentional training session. *Nicotine and Tobacco Research*, *12*(12), 1261–1264. https://doi.org/10.1093/ntr/ntq171

Miller, E. K., & Cohen, J. D. (2001). *An integrative theory of prefrontal cortex function.* 167–202.

Mogg, K., & Bradley, B. P. (2002). Selective orienting of attention to masked threat faces in social anxiety. *Behaviour Research and Therapy*, *40*(12), 1403–1414. https://doi.org/10.1016/S0005-7967(02)00017-7

Mogg, K., Bradley, B. P., Field, M., & De Houwer, J. (2003). Eye movements to smoking-related pictures in smokers: Relationship between attentional biases and implicit and explicit measures of stimulus valence. *Addiction*, *98*(6), 825–836. https://doi.org/10.1046/j.1360-0443.2003.00392.x

Moss, A. C., & Albery, I. P. (2009). A dual-process model of the alcohol–behavior link for social drinking. *Psychological Bulletin*, *135*(4), 516–530. https://doi.org/10.1037/a0015991

Murphy, T. J., Pagano, R. R., & Marlatt, G. A. (1986). Lifestyle modification with heavy alcohol drinkers: Effects of aerobic exercise and meditation. *Addictive Behaviors*, *11*(2), 175–186. https://doi.org/10.1016/0306-4603(86)90043-2

Nelson, B. D., Jackson, F., Amir, N., & Hajcak, G. (2015). Single-session attention bias modification and error-related brain activity. *Cognitive, Affective & Behavioral Neuroscience*, 776–786. https://doi.org/10.3758/s13415-015-0365-4

Noël, X., Colmant, M., Van Der Linden, M., Bechara, A., Bullens, Q., Hanak, C., & Verbanck, P. (2006). Time course of attention for alcohol cues in abstinent alcoholic patients: The role of initial orienting. *Alcoholism: Clinical and Experimental Research*, *30*(11), 1871–1877. https://doi.org/10.1111/j.1530-0277.2006.00224.x

O'Neill, A., Bachi, B., & Bhattacharyya, S. (2020). Attentional bias towards cannabis cues in cannabis users: A systematic review and meta-analysis. *Drug and Alcohol Dependence*, *206*(October 2019), 107719. https://doi.org/10.1016/j.drugalcdep.2019.107719

Ostafin, B. D., Bauer, C., & Myxter, P. (2012). Mindfulness decouples the relation between automatic alcohol motivation and heavy drinking. *Journal of Social and Clinical Psychology*, *31*(7), 729–745. https://doi.org/10.1521/jscp.2012.31.7.729

Padmala, S., Bauer, A., & Pessoa, L. (2011). Negative emotion impairs conflict-driven executive control. *Frontiers in Psychology*, *2*(AUG), 1–5. https://doi.org/10.3389/fpsyg.2011.00192

Pagnoni, G., & Cekic, M. (2007). Age effects on gray matter volume and attentional performance in Zen meditation. *Neurobiology of Aging*, *28*(10), 1623–1627. https://doi.org/10.1016/j.neurobiolaging.2007.06.008

Park, T., Reilly-Spong, M., & Gross, C. R. (2013). Mindfulness: a systematic review of instruments to measure an emergent patient-reported outcome (PRO). *Quality of Life Research*, *22*(10), 2639–2659. https://doi.org/10.1007/s11136-013-0395-8.Mindfulness

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*, *236*(12), 3465–3476. https://doi.org/10.1007/s00213-019-05313-0

Pennington, C. R., Shaw, D. J., Adams, J., Kavanagh, P., Reed, H., Robinson, M., Shave, E., & White, H. (2020). Where's the wine? Heavy social drinkers show attentional bias towards alcohol in a visual conjunction search task. *Addiction*, *115*(9), 1650–1659. https://doi.org/10.1111/add.14997

Persson, J., Lustig, C., Nelson, J. K., & Reuter-Lorenz, P. A. (2007). Age differences in deactivation: A link to cognitive control? *Journal of Cognitive Neuroscience*, *19*(6), 1021–1032. https://doi.org/10.1162/jocn.2007.19.6.1021

Prakash, R. S., Hussain, M. A., & Schirda, B. (2015). The role of emotion regulation and cognitive control in the association between mindfulness disposition and stress. *Psychology and Aging*, *30*(1), 160–171. https://doi.org/10.1037/a0038544

Prochaska, J. O., & Norcross, J. C. (2001). Stages of Change. *Psychotherapy: Theory, Research, Practice, Training*, *38*(4), 443–448. https://doi.org/10.1177/0145445502026002006

Rehme, A. K., Bey, K., Frommann, I., Mogg, K., Bradley, B. P., Bludau, J., Block, V., Sträter, B., Schütz, C. G., & Wagner, M. (2018). Selective attention to smoking cues in former smokers. *European Neuropsychopharmacology*, *28*(2), 276–284. https://doi.org/10.1016/j.euroneuro.2017.12.003

Rettie, H. C., Hogan, L. M., & Cox, W. M. (2018). Negative attentional bias for positive

recovery-related words as a predictor of treatment success among individuals with an alcohol use disorder. *Addictive Behaviors*, *84*(December 2017), 86–91. https://doi.org/10.1016/j.addbeh.2018.03.034

Schoenmakers, T. M., de Bruin, M., Lux, I. F. M., Goertz, A. G., Van Kerkhof, D. H. A. T., & Wiers, R. W. (2010). Clinical effectiveness of attentional bias modification training in abstinent alcoholic patients. *Drug and Alcohol Dependence*, *109*(1–3), 30–36. https://doi.org/10.1016/j.drugalcdep.2009.11.022

Schoenmakers, T., Wiers, R. W., & Field, M. (2008). Effects of a low dose of alcohol on cognitive biases and craving in heavy drinkers. *Psychopharmacology*, *197*(1), 169–178. https://doi.org/10.1007/s00213-007-1023-5

Schoenmakers, T., Wiers, R. W., Jones, B. T., Bruce, G., & Jansen, A. T. M. (2007). Attentional re-training decreases attentional bias in heavy drinkers without generalization. *Addiction*, *102*(3), 399–405. https://doi.org/10.1111/j.1360-0443.2006.01718.x

Sharma, D. (2017). The variable nature of cognitive control in a university sample of young adult drinkers. *Journal of Applied Social Psychology*, *47*(3), 118–123. https://doi.org/10.1111/jasp.12416

Sharma, D., Albery, I. P., & Cook, C. (2001). Selective attentional bias to alcohol related stimuli in problem drinkers and non-problem drinkers. *Addiction*, *96*(2), 285–295. https://doi.org/10.1046/j.1360-0443.2001.96228512.x

Shook, N. J., Ford, C., Strough, J., Delaney, R., & Barker, D. (2017). In the moment and feeling good: Age differences in mindfulness and positive affect. *Translational Issues in Psychological Science*, *3*(4), 338–347. https://doi.org/10.1037/tps0000139

Simon, J. R. (1969). Reactions toward the source of stimulation. *Journal of Experimental Psychology*, *81*(1), 174–176. https://doi.org/10.1037/h0027448

Smith, P., N'Diaye, K., Fortias, M., Mallet, L., & Vorspan, F. (2020). I can't get it off my

mind: Attentional bias in former and current cocaine addiction. *Journal of Psychopharmacology*, *34*(11), 1218–1225. https://doi.org/10.1177/0269881120944161

Snelleman, M., Schoenmakers, T. M., & van de Mheen, D. (2015). Attentional Bias and Approach/Avoidance Tendencies Do Not Predict Relapse or Time to Relapse in Alcohol Dependency. *Alcoholism: Clinical and Experimental Research*, *39*(9), 1734–1739. https://doi.org/10.1111/acer.12817

Spears, C. A., Hedeker, D., Li, L., Wu, C., Anderson, N. K., Houchins, S. C., Vinci, C., Hoover, D. S., Vidrine, J. I., Cinciripini, P. M., Waters, A. J., & Wetter, D. W. (2017). Mechanisms underlying mindfulness-based addiction treatment versus cognitive behavioral therapy and usual care for smoking cessation. *Journal of Consulting and Clinical Psychology*, *85*(11), 1029–1040. https://doi.org/10.1037/ccp0000229

Stewart, J., de Wit, H., & Eikelboom, R. (1984). Role of unconditioned and conditioned drug effects in the self-administration of opiates and stimulants. *Psychological Review*, *91*(2), 251–268. https://doi.org/10.1037/0033-295X.91.2.251

Stroop, J. R. (1935). Studies in interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*(6), 643–662.

Tang, Y. Y., Hölzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience*, *16*(4), 213–225. https://doi.org/10.1038/nrn3916

Tang, Y. Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., Yu, Q., Sui, D., Rothbart, M. K., Fan, M., & Posner, M. I. (2007). Short-term meditation training improves attention and self-regulation. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(43), 17152–17156. https://doi.org/10.1073/pnas.0707678104

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: role of

automatic and nonautomatic processes. *Psychological Review*, *97*(2), 147–168. https://doi.org/10.1037/0033-295X.97.2.147

Tops, M., Boksem, M. A. S., Quirin, M., IJzerman, H., & Koole, S. L. (2014). Internally directed cognition and mindfulness: An integrative perspective derived from predictive and reactive control systems theory. *Frontiers in Psychology*, *5*(MAY), 1–21. https://doi.org/10.3389/fpsyg.2014.00429

Van Kampen, A. D., Cousijn, J., Engel, C., Rinck, M., & Dijkstra, B. A. G. (2020a). Attentional bias, craving and cannabis use in an inpatient sample of adolescents and young adults diagnosed with cannabis use disorder: The moderating role of cognitive control. *Addictive Behaviors*, *100*, 106126. https://doi.org/10.1016/j.addbeh.2019.106126

Van Kampen, A. D., Cousijn, J., Engel, C., Rinck, M., & Dijkstra, B. A. G. (2020b). Attentional bias, craving and cannabis use in an inpatient sample of adolescents and young adults diagnosed with cannabis use disorder: The moderating role of cognitive control. *Addictive Behaviors*, *100*(December 2018), 106126. https://doi.org/10.1016/j.addbeh.2019.106126

van Steenbergen, H., Band, G. P. H., & Hommel, B. (2010). In the mood for adaptation: How affect regulates conflict-driven control. *Psychological Science*, *21*(11), 1629–1634. https://doi.org/10.1177/0956797610385951

Van Steenbergen, H., Band, G. P. H., & Hommel, B. (2009). Reward counteracts conflict adaptation: Evidence for a role of affect in executive control. *Psychological Science*, *20*(12), 1473–1477. https://doi.org/10.1111/j.1467-9280.2009.02470.x

Waters, A. J., & Feyerabend, C. (2000). Determinants and Effects of Attentional Bias in Smokers• 1. *Psychology of Addictive Behaviors*, *14*(2), 111–120. https://doi.org/10.1037//Og93-164X.14.2.111

Wiers, R. W., Gladwin, T. E., Hofmann, W., Salemink, E., & Ridderinkhof, K. R.

(2013). Cognitive Bias Modification and Cognitive Control Training in Addiction and Related Psychopathology: Mechanisms, Clinical Perspectives, and Ways Forward. *Clinical Psychological Science*, *1*(2), 192–212. https://doi.org/10.1177/2167702612466547

Wiers, Reinout W., Cox, W. M., Field, M., Fadardi, J. S., Palfai, T. P., Schoenmakers, T., & Stacy, A. W. (2006). The search for new ways to change implicit alcohol-related cognitions in heavy drinkers. *Alcoholism: Clinical and Experimental Research*, *30*(2), 320–331. https://doi.org/10.1111/j.1530-0277.2006.00037.x

Wiers, Reinout W., & Stacy, A. W. (2006). Implicit cognition and addiction. *Current Directions in Psychological Science*, *15*(6), 292–296. https://doi.org/10.1111/j.1467-8721.2006.00455.x

Zeidan, F., Johnson, S. K., Diamond, B. J., David, Z., & Goolkasian, P. (2010). Mindfulness meditation improves cognition: Evidence of brief mental training. *Consciousness and Cognition*, *19*(2), 597–605. https://doi.org/10.1016/j.concog.2010.03.014

Zgierska, A., Rabago, D., Chawla, N., Kushner, K., Koehler, R., & Marlatt, A. (2009). Mindfulness meditation for substance use disorders: A systematic review. *Substance Abuse*, *30*(4), 266–294. https://doi.org/10.1080/08897070903250019

Zhao, H., Yang, B., Zhu, Q., Zhang, G., Xiao, Y., Guo, X., Huang, X., & Zhang, Z. (2017). Eye Movement Evidence of Attentional Bias for Substance-Related Cues in Heroin Dependents on Methadone Maintenance Therapy. *Substance Use and Misuse*, *52*(4), 527–534. https://doi.org/10.1080/10826084.2016.1264967

Ziaee, S. S., Fadardi, J. S., Cox, W. M., & Yazdi, S. A. A. (2016). Effects of attention control training on drug abusers' attentional bias and treatment outcome. *Journal of Consulting and Clinical Psychology*, *84*(10), 861–873. https://doi.org/10.1037/a0040290

Appendices

Appendix A: Stimuli

Appendix A1: Image stimuli used in Stroop task Studies5


A9


N9

A10


N10

A11


N11


A12


N12


A13


N13

A14


N14


A15


N15


A16


N16


A17


N17


A18


N18


A19


N19


A20


N20


A21


N21


A22


N22


A23


N23


A24


N24


A25


N25


A26


N26

A27


N27


A28


N28

A29

N29


A30


N30


A31


N31

A32


N32


A33


N33


A34


N34


A35


N35

A36


N36


A37


N37


A38


N38


A39


N39


A40


N40


A41


N41


A42


N42


A43


N43


A44


N44


A45


N45


A46


N46


A47


N47


A48


N48


A49


N49


A50


N50


A51


N51


A52


N52


A53


N53

A54

N54


A55


N55

A56


N56


A57

N57


A58


N58


A59

N59


A60


N60


A61


N61


A62


N62


A63


N63


A64


N64


A65


N65


A66


N66


A67


N67


A68


N68


A69


N69


A70


N70

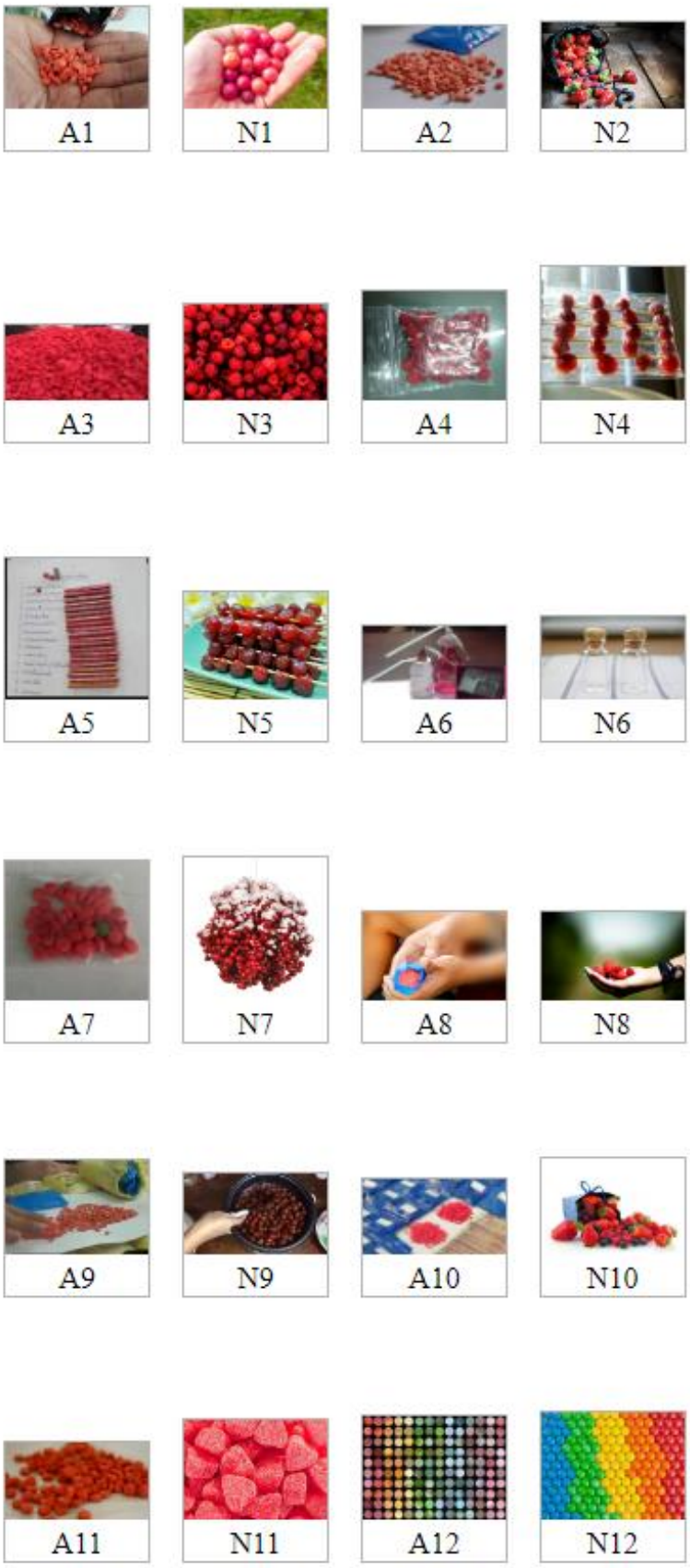

A71


N71

A72


N72

Appendix A2: Image stimuli used in Stroop task Studies 2, 4 & 6




A13


N13


A14


N14


A15


N15

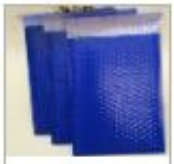

A16


N16


A17


N17


A18


N18


A19


N19


A20

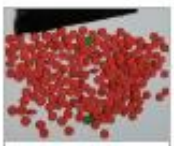

N20


A21


N21


A22


N22


A23


N23


A24


N24


A25


N25


A26


N26


A27


N27


A28


N28


A29


N29


A30


N30


A31


N31

A32


N32


A33


N33


A34


N34


A35

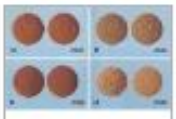

N35


A36


N36


A37


N37


A38


N38


A39


N39


A40


N40


A41


N41


A42


N42


A43


N43


A44


N44


A45


N45


A46


N46


A47


N47


A48


N48


A49


N49


A50


N50


A51


N51


A52


N52

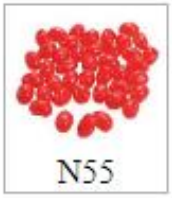

A53


N53


A54


N54


A55


N55


A56


N56


A57

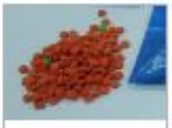

N57


A58


N58


A59


N59


A60


N60


A61


N61


A62


N62


A63


N63


A64


N64


A65


N65


A66


N66


A67


N67


A68


N68


A69


N69


A70


N70


A71

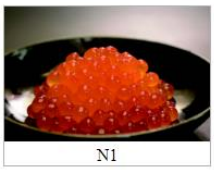

N71


A72


N72

Appendix A3: Image stimuli used in visual probe task Studies 2, 4 & 6


A1


N1


A2


N2


A3


N3


A4


N4


A5


N5


A6


N6


A7


N7


A8


N8


A9


N9


A10


N10


A11


N11


A12


N12


A13


N13


A14

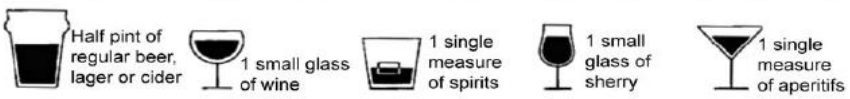

N14

Appendix B: Questionnaire and Apparatus

Appendix B1: AUDIT

Introduction: Because alcohol use can affect health and interfere with certain medications and treatments, it is important that we ask you some questions about your use of alcohol. Your answers will remain confidential, so please be as accurate as possible. Try to answer the questions in terms of 'standard drinks'. Please ask for clarification if required.

This is one unit of alcohol…



and each of these is more than one unit

AUDIT Questions Please tick the response that best fits your drinking.

	0	1	2	3	4
1. How often do you have a drink containing alcohol?	Never	Monthly or less	2 - 4 times per month	2 - 3 times per week	4+ times per week
2. How many units of alcohol do you drink on a typical day when you are drinking?	1 or 2	3 or 4	5 or 6	7 or 9	10 or more
3. How often have you had 6 or more units if female, or 8 or more if male, on a single occasion in the last year?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
4. 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
	0	1	2	3	4
5. How often during the last year have you failed to do what was normally expected from you because of your drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
6. How often during the last year have you needed an alcoholic drink in the morning to get yourself going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily

8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
9. Have you or somebody else been injured as a result of your drinking?	No		Yes, but not in the last year		Yes, during the last year
10 Has a relative or friend, doctor or other health worker been concerned about your drinking or suggested that you cut down?	No		Yes, but not in the last year		Yes, during the last year

Scoring: Total AUDIT scores between 0-7 are considered to be low risk, 8-15 Moderate risk, 16-19 high risk and 20-40 addiction likely.

Appendix B2: Desires for Alcohol Questionnaire (DAQ)

Instructions: Please indicate how much you agree or disagree with each of following statements by placing a single checkmark (like this: X) along each line between STRONGLY DISAGREE and STRONGLY AGREE. The closer you place checkmark to one end or the other indicates the strength of your disagreement or agreement. We are interested in how you are thinking or feeling *right now* as you are filling out this questionnaire. Please complete every item.

RIGHT NOW

1. I want a drink so much I can almost taste it.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

2. My desire to drink now seems overwhelming.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

3. I would do almost anything to have a drink now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

4. I am going to drink as soon as I possibly can.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

5. I would consider having a drink now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

6. I would accept a drink now if it was offered to me.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

7. I would feel as if all the bad things in my life had disappeared if I drank now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

8. Even major problems in my life would not bother me if I drank now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

9. I would feel less worried about my daily problems if I drank now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

10. Drinking now would make me feel less tense.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

11. If I started drinking now I would be able to stop.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

12. I could easily limit how much I would drink if I drank now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

13. Drinking would be satisfying now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

14. Drinking would be pleasant now.

STRONGLY DISAGREE_____:_____:_____:_____:_____:_____:_____ STRONGLY AGREE

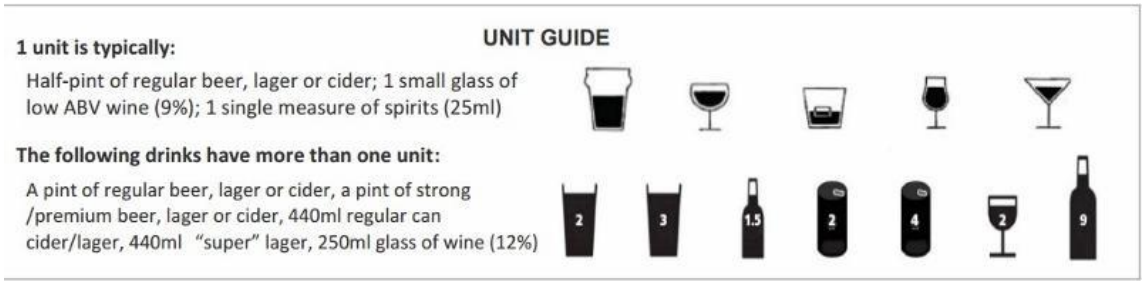
Appendix B3: Timeline Follow Back

Today's date :……

For the previous 30 days, please fill in events/what you did and how many units you drank.

The purpose is to get as accurate a picture of what your drinking has been like for the indicated time period in terms of number of drinking days and number of drinks per day.

Using the attached unit guide and calendar below.



Calendar for September 2016–February 2017 (United Kingdom)

September 2016

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

November 2016

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

5: Guy Fawkes Day
13: Remembrance Sunday
30: St Andrew's Day (Scotland)

January 2017

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

1: New Year's Day
2: 'New Year's Day' observed
2: New Year's Day Holiday
3: 2nd January (substitute day) (Scotland)

October 2016

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

31: Halloween

December 2016

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

25: Christmas Day
26: Boxing Day
27: Bank Holiday

February 2017

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

INSTRUCTIONS:

1. In reporting your total daily consumption, we would like you to report it in STANDARD DRINKS (use the unit guide).

2. On the days that you did not drink any alcoholic beverages mark those days with a "0".

3. On the days that you did consume a beverage containing alcohol, write in the TOTAL number of Standard Drinks that you drank on those days. This includes days of combined beverage use. For example, if you drank a glass of wine with dinner and a drink containing 1-1/2 oz. of hard liquor after dinner, you would count that as 2 standard drinks for that day. The important thing is to make sure that something is filled-in for each day.

4. In filling out the calendar, we would like you to be as accurate as possible. However, if you cannot recall whether you consumed an alcoholic beverage on Monday or Thursday of a certain week, or whether it was the week of November 9th or the week of November 16th, give it your best shot!

Please complete all placements.

	Events/ What you did (optional)	How many units you drank (must complete all)
Today		
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Day 8		
Day 9		
Day 10		
Day 11		
Day 12		
Day 13		
Day 14		
Day 15		
Day 16		
Day 17		
Day 18		
Day 19		
Day 20		
Day 21		
Day 22		
Day 23		
Day 24		
Day 25		
Day 26		
Day 27		
Day 28		
Day 29		
Day 30		

Appendix B4: SOCRATES 8A

SOCRATES -8A – English version

INSTRUCTIONS: Please read the following statements carefully. Each one describes a way that you might (or might not) feel *about your drinking*. For each statement, circle one number from 1 to 5, to indicate how much you agree or disagree with it *right now*. Please circle one and only one number for every statement.

	Yes. Strongly Disagree	**No. Disagree**	**? Undecided or Unsure**	**Yes. Agree**	**Yes. Strongly Agree**
1. I really want to make changes in my drinking.	1	2	3	4	5
2. Sometimes I wonder if I am an alcoholic.	1	2	3	4	5
3. If I don't change my drinking soon, my problems are going to get worse.	1	2	3	4	5
4. I have already started making some changes in my drinking.	1	2	3	4	5
5. I was drinking too much at one time, but I've managed to change my drinking.	1	2	3	4	5
6. Sometimes I wonder if my drinking is hurting other people.	1	2	3	4	5
7. I am a problem drinker.	1	2	3	4	5
8. I'm not just thinking about changing my drinking, I'm already doing something about it.	1	2	3	4	5
9. I have already changed my drinking, and I am looking for ways to keep from slipping back to my old pattern.	1	2	3	4	5
10. I have serious problems with drinking.	1	2	3	4	5
11. Sometimes I wonder if I am in control of my drinking.	1	2	3	4	5
12. My drinking is causing a lot of harm.	1	2	3	4	5
13. I am actively doing things now to cut down or stop drinking.	1	2	3	4	5
14. I want help to keep from going back to the drinking problems that I had before.	1	2	3	4	5
15. I know that I have a drinking problem.	1	2	3	4	5
16. There are times when I wonder if I drink too much.	1	2	3	4	5
17. I am an alcoholic.	1	2	3	4	5
18. I am working hard to change my drinking.	1	2	3	4	5
19. I have made some changes in my drinking, and I want some help to keep from going back to the way I used to drink.	1	2	3	4	5

SOCRATES 8A - Thai version

คำแนะนำ: โปรดอ่านข้อความต่อไปนี้อย่างละเอียด แต่ละข้อด้านล่างนี้อธิบายถึงสิ่งที่คุณอาจคิด/รู้สึก (หรืออาจจะไม่) เกี่ยวกับการใช้ยาของคุณ ให้วงกลมรอบหมายเลข เพื่อระบุว่าคุณเห็นด้วยหรือไม่เห็นด้วยกับข้อความนี้

	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยมาก
1. ฉันมีความต้องการอย่างมากที่จะเปลี่ยนแปลงการดื่มแอลกอฮอล์ของฉัน	1	2	3	4	5
2. บางครั้งฉันสงสัยว่าฉันเป็น “ผู้ติดแอลกอฮอล์”	1	2	3	4	5
3. ถ้าฉันไม่เปลี่ยนแปลงการดื่มแอลกอฮอล์ของฉันในเร็ววัน ปัญหาของฉันจะยิ่งเลวร้ายลงอีก	1	2	3	4	5
4. ฉันได้เริ่มการเปลี่ยนแปลงบางอย่างเกี่ยวกับการดื่มแอลกอฮอล์ของฉัน	1	2	3	4	5
5. ฉันเคยดื่มแอลกอฮอล์มากในครั้งหนึ่ง ๆ แต่ฉันได้เปลี่ยนแปลงแล้ว	1	2	3	4	5
6. บางครั้งฉันสงสัยว่าการดื่มแอลกอฮอล์ของฉันเป็นการทำร้ายผู้อื่น	1	2	3	4	5
7. ฉันมีปัญหาเรื่องการดื่มแอลกอฮอล์	1	2	3	4	5
8. ฉันไม่ใช่แค่คิดเปลี่ยนแปลงการดื่มแอลกอฮอล์ของฉันแต่ฉันได้ทำอะไรบางอย่างเพื่อเปลี่ยนแปลงการดื่มสุราแล้ว	1	2	3	4	5
9. ฉันได้เปลี่ยนแปลงการดื่มแอลกอฮอล์ของฉัน และฉันกำลังมองหาแนวทางรักษาตนเองเพื่อไม่ให้กลับไปดื่มแอลกอฮอล์อีก	1	2	3	4	5
10. ฉันมีปัญหาอย่างมากเกี่ยวกับการดื่มแอลกอฮอล์	1	2	3	4	5
11. บางครั้งฉันสงสัยว่าฉันอยู่ภายใต้การควบคุมของแอลกอฮอล์	1	2	3	4	5
12. การดื่มแอลกอฮอล์ของฉันเป็นต้นเหตุของอันตรายมากมาย	1	2	3	4	5
13. ในปัจจุบันฉันกำลังทำบางสิ่งบางอย่างอย่างกระตือรือร้นเพื่อลดหรือหยุดการดื่มแอลกอฮอล์ของฉัน	1	2	3	4	5
14. ฉันต้องการความช่วยเหลือเพื่อรักษาตัวเองไม่ให้กลับไปดื่มแอลกอฮอล์อีก เหมือนที่เคยเป็นมาก่อน	1	2	3	4	5
15. ฉันรู้ว่าฉันมีปัญหาเรื่องการดื่มแอลกอฮอล์	1	2	3	4	5
16. มีบางเวลาที่ฉันสงสัยว่าฉันดื่มแอลกอฮอล์มากเกินไป	1	2	3	4	5
17. ฉันเป็นคนติดแอลกอฮอล์	1	2	3	4	5
18. ฉันกำลังพยายามอย่างหนักเพื่อเปลี่ยนแปลงการดื่มแอลกอฮอล์ของฉัน	1	2	3	4	5
19. ฉันได้เปลี่ยนแปลงบางอย่างเกี่ยวกับการดื่มแอลกอฮอล์ของฉัน และฉันต้องการความช่วยเหลือบางอย่างเพื่อช่วยไม่ให้ฉันกลับไปดื่มอีก	1	2	3	4	5

Appendix B5: SOCRATES 8D

SOCRATES 8D - English version

INSTRUCTIONS: Please read the following statements carefully. Each one describes a way that you might (or might not) feel *about your drug use*. For each statement, circle one number from 1 to 5, to indicate how much you agree or disagree with it *right now*. Please circle one and only one number for every statement.

	No. Strongly Disagree	No. Disagree	? Undecided or Unsure	Yes. Agree	Yes. Strongly Agree
1. I really want to make changes in my use of drugs.	1	2	3	4	5
2. Sometimes I wonder if I am an addict.	1	2	3	4	5
3. If I don't change my drug use soon, my problems are going to get worse.	1	2	3	4	5
4. I have already started making some changes in my use of drugs.	1	2	3	4	5
5. I was using drugs too much at one time, but I've managed to change that.	1	2	3	4	5
6. Sometimes I wonder if my drug use is hurting other people.	1	2	3	4	5
7. I have a drug problem.	1	2	3	4	5
8. I'm not just thinking about changing my drug use, I'm already doing something about it.	1	2	3	4	5
9. I have already changed my drug use, and I am looking for ways to keep from slipping back to my old pattern.	1	2	3	4	5
10. I have serious problems with drugs.	1	2	3	4	5
11. Sometimes I wonder if I am in control of my drug use.	1	2	3	4	5
12. My drug use is causing a lot of harm.	1	2	3	4	5
13. I am actively doing things now to cut down or stop my use of drugs.	1	2	3	4	5
14. I want help to keep from going back to the drug problems that I had before.	1	2	3	4	5
15. I know that I have a drug problem.	1	2	3	4	5
16. There are times when I wonder if I use drugs too much.	1	2	3	4	5
17.I am a drug addict.	1	2	3	4	5
18. I am working hard to change my drug use.	1	2	3	4	5
19. I have made some changes in my drug use, and I want some help to keep from going back to the way I used before.	1	2	3	4	5

SOCRATES 8A - Thai version

คำแนะนำ: โปรดอ่านข้อความต่อไปนี้อย่างละเอียด แต่ละข้อด้านล่างนี้อธิบายถึงสิ่งที่คุณอาจคิด/รู้สึก (หรืออาจจะไม่) เกี่ยวกับการใช้ยาของคุณ ให้วงกลมรอบหมายเลข เพื่อระบุว่าคุณเห็นด้วยหรือไม่เห็นด้วยกับข้อความนี้

	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยมาก
1. ฉันมีความต้องการอย่างมากที่จะเปลี่ยนแปลงการเสพยาบ้าของฉัน	1	2	3	4	5
2. บางครั้งฉันสงสัยว่าฉันเป็น “ผู้ติดยาบ้า”	1	2	3	4	5
3. ถ้าฉันไม่เปลี่ยนแปลงการใช้ยาบ้าของฉันในเร็ววัน ปัญหาของฉันจะยิ่งเลวร้ายลงอีก	1	2	3	4	5
4. ฉันได้เริ่มการเปลี่ยนแปลงบางอย่างเกี่ยวกับการเลิกยาบ้าของฉัน	1	2	3	4	5
5. ฉันเคยเสพยาบ้าปริมาณมากในครั้งหนึ่ง ๆ แต่ฉันได้เปลี่ยนแปลงแล้ว	1	2	3	4	5
6. บางครั้งฉันสงสัยว่าการเสพยาบ้าของฉันเป็นการทำร้ายผู้อื่น	1	2	3	4	5
7. ฉันมีปัญหาเรื่องการเสพยาบ้า	1	2	3	4	5
8. ฉันไม่ใช่แค่คิดเปลี่ยนแปลงการการเสพยาบ้าของฉันแต่ฉันได้ทำอะไรบางอย่างเพื่อเปลี่ยนแปลงการเสพยาบ้าแล้ว	1	2	3	4	5
9. ฉันได้เปลี่ยนแปลงการดื่มแอลกอฮอล์ของฉัน และฉันกำลังมองหาแนวทางรักษาตนเองเพื่อไม่ให้กลับไปเสพยาบ้าอีก	1	2	3	4	5
10. ฉันมีปัญหาอย่างมากเกี่ยวกับการใช้ยาบ้า	1	2	3	4	5
11. บางครั้งฉันสงสัยว่าฉันอยู่ภายใต้การควบคุมของยาบ้า	1	2	3	4	5
12. การเสพยาบ้าของฉันเป็นต้นเหตุของอันตรายมากมาย	1	2	3	4	5
13. ในปัจจุบันฉันกำลังทำบางสิ่งบางอย่างอย่างกระตือรือร้นเพื่อลดหรือหยุดการเสพยาบ้าของฉัน	1	2	3	4	5
14. ฉันต้องการความช่วยเหลือเพื่อรักษาตัวเองไม่ให้กลับไปเสพยาบ้าอีก เหมือนที่เคยเป็นมาก่อน	1	2	3	4	5
15. ฉันรู้ว่าฉันมีปัญหาเรื่องการเสพยาบ้า	1	2	3	4	5
16. มีบางเวลาที่ฉันสงสัยว่าฉันเสพยาบ้ามากเกินไป	1	2	3	4	5
17. ฉันเป็นคนติดยาบ้า	1	2	3	4	5
18. ฉันกำลังพยายามอย่างหนักเพื่อเปลี่ยนแปลงการเสพยาบ้าของฉัน	1	2	3	4	5
19. ฉันได้เปลี่ยนแปลงบางอย่างเกี่ยวกับการเสพยาบ้าของฉัน และฉันต้องการความช่วยเหลือบางอย่างเพื่อช่วยไม่ให้ฉันกลับไปเสพอีก	1	2	3	4	5

Appendix B6: Craving Experience Questionnaire (CEQ)

CEQ - English version

Today's Date: ____/____/____ **_____** **CEQ-S11**

These questions are about your craving or desire for .....

Think about the time in the LAST ..... you MOST WANTED it.

For each item, mark an X in a box to make your rating.

		0	1	2	3	4	5	6	7	8	9	10	
At that time…													
…how much did you want it?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…how much did you need it?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…how strong was the urge to have it?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
At that time, how vividly did you…													
…picture it?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…imagine its taste?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…imagine its smell?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…imagine what it would feel like in your mouth or throat?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…imagine how your body would feel?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
At that time…													
…how hard were you trying not to think about it?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…how intrusive were the thoughts?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely
…how hard was it to think about anything else?	Not at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Extremely

Today's Date: ____/_____/____ _____ CEQ-F11

These questions are about your craving or desire for .....

Please answer HOW OFTEN these things happened in the last .....

Over the last ....., how often did you	0	1	2	3	4	5	6	7	8	9	10	
… want it?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
… need it?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
… have a strong urge to have it?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
… picture it?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
… imagine its taste?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
… imagine its smell?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
…imagine what it would feel like in your mouth or throat?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
…imagine how your body would feel?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
Over the last ------, how often												
… were you trying not to think about it?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
… were the thoughts intrusive?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly
… was it hard to think about anything else?	Not at all ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constantly

CEQ - Thai version

CEQ11

วันนี้ วันที่.....

ให้คุณนึกถึงเมื่อ……. ในช่วงเวลาที่คุณอยากยามากที่สุด

ให้ตอบทุกข้อ โดยกากบาท (X) ตัวเลขที่เลือก

ในเวลานั้น														ข้อ
คุณต้องการมันมากเท่าไหร่	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	1
คุณรู้สึกว่าขาดมันไม่ได้	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	2
ความรุนแรงของความรู้สึกที่อยากใช้มัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	3
ในเวลานั้น ความชัดเจน ของด้านต่างๆ มีมากเท่าไหร่														
การนึกภาพของยา	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	4
จินตนาการรสชาติของมัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	5
จินตนาการกลิ่นของมัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	6
จินตนาการถึงความรู้สึกว่า ถ้าหากมันอยู่ในปาก ในคอ ของคุณ	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	7
จิตนาการว่าร่างกายของคุณจะรู้สึกอย่างไร	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	8
ในเวลานั้น														
มีความยากเย็นที่จะไม่คิดถึงมันมากเท่าไหร่	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	9
มันบุกรุกเข้าไปอยู่ในความคิดของคุณมากเท่าไร	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	10
มีความยากเย็นแค่ไหนที่จะคิดถึงสิ่งอื่นที่ไม่เกี่ยวข้องกับยา	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	มากที่สุด	11

CEQ11

วันนี้ วันที่.....

ในหน้านี้ ขอให้คุณตอบคำถามคล้ายๆกับหน้าที่แล้ว
แต่ ครั้งนี้ให้คุณตอบเกี่ยวกับ ความถี่ หรือ ความบ่อย ในด้านต่างๆ
ที่เกิดขึ้นเมื่อ……..
ให้ตอบทุกข้อ โดยกากบาท (X) ตัวเลขที่เลือก

													ข้อ
ต้องการมัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	1
ขาดมันไม่ได้	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	2
มีความอยากที่จะใช้มัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	3
นึกถึงภาพของมัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	4
จินตนาการถึงรสชาติของมัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	5
จินตนาการถึงกลิ่นของมัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	6
จินตนาการถึงความรู้สึกว่าหากมันอยู่ในปาก ในคอ ของคุณ	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	7
จิตนาการว่าร่างกายของคุณจะรู้สึกอย่างไร	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	8

ในช่วง ……..ที่ผ่านมา บ่อยแค่ไหนที่

จะไม่คิดถึงมัน	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	9
มันบุกรุกเข้าไปอยู่ในความคิดของคุณ	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	10
มีความยากเย็นแค่ไหนที่จะคิดถึงสิ่งอื่นที่ไม่เกี่ยวข้องกับยา	ไม่เลย	0	1	2	3	4	5	6	7	8	9	10	ตลอดเวลา	11

Appendix B7.1: Mindful Attention Awareness Scale (MAAS), state version

MAAS –English version

Instructions: Using the 0-6 scale shown, please indicate to what degree were you having each experience described below when you were paged. Please answer according to what really reflected your experience rather than what you think your experience should have been.

	Not at all			Some what			Very much
1. I was finding it difficult to stay focused on what was happening.	0	1	2	3	4	5	6
2. I was doing something without paying attention.	0	1	2	3	4	5	6
3. I was preoccupied with the future or the past.	0	1	2	3	4	5	6
4. I was doing something automatically, without being aware of what I was doing.	0	1	2	3	4	5	6
5. I was rushing through something without being really attentive to it.	0	1	2	3	4	5	6

MAAS –Thai version

คำแนะนำ: ให้ใช้เลข 0 – 6 ระบุว่าคุณมีประสบการณ์เหล่านี้มากน้อยเพียงใด**<u>ในขณะนี้</u>** โปรดตอบตามความจริง ***มิใช่*** *สิ่งที่คุณอยากให้เป็น*

	ไม่เลย			มีบ้าง			มากที่สุด
1. ฉันพบว่ามันยากที่จะจดจ่อกับสิ่งที่กำลังเกิดขึ้น	0	1	2	3	4	5	6
2. ฉันได้ทำบางอย่างที่โดย **ไม่ได้** ให้ความใส่ใจกับมัน	0	1	2	3	4	5	6
3. ฉันหมกมุ่นอยู่กับเรื่องอนาคตหรือในอดีต	0	1	2	3	4	5	6
4. ฉันได้ทำอะไรบางอย่างแบบอัตโนมัติ โดยที่ไม่รู้ตัวว่าฉันกำลังทำอะไรอยู่	0	1	2	3	4	5	6
5. ฉันกำลังเร่งรีบทำบางสิ่งบางอย่าง โดยที่ **ไม่ได้** ใส่ใจกับมันจริงๆ	0	1	2	3	4	5	6

Appendix B8: Toronto Mindfulness Scale (TMS-Trait) (Davis et al, 2009)

TMS-T (English version)

Instructions: We are interested in what you just experienced. Below is a list of things that people sometimes experience. Please read each statement. Next to each statement are five choices: "not at all," "a little," "moderately," "quite a bit," and "very much." Please indicate the extent to which you agree with each statement. In other words, how well does the statement describe what you just experienced, just now?

	Not at all	A little	Moderately	Quite a bit	Very much
1. I experience myself as separate from my changing thoughts and feelings.	0	1	2	3	4
2. I am more concerned with being open to my experiences than controlling or changing them.	0	1	2	3	4
3. I am curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings or sensations.	0	1	2	3	4
4. I experience my thoughts more as events in my mind than as a necessarily accurate reflection of the way things 'really' are.	0	1	2	3	4
5. I am curious to see what my mind is up to from moment to moment.	0	1	2	3	4
6. I am curious about each of my thoughts and feelings as they occur.	0	1	2	3	4
7. I am receptive to observing unpleasant thoughts and feelings without interfering with them.	0	1	2	3	4
8. I am more invested in just watching my experiences as they arise, than in figuring out what they could mean.	0	1	2	3	4
9. I approach each experience by trying to accept it, no matter whether it is pleasant or unpleasant.	0	1	2	3	4
10. I remain curious about the nature of each experience as it arises.	0	1	2	3	4
11. I am aware of my thoughts and feelings without overidentifying with them.	0	1	2	3	4
12. I am curious about my reactions to things.	0	1	2	3	4
13. I am curious about what I might learn about myself by just taking notice of what my attention gets drawn to.	0	1	2	3	4

Scoring:
Key: All items were written in the positively keyed direction, so no reverse scoring of items is required.
Curiosity score: The following items are summed: 3, 5, 6, 10, 12, 13
Decentering score: The following items are summed: 1, 2, 4, 7, 8, 9, 11

TMS-T (Thai version)

คำแนะนำ: เรามีความสนใจในประสบการณ์บางอย่างที่คุณเพิ่งประสบมา ด้านล่างนี้เป็นประสบการณ์ที่คนเราบางครั้งได้รับ โปรดอ่านข้อความทีละข้อ และถัดจากข้อความ เป็นช่องให้คะแนน

0 = ไม่เลย, 1= เล็กน้อย, 2 = ปานกลาง, 3 = ค่อนข้างมาก และ 4 = มาก

*โปรดให้คะแนนว่า **<u>ในขณะนี้</u>** คุณเห็นด้วยกับข้อความเหล่านี้ในระดับใด*

	ไม่เลย	เล็กน้อย	ปานกลาง	ค่อนข้างมาก	มาก
1.ในขณะนี้ ฉันรู้สึกว่า ตัวของฉัน แยกออกจากความคิดและความรู้สึกของฉันที่กำลังเปลี่ยนแปลง	0	1	2	3	4
2. ในขณะนี้ ฉันให้ความสำคัญกับการเปิดรับประสบการณ์ มากกว่าที่จะควบคุมหรือเปลี่ยนแปลงประสบการณ์เหล่านั้น	0	1	2	3	4
3. ในขณะนี้ ฉันสงสัยว่าฉันจะได้เรียนรู้อะไรเกี่ยวกับตัวเอง ด้วยการสังเกตว่าฉันตอบสนองอย่างไรต่อความคิด ความรู้สึก หรือทางประสาทสัมผัส	0	1	2	3	4
4. ในขณะนี้ ฉันรู้ว่าความคิดของฉัน เป็นสิ่งที่เกิดในใจ มากกว่าเป็นการสะท้อนความถูกต้องของสิ่งต่างๆที่เป็นจริง	0	1	2	3	4
5. ในขณะนี้ ฉันอยากรู้ว่า จิตใจของฉันเคิดอะไร จากชั่วขณะหนึ่งถึงชั่วขณะหนึ่ง	0	1	2	3	4
6. ในขณะนี้ ฉันอยากรู้เกี่ยวกับแต่ละความคิดและความรู้สึกที่ฉันมี	0	1	2	3	4
7. ในขณะนี้ ฉันรู้สึกกระตือรือร้นที่จะสังเกตความคิดและความรู้สึกอันไม่พึงประสงค์ โดยไม่รบกวนความคิดความรู้สึกเหล่านั้น	0	1	2	3	4
8. ในขณะนี้ ฉันเฝ้าดูการเกิดขึ้นของเหตุการณ์ มากกว่าที่จะค้นหาความหมายของมัน	0	1	2	3	4
9. ในขณะนี้ ฉันเข้าหาแต่ละประสบการณ์ โดยพยายามที่จะยอมรับมัน ไม่ว่าจะเป็นที่น่าพอใจหรือไม่น่าพอใจ	0	1	2	3	4
10. ในขณะนี้ ฉันยังคงอยากรู้ถึงธรรมชาติของแต่ละสิ่งที่เกิดขึ้น	0	1	2	3	4
11. ในขณะนี้ ฉันตระหนักถึงความคิดและความรู้สึกของฉัน โดยไม่ให้เกี่ยวข้องกับตัวฉันมากเกินไป	0	1	2	3	4
12. ในขณะนี้ ฉันอยากรู้ถึงปฏิกิริยาของฉันที่มีต่อสิ่งต่างๆ	0	1	2	3	4
13. ในขณะนี้ ฉันอยากรู้ถึงสิ่งที่ฉันอาจจะได้เรียนรู้เกี่ยวกับตัวเองจากการสังเกตความสนใจของตัวฉันเอง	0	1	2	3	4

Appendix B9: Positive affect and Negative affect scale (PANAS)

PANAS - English version

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. Indicate to what extent you feel this way right now, that is, at the present moment OR indicate the extent you have felt this way over the past week (circle the instructions you followed when taking this measure)

1	2	3	4	5
Very Slightly or Not at All	A Little	Moderately	Quite a Bit	Extremely

…….1. Interested
…….2. Distressed
…….3. Excited
…….4. Upset
…….5. Strong
…….6. Guilty
…….7. Scared
…….8. Hostile
…….9. Enthusiastic
…….10. Proud
…….11. Irritable
…….12. Alert
…….13. Ashamed
…….14. Inspired
…….15. Nervous
…….16. Determined
…….17. Attentive
…….18. Jittery
…….19. Active
…….20. Afraid

PANAS - Thai version

แบบสอบถามนี้ประกอบด้วยคำที่อธิบายความรู้สึกและอารมณ์ที่แตกต่างกัน อ่านแต่ละข้อ จากนั้นให้ใช้เลข 1 ถึง 5 ระบุว่าคุณมีความรู้สึกหรืออารมณ์เหล่านี้ในระดับใด <u>ในขณะนี้ หรือ ในช่วงสัปดาห์ที่ผ่านมา</u> (วงกลมรอบเวลาที่คุณให้คำตอบนี้)

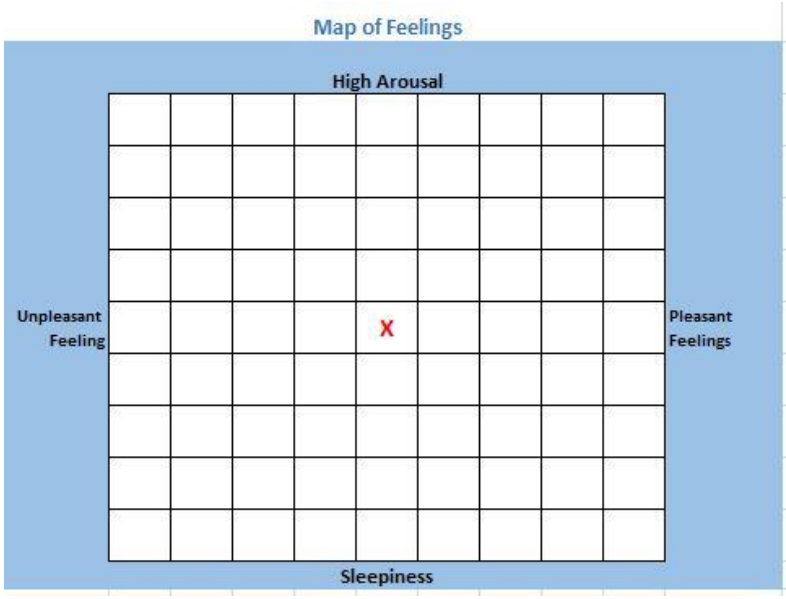
1	2	3	4	5
น้อยมาก หรือไม่มีเลย	นิดหน่อย	ปานกลาง	ค่อนข้างมาก	มากที่สุด

…….1. **สนใจใคร่รู้**	…….11. **หงุดหงิด**
…….2. **ไม่สุขสบาย**	…….12. **ตื่นตัว**
…….3. **ตื่นเต้น**	…….13. **ละอาย**
…….4. **อารมณ์เสีย**	…….14. **มีแรงใจ**
…….5. **เข้มแข็ง**	…….15. **ประหม่า**
…….6. **รู้สึกผิด**	…….16. **มุ่งมั่น**
…….7. **กลัว**	…….17. **เอาใจใส่**
…….8. **ไม่เป็นมิตร**	…….18. **กระวนกระวายใจ**
…….9. **เหนื่อย**	…….19. **กระฉับกระเฉง**
…….10. **ภูมิใจ**	…….20. **เกรงกลัว**

Appendix B10: Affect grid

Instruction:

This is an "affect grid", you use the affect grid to describe feelings. It is in the form of a square, a kind of map of feelings. The center of the square (marked by X in the grid below) represents a neutral, average, everyday feeling. It is neither positive nor negative. The right half of the grid represents pleasant feelings. The farther to the right the more pleasant. The left half presents unpleasant feelings. The farther to the left, the more unpleasant.

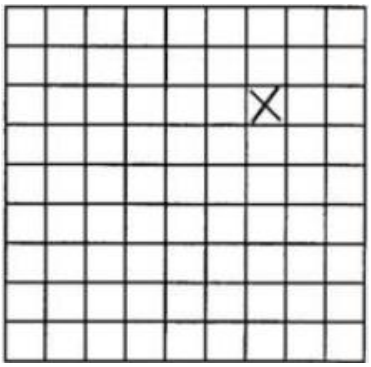


The vertical dimension of the map represent degree of arousal. Arousal has to do with how wide awake, alert, or activated a person feels independent of whether the feeling is positive or negative. The top half is for feelings that are above average in arousal. The lower half for feelings below average. The bottom represents sleep, and the higher you go, the more awake a person feels. So, the next step up from the bottom would be half awake/half asleep. At the top of the square is maximum arousal.

If you imagine the state we might call fransic excitement (remembering that it could be either positive or negative), then this feeling would define the top of the grid. If the "frantic excitement" was positive it would of course, fall on the right half of the grid. The more positive, it further to right. If the "frantic excitement" was negative, it would fall on the left half for the grid. The more negative, the further to the left. If the "frantic excitement" was neither positive nor negative, then if would fall in the middle square of the top row.

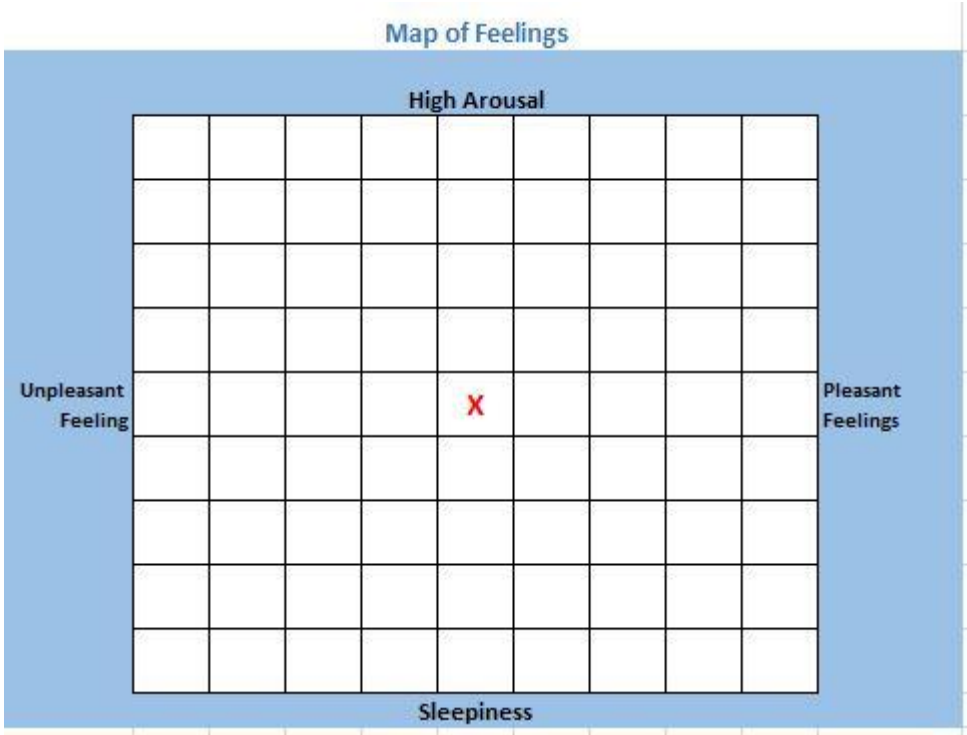
Other areas of the grid can be labelled as well. Up and to the right are feelings of ecstasy, excitement, joy. Opposite these, down and to the left, are feelings of depression, melancholy, sadness, and gloom. Up and to the left are feelings of stress and tension. Opposite these, down and to the right, are feelings of calm, relaxation, serenity.

Example: Suppose, instead, that you were only *mildly surprised* but that the surprise was a mildly pleasant one. You might put your mark as shown below.



Feelings are complex. They come in all shades and degrees. The labels we have given are merely landmarks to help you understand the affect grid.

When actually using the grid, please look over the entire grid to get a feel for the meaning of the various areas then click to indicate the exact shade and intensity of your right now feeling.



Appendix B11: Audio scripts (Mindful-colouring)

English version

"Hello. You have now completed several questionnaires and tasks. It is now time to relax your mind whilst colouring a picture. You have a booklet containing a picture, some colouring pencils and a headphone to use during this colouring session. Please listen carefully.

Please open the booklet. You will see two pictures, one is a colour picture on the top and the other is a plain picture. This is a mindful colouring designed to settle you in the present moment. Before you start colouring, allow your eyes to settle on the pattern in front of you, whilst ignoring the coloured picture. Bring your awareness towards the pattern and spend a few moments observing it.

Now gathering your attention, and moving it to focus on the centre of the pattern. So that the spotlight of attention takes in all the intricacies of that area of the pattern. Observing the pattern moment by moment. Now move your attention to take in the next small piece of the pattern, then the next small piece. Sooner or later you will probably find that the mind, wanders away, from the process to thinking, planning, remembering or daydreaming, when this happens there is no need to criticize yourself.

During the colouring you will hear a bell, every time you hear the bell, use this to remind you to gently escort your attention back to the pattern. Whenever you hear the instruction to stop colouring, you need to stop even though you may not have finished the colouring yet. Remember, you still need to ignore the coloured picture.

Now bring your awareness back to the centre of the pattern. "Select a colour" and "begin" to fill in the centre of the pattern. Take your time to colour from the centre towards the outer parts of the pattern. And remember to bring your attention back to the pattern whenever you hear the bell. Please start your colouring now"

Thai version

"สวัสดี. คุณได้ทำแบบสอบถามและงานหลายอย่างเสร็จสิ้นแล้ว ถึงเวลาผ่อนคลายจิตใจของคุณในขณะที่ระบายสีรูปภาพ คุณมีสมุดเล่มเล็กที่มีรูปภาพ ดินสอสี และหูฟังที่จะใช้ในช่วงการระบายสีนี้

โปรดฟังอย่างตั้งใจ

กรุณาเปิดสมุดเล่มเล็ก คุณจะเห็นภาพสองภาพ ด้านบนเป็นภาพสี ด้านล่างเป็นภาพลวดลายขาวดำ นี่คือกิจกรรมที่ออกแบบมาเพื่อคุณได้อยู่กับช่วงเวลาปัจจุบัน

ก่อนที่คุณจะเริ่มระบายสีให้คุณจับจ้องไปที่ลวดลายขาวดำด้านหน้าของคุณ ไม่ต้องสนใจภาพสี นำการรับรู้ของคุณไปสู่รูปขาวดำ และใช้เวลาสักครู่ในการสังเกต ตอนนี้รวบรวมความสนใจของคุณมาตรงกลางของรูปขาวดำ

ตอนนี้ย้ายความสนใจของคุณไปที่ชิ้นส่วนเล็กๆ ของลวดลายบนภาพขาวดำนั้น เริ่มจากชิ้นหนึ่งแล้วก็ชิ้นที่อยู่ติดกัน ไม่ช้าก็เร็วคุณจะพบว่าจิตใจไม่อยู่กับภาพขาวดำนั้น การใจลอยนี้อาจเกิดขึ้นได้ คุณไม่ต้องกังวลไปกับการใจลอยนั้น ให้กลับมามีสมิธิจดจ่อกับชิ้นส่วนเล็กๆที่ลวดลายภาพขาวดำต่อไป

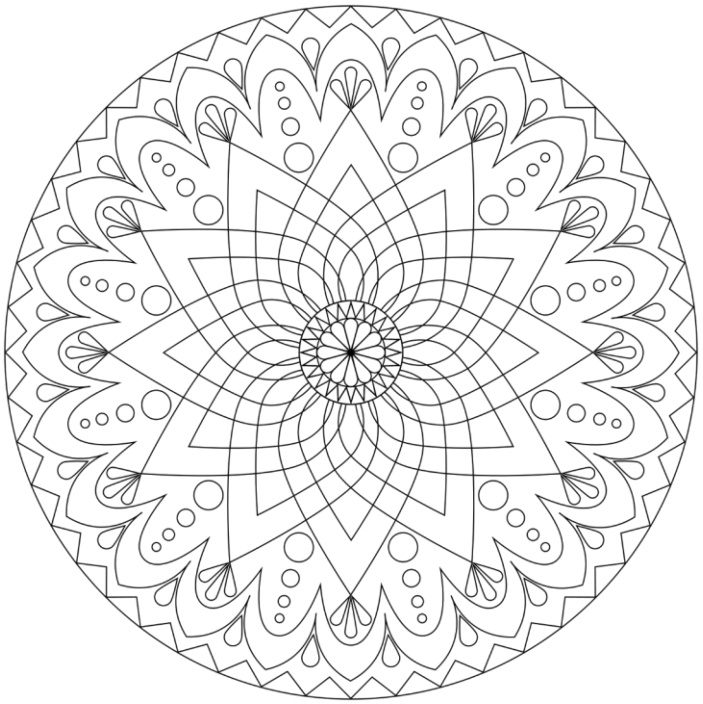
ในระหว่างการระบายสีคุณจะได้ยินเสียงระฆัง ทุกครั้งที่คุณได้ยินเสียงระฆังให้ใช้เสียงนี้เตือนให้คุณค่อย ๆ พาความสนใจกลับไปที่ลวดลาย เมื่อใดก็ตามที่คุณได้ยินคำสั่งให้หยุดการระบายสี คุณต้องหยุดแม้ว่าคุณอาจจะระบายสียังไม่เสร็จก็ตาม อย่าลืมว่าคุณยังต้องไม่มองภาพสี

ตอนนี้ให้นำความรู้ตัวของคุณกลับมาสู่ศูนย์กลางของรูปขาวดำ ให้คุณลงมือ “ เลือกสี” และ“ เริ่มระบายสี” ได้ ให้ระบายจากตรงกลางแล้วขยายออกไป และอย่าลืมนำความสนใจกลับไปที่ลวดลายภาพขาวดำเมื่อคุณได้ยินเสียงระฆัง

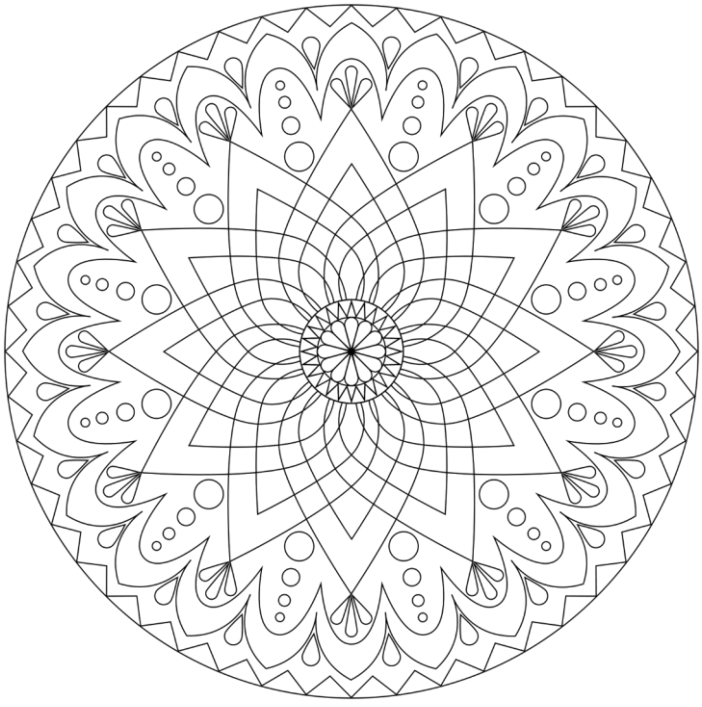
เริ่มระบายสีได้

Appendix B12: Booklet: Alcohol study

Booklet for experimental group

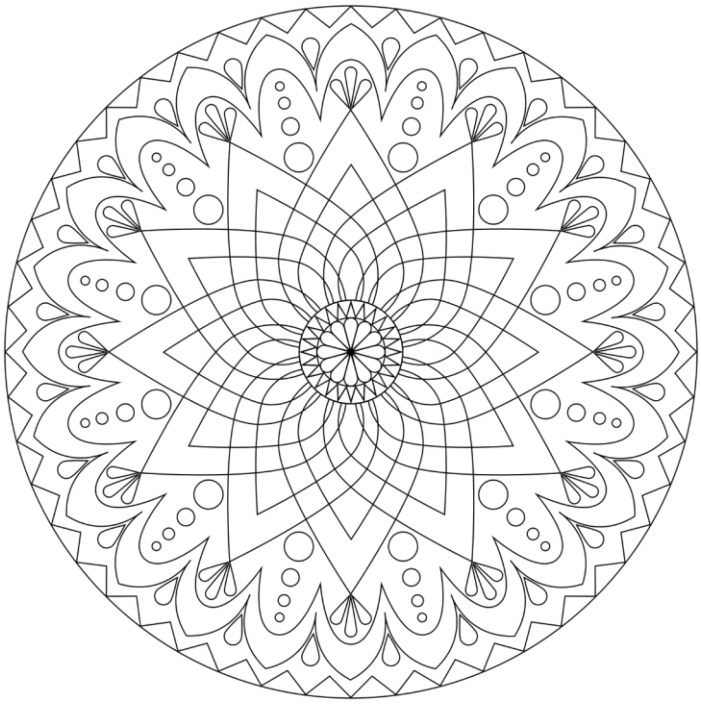


Booklet for control group

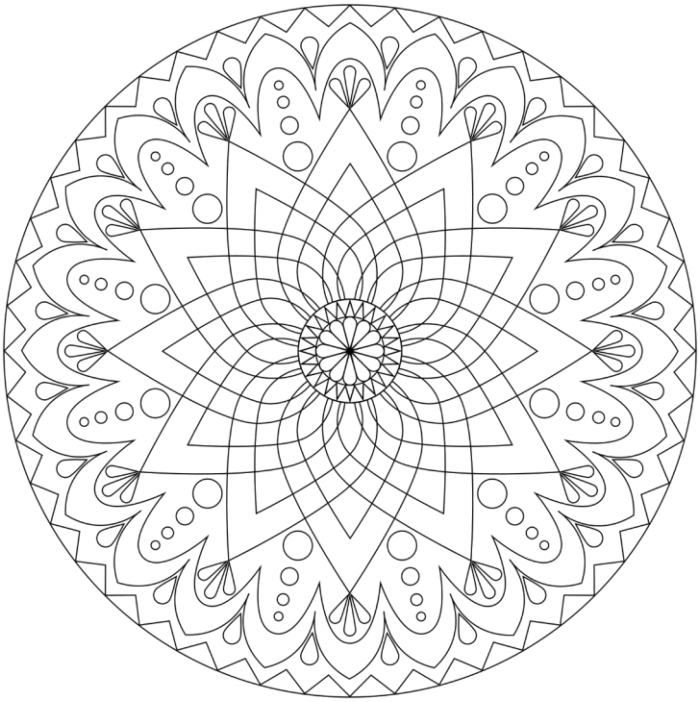


Appendix B13: Booklet: Methamphetamine study

Booklet for Experimental group



Booklet for control group



APPENDIX B14: Picture of VDO: 10 position of mindful movement

From https://www.youtube.com/watch?v=RlPsqRG9yo8&t=315s

Appendix B15: Mindful-breathing and body scan: Audio scripts

Thai script	Translated to English
“ขอให้คุณสมมุติตัวเองว่าเป็นคนอีกคนหนึ่งที่อยู่ข้างๆตัวคุณในขณะนี้ และกำลังเฝ้าดูตัวคุณอย่างใกล้ชิด คุณเห็นภาพตัวเองชัดเจนหรือไม่ ทั้งด้านหน้า ด้านข้าง และด้านหลัง คราวนี้ ขอให้คุณสังเกตตัวเองให้ใกล้ชิดมากยิ่งขึ้น สังเกตดูสิว่าการหายใจของคุณเป็นอย่างไร ช้าหรือเร็ว เป็นจังหวะสม่ำเสมอหรือไม่ เฝ้าดูตัวคุณหายใจเข้าออกสักระยะหนึ่ง จากนั้น ให้คุณสังเกตร่างกายของคุณอย่างใกล้ชิด ท่านั่งของคุณเป็นอย่างไร ใบหน้าเป็นอย่างไร ลำคอของคุณตั้งตรง หรือคุณกำลังก้มหน้า คุณกำลังนั่งหลังตรง หรือกำลังพิงพนักเก้าอี้ตามสบาย แขนทั้งสองข้างของคุณละเป็นอย่างไร มือของคุณวางอยู่ในท่าใด ขาทั้งสองข้างของคุณเป็นอย่างไร เท้าทั้งสองข้างวางราบกับพื้นหรือไม่ สังเกตร่างกายของตัวคุณต่อไปสักระยะหนึ่ง เมื่อสังเกตร่างกายภายนอกแล้ว ให้คุณสังเกตถึงลงไปอีกว่าร่างกายของคุณเป็นปกติดีอยู่หรือไม่ มีอาการเจ็บปวดตรงส่วนไหนบ้าง ถ้ามีอาการเจ็บป่วยตรงส่วนใด ให้คุณอยู่กับความเจ็บปวดตรงนั้นสักพักหนึ่ง เฝ้าดูความเจ็บปวดที่เกิดขึ้น สังเกตดูว่ามันยังเจ็บปวดเท่าเดิม หรือมากขึ้น หรือน้อยลง จากนั้น ให้คุณลองเปลี่ยนมาสังเกตความคิดของคุณบ้าง ตอนนี้คุณกำลังคิดอะไรอยู่ คิดเรื่องเดียวหรือหลายเรื่อง ลองเฝ้าติดตามความคิดของคุณไปเรื่อย ๆ คุณจะสังเกตเห็นว่า ลมหายใจ ร่างกาย ความคิด ความรู้สึก และอารมณ์ของคุณ ไม่หยุดนิ่ง แต่จะมีการเปลี่ยนแปลงอยู่ตลอดเวลา คุณจึงไม่ควรไปยึดติดอยู่กับมัน คุณไม่จำเป็นต้องหวาดกลัว วิตกกังวล หรือเป็นทุกข์อยู่กับมัน เพราะเมื่อมันเกิดขึ้น มันก็จะค่อย ๆ ผ่านไป และค่อยๆหมดไปในที่สุด แล้วก็จะมีสิ่งใหม่ ๆ เกิดตามมา เหมือนระลอกคลื่นที่ไม่มีวันจะหยุดนิ่งอยู่กับที่ ขอให้คุณปล่อยวาง เพื่อคุณจะได้รู้สึกผ่อนคลาย เบาสบาย และเป็นทุกข์น้อยลง มีความสุขมากขึ้น ตอนนี้ ขอให้คุณกลับเป็นตัวของตัวเอง และกลับสู่เวลาปัจจุบัน กลับมาสู่ห้องนี้อีกครั้งหนึ่ง”	*“Please make yourself comfortable and close your eyes. Picture in your mind’s eye that you're sitting next to yourself in a chair, looking at your own body. Can you see yourself clearly, at the front, side and back?* *Now, look at yourself more closely. Observe your breathing – is it slow, fast, or regular? Watch yourself breathe in and out.* *Now observe your posture. What is your sitting position? What is your facial expression? Is your head upright or tilted? Are you sitting up straight or slouching a little? Where are your arms and hands? Your legs? Are both feet flat on the ground? Observe your body.* *Now shift your attention from your external body to the inside. Do you feel pain in any part of your body? Pay attention to that area. As you observe it, does the pain increase, decrease or stay the same?* *Now focus on your mind. What are you thinking now? Do you have a single thought or many different thoughts popping in and out? Try to watch your thoughts as they come and go.* *And now bring your attention back to your breath.* *As you do these exercises, you will notice that your physical sensations, your feelings and your thoughts are not static but will change over time. You can let them come and go. You do not have to stay afraid, anxious or distressed. If those feelings arise, they will gradually disappear. New feelings and thoughts will arise, like ocean waves that come and go and come again. As you observe these waves, you will feel more relaxed. You will feel lighter. You will feel happier.* *Now slowly become aware of your present surroundings. Take a deep breath. And slowly open your eyes.”*