Placebo expectancy effect of consuming psychoactive beverages on cognition and mood

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ABSTRACT

Energy drinks have become very popular over the past few years with over half the student population in colleges and universities consuming them at least once a month (Malinauskas et al., 2007). It has been reported that the most common reasons why students consume energy drinks are to maintain alertness, reduce symptoms of hangover, increase energy, to help with driving and to prevent sleepiness (Attila and Cakir, 2011; Malinauskas et al., 2007). Previous research has suggested that energy drinks enhance sensorimotor speed, behaviour, and reduce levels of fatigue (Alford et al., 2001; Horne and Reyner, 2001; Howard and Marczinski, 2010; Kennedy and Scholey, 2004; Smit et al., 2004). The two key ingredients found in energy drinks are caffeine and glucose which have been examined together and alone, which have indicated enhanced reaction times, improvement in both verbal memory and sustained attention and more recently there is evidence to show that expectancy may play a key role in predicting intentions of future consumption (Adan and serra-Grabulosa, 2010). According to Kirsch (1997) people have specific expectations when they consume psychoactive substances that trigger physiological and psychological reactions, which tend to be independent of the psychoactive substance ingested. The concept of expectancy effects can be unambiguous especially when the information provided to the participants prior to the experimental study is specific to a possible outcome response.

This thesis investigated the extent of expectancy effect on cognition and mood when psychoactive drinks containing caffeine and glucose were consumed in comparison to non-psychoactive drinks. The investigation commenced with examining the independent effects of caffeine and glucose, followed by the combination of caffeine and glucose as an energy drink on mood and cognition. The investigation advanced by comparing drink presentation effects (i.e., consuming the experimental drink from a branded bottle versus from a glass) irrespective of drink content on mood and cognition. Finally, the investigation lead to exploring what factors may predict expectancy effects when participants' consumed psychoactive drinks among healthy adults. This was done by applying the Theory of Planned Behaviour model (TPB) (Azjen, 1991) to explore the contribution of specific attitudes, subjective norms and perceived behavioural control to the extent of expectancy effects as well as to behavioural intention, with additional variables including; beliefs, habits, past-behaviour, self-identity. Self-identity representing someone who drinks energy drinks regularly. The level of internal consistency for Cronbach's alpha was conducted for each variable within the TPB model and for the additional variables included for test reliability.

This thesis consisted of four studies, which found that consumption of caffeine and glucose independently and also in combination resulted in psychoactive effects on mood and cognition. Experiment 2 was the only study, which indicated an expectancy effect for immediate verbal recall task and the mood subscale tension. Conversely, for experiment 4 there was a reverse effect found for the immediate verbal recall task. However, there were significant expectancy and psychoactive effects found for mood subscales throughout the four studies. It was also found that the TPB model had two significant variables past-behaviour and self-identity predicted intentions suggesting that participants who regularly consume psychoactive beverages have salient beliefs about consuming psychoactive drinks and the TPB model can be utilised to predict their intentions. Furthermore, the Theory of planned behaviour model found that habit and self-identity significantly predicted participants' expectancy effects on the vigour. Indicating consumers of energy drinks are familiar with expected outcome response. This model was unsuccessful in predicting expectancy response for cognitive performance. Thus, overall the findings from the four studies indicated that caffeine and glucose have cognitive enhancing properties, which also positively improve mood. However, expectancy effects have been identified for mood only, whereas the overall findings within this thesis were unable to identify significant predictors of expectancy effect and response.

Keywords: Psychoactive drinks, Caffeine, Glucose, Memory, Cognition, Mood, Placebo, Expectancy effect.

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Chapter 1: Thesis Overview

1.1 Rationale for the Research

This thesis consists of series of studies that examine the source of performance enhancing effects of energy drinks. There is a large amount of research that has examined the cognitive and mood enhancing effects of certain components of food and drink. The two most extensively investigated are glucose (e.g. Sunram- Lea et al., 2004) and caffeine (e.g. Yeomans et al, 2000). These have been examined both independently and in combination in the form of an energy drink (e.g. Smit et al., 2004). However, there is also a body of work indicating that expectancy effects of psychoactive ingredients (caffeine and glucose) found in energy drinks also influences mood and cognition. For instance, Green et al, (2001) investigated the extent of expectancy in the facilitation of glucose on cognition. The findings from this study reported that glucose enhanced cognitive performance overall, but this was found only when participants were informed they are consuming glucose, whereas, this effect was not found when participants were told that they are receiving aspartame which is an artificial sweetener. The placebo drinks were made so that there was no detectable taste difference or appearance to the glucose drink. It was concluded in this study that there was some contribution of expectancy to the positive effects of glucose on cognition. This thesis will aim to extend this initial pilot work, researched by Green et al (2001), which only examined the placebo expectancy effects in the relationship between glucose and cognition. The present study will extend the initial pilot work by examining the placebo effects of consuming psychoactive beverages (caffeine and glucose) on cognition and mood. The psychoactive beverages containing caffeine and glucose will be tested independently and in combination in order to measure the ability of actual psychoactive effects and the extent of expectancy using a within-subjects balanced placebo design.

Energy drinks have become very popular over the past few years with over half the student population in colleges and universities consuming them at least once a month (Malinauskas et al., 2007). It has been reported that the most common reasons why students consume energy drinks are to maintain alertness, reduce symptoms of hangover, increase energy, to help with driving and to prevent sleepiness (Attila and Cakir, 2011; Malinauskas et al.,

2007). Previous research has suggested that energy drinks enhance sensorimotor speed, behaviour, and reduce levels of fatigue (Alford et al., 2001; Horne and Reyner, 2001; Howard and Marczinski, 2010; Kennedy and Scholey, 2004; Smit et al., 2004).

Popular energy drinks contain 80mg of caffeine per 8oz serving (Koppelstaetter et al., 2010; Smith, 2011) as compared with a regular cup of coffee of 8oz containing 60-85mg of caffeine and 1oz of espresso containing 30-50mg (International Food Information Council, 2008). According to James & Rogers (2005), the beneficial effects of caffeine on cognitive performance are due to the reversal of caffeine withdrawal effects, with caffeine withdrawal resulting in cognitive impairments and changes in mood, psychological stress, lack of sleep and physical fatigue and exhaustion (Koppelstaetter et al., 2010; Lieberman, 2003; Lorist & Tops, 2003). Therefore indicating habitual caffeine consumers who encounter withdrawal effects after abstaining from caffeine for couple of hours are more likely to experience enhancing cognitive performance when they consume caffeine in comparison to non-habitual caffeine consumers. For instance, Hewlett and Smith's (2007) study reported that caffeine enhanced vigilance and reaction times in both habitual and non-habitual caffeine consumers. This study suggested habitual caffeine consumer's reaction times and vigilance might have been enhanced due to caffeine withdrawal effects. Whereas, for non-habitual participants this enhanced effect may have been due to the actual psycho-stimulating components of caffeine. In other studies this was not the case, as the reaction times were better for habitual consumers compared to moderate-habitual consumers (who do not drink caffeine regularly throughout a day), all of whom had abstained for thirty hours prior to the arrival to the laboratory in order to capture potential withdrawal symptoms in their peak range, which confirmed the suggestion of the larger effect being the reversal of caffeine withdrawal (Juliano & Griffiths 2004; Addicott and Laurienti, 2009; Attwood et al.,2007). Given the studies above, the present experiments in this thesis requested all participants to abstain from food and drink containing caffeine and glucose ingredients at least couple hours prior testing to measure possible withdrawal effects.

The second key ingredient claimed to be responsible for performance enhancement is glucose. According to Gorby et al., (2010) glucose is known to enhance certain areas of cognitive performance including, spatial awareness, logic and short-term memory. Energy drinks tend to have 27mg of glucose per 8oz serving as compared with, say, a regular coke can which has approximately 39mg per 8oz or orange juice which tends to have 25mg per

8oz (Koppelstaetter et al., 2010; Smith, 2011). Caffeine and glucose have been examined together and alone which have indicated enhanced reaction times and improvement in both verbal memory and sustained attention, with greater effect found on cognitive performance when caffeine and glucose are combined in one experimental drink (Adan and serra-Grabulosa, 2010).

According to Kirsch (1997) people have specific expectations when they consume psychoactive substances that trigger physiological and psychological reactions, which tend to be independent of the psychoactive substance ingested. These types of reactions and behaviour tend to be examined via the so-called balanced placebo design, e.g. this is when participants are either informed they are ingesting a psychoactive substance or a placebo or vice versa.

Kirsch (1999) demonstrated response expectancy theory, which is based on the concept what people experience depends relatively on what they expect to experience (Kirsch, 1985). This concept of response expectancy lies behind the placebo effect (Kirsch, 1999). Response expectancy theory is supported by research demonstrating that both subjective and physiological responses can be altered by changing people's expectancies (Kirsch, 1999). Hence, this concept has been applied to the understanding of pain, depression, anxiety disorders, asthma, addictions and psychogenic illnesses.

The concept of expectancy effects can be unambiguous especially when the information provided to the participants prior to the experimental study is specific to a possible outcome response. For instance, in the present thesis, in experiments 2 – 4 participants were given information about the experimental drinks, which was either correct or incorrect (i.e. given energy drink but informed they are given placebo, or given energy drink and informed they are consuming an energy drink). Giving such manipulative information prior drink consumption would create possible expectancy response. Thus, the manipulation process would include examining the effects of information about the drink given prior consumption, consuming the experimental beverage from a reputed branded bottle and from a clear glass. Hence, manipulation of such factors listed above would indicate whether the enhancement in cognitive performance and mood are dependent on the perception of the information, or physical appearance of beverage consumed, irrespective of drink content. Similarly, consumption of branded energy drinks also bring out the concept of learned experience

which consumers associate with being positive or negative. Conducting a series of balanced placebo studies may confirm whether the actual psychoactive ingredients (caffeine and glucose) found in energy drinks enhance cognitive performance and improve mood or are these findings a result of preconditioning, previous knowledge, and attitude towards energy drinks.

In order to investigate the concept behind how expectancy effects are derived from external cues, habits, preconditioning, knowledge, and attitudes, the Theory of planned behaviour model (TPB) was adapted to predict expectancy outcome behaviour and responses. This model assessed the extent of the listed constructs within the TPB model and the additional variables included within this model on predicting expectancy effect (see Chapter 6). This thesis is intends to set out studies, which specifically look at predicting expectancy variables by subtracting the drink conditions (*given placebo and told they are consuming a placebo drink* from *given placebo drink and told they are consuming an energy drink*). In order to understand participants' behavioural expectancy outcome, it is important to examine participants' attitudes, subjective norms, perceived behavioural control, intentions, beliefs, habits, past behaviour and self-identity. As the TPB model constructs: attitude, subjective norms, perceived behavioural control and intentions are antecedents of planned behaviour which may also predicts expectancy effects. This thesis will use the TPB model to explain and understand what antecedents predict expectancy effects when participants think they are consuming psychoactive beverages.

TPB model is a social cognition model that aims to map out the influences on behavioural intention. This model was developed by Fishbein and Ajzen (1975) as the Theory of Reasoned action, which was later revised and expanded by Ajzen (1985) as the Theory of Planned Behaviour model. Figure 1-1 illustrates the interplay between the psychosocial constructs in the TPB model.

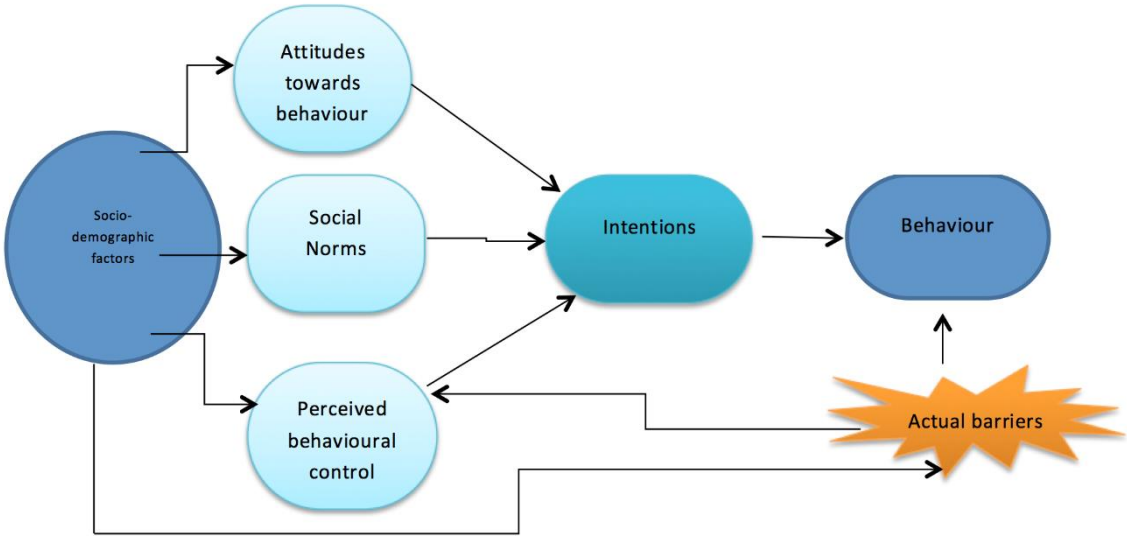

Figure 1-1 The Theory of Planned Behaviour Model

The TPB model is a theoretical approach that has been used to predict various healthy behaviours (Glanz, Rimer, & Lewis, 2002; Armitage & Conner, 2001; Hardeman et al., 2002; Godin & Kok, 1996). The TPB states that the constructs, attitude, subjective norms and perceived behavioural control, impact on a person's behavioural intention, which then influences the individual's outcome behaviour. The outcome behaviour is linked to possible expectancy response (e.g., the operation of attitudes and beliefs are essentially beliefs that the experimental drink will have a certain effect on their performance).

There are various expectancy models that explain the process of expectancy. These models of expectancies will be discussed in the literature review that presents the understanding of how packaging of energy drinks can create expectancy effects, using placebo designs to examine the difference between packaging, and their actual effects in the absence of such expectancies. Thus, the aim of this research was to explore how expectancy of energy drinks is developed and how expectancy effects influence performance and mood. This thesis will systematically investigate the various psychological factors that can affect performance and mood enhancing effects of energy drinks other than the actual psychoactive nature of ingredients present in the drink. This thesis will have three main components. It will investigate the presences of expectancy effect by manipulating participants' perceptions of the nutritional composition of the drinks. This will clarify whether participant's enhanced performance is due to the manipulation of perception of the nutritional composition, i.e. given placebo drink and informed they are consuming an energy drink, given a placebo drink

and informed they are consuming a placebo drink, given an energy drink and informed they are consuming an energy drink and lastly given an energy drink and told they are consuming a placebo drink. Alternatively, the series of studies may indicate that participant's performance was not enhanced via manipulation, but by the actual psycho-stimulating effects of the beverage consumed. The outcome variables will include perceived mood, arousal levels, and cognitive function, the latter being assessed with a battery of computer based measures assessing memory, attention, visuo-spatial processing and planning ability.

1.2 Literature review

The purpose of this review is to examine the background and theoretical basis for the research subject in question on evidence available. The literature review provides a broad understanding of the characteristics and the effects the psychoactive ingredients (caffeine and glucose) have physiologically and psychologically on individuals. The literature review also discusses previous placebo expectancies studies that provide an understanding of how expectancy effects are created and how this may be developed to understand expectancy effects in non-medical situations.

The first section of the literature review explores research on caffeine and how the psycho-stimulating effects that enhance cognitive performance and mood. The discussion then leads onto whether the stimulating caffeine effects are only existent in habitual consumers and, or consumers who are not habitual but familiar with caffeine effects. The second section of the literature review then discusses the psycho-stimulating effects of glucose and how this affects cognition and mood. The third section examines and identifies the various placebo and expectancy studies. This section provides an in-depth understanding of how expectancy effects can arise by exploring a range of expectancy models, which supports the foundation of the research being investigated. The fourth and final section explores the effects of branding of products and how this creates expectancy of possible outcome behaviour and responses.

The final section of the literature review proposes using the Theory of Planned Behaviour model (TPB) to examine whether components within the TPB model predict expectancy, based on a synthesis of the literature reviewed, which suggests how expectancy effects may interact with actual psychoactive effects of the stimulants caffeine and glucose, to include

pre-exposure, attitudes, beliefs and familiarity of these ingredients. The chapter concludes with the main aims and hypotheses of the research and a summary of the thesis structure.

1.2.1 Caffeine Literature

1.2.1.1 The Physical Psychoactive Effects of Caffeine

The term stimulant often arouses emotionally pejorative reflexes and it is important to make a distinction between stimulant and non-stimulating drinks to determine whether the physiological effects of drinks such as caffeine are determined by expectancy effects or dosage of caffeine actually affect neurophysiologic responses (Glade, 2010). Coffee is renowned worldwide as a beverage with expectations to enhance mood, performance and prevent feeling fatigue (Fillmore & Vogel-Sprott, 1992; Lotshaw, Bradley & Brooks, 1996). Various research, has reported different outcomes that will be discussed in this section. This section will explore research papers including: what are consumers' expectation of caffeine, withdrawal effects for habitual consumers of caffeine, what are the positive and negative mood effects of consuming caffeine, how does caffeine impacts on the human neural activity.

Caffeine consumers may drink caffeinated beverages for two reasons, for taste or the expectation of what caffeine has on them both psychologically and physiologically. Regular caffeine consumers are aware of the stimulating effects caffeine has upon them. The recognition of this is apparent, as regular consumers generally consume caffeine beverages in the morning before work, during working hours or before particular situation to enhance their alertness and reduce fatigue (Fillmore et al., 1992).

1.2.1.2 The effects of different caffeine dosage on cognition and mood

According to Glade (2010), caffeine consumption produces significant improvements in attention, general alertness, short-term memory, reasoning, reaction time, response accuracy and vigilance. Paralleling the cognitive effects found for cognitive performance, caffeine also improves mood such as; reduced depression (Childs & de Wit, 2008), reduced anxiety (Quinlan, Lane & Aspinall, 1997), enhanced happiness (Amendola, Gabrieli & Lieberman, 1998). The understanding that is derived from the effects of caffeine consumption is dependent on dose of caffeine consumed and how this induces different expectation

outcomes. Thus, depending on the level of consumption, the expectation of caffeine effects will differ in placebo studies. For instance, consumers may have higher expectancy effects from drinking strong espresso than from a milder coffee.

It has been acknowledged that the consumption of caffeine or lack of consumption of caffeine for habitual consumers results in direct effect on mood. This is because the psychoactive effects of caffeine depend to a large measure on the regularity of caffeine intake (Robelin & Rogers, 1998). Regular caffeine consumers have reported to have increased alertness, energy, mood and that the caffeine also aids relaxation (Schweitzer, Muehlbach & Walsh, 1992). In contrast, caffeine has also been illustrated to have adverse effects on mood (Gilbert, 1984). There are contrasting findings suggesting the dose of caffeine ingested may different effects on both mood and arousal levels. For instance, an increase in alertness, wellbeing, calmness, and self-rated happiness are some of the emotional and physiological changes that occur when caffeine is ingested (Zwyghuizen-Doorenbos, Roehrs, Lipschutz, Timms and Roth, 1990). Experiencing negative feelings such as anxiety, anger and nervousness (Roache and Gruffiths., 1987; Chait., 1992; Rush Sullivan and Griffiths., 1995) are all found to be dependent on the dose of caffeine digested.

Hewlett & Smith (2007) reported that the consumption between (32mg – 50mg) of caffeine significantly stimulates attention and alertness within twenty minutes of consumption was measured by assessing cognitive performance. Subsequently, a placebo study conducted by Peeling & Dawson (2007) examined the ineffectiveness of placebo pill in comparison to (100mg) of caffeine, which was consumed as a pill capsule by students one hour before attending a seventy-five minutes lecture. This study found that consuming a higher dose of caffeine, the students reported post-lecture greater alertness, mental clarity and wakefulness, as they felt more energetic compared to the placebo group. This study indicated that consuming caffeine had beneficial effects on students attending the seventy-five minute lecture compared to the participants who consumed the placebo pill. This concept can be adopted to test the expectancy and actual psychoactive effects of caffeine using the TPB model by assessing how each measure influences each construct within the TPB model.

Another study explored the effects of caffeine upon mood and arousal. Lieberman (1992) concluded when participants consume doses of 300mg or more of caffeine participants' anxiety levels increase. It was established that when smaller amounts of caffeine was

ingested there were marginal effects on mood and anxiety. When caffeine is ingested in moderate volumes, it is found to reduce self-rated depression (Lieberman, 1988). It has also been acknowledged that consuming doses between (20-200mg) of caffeine generates feelings such as; the ability to focus and concentrate, happiness and increased energy levels, and anything above this dose increases anxiety levels which naturally decreases ability to focus (Lieberman, Wurtman, Emde and Coviella.,1987). Thus, the series of studies in this thesis used caffeine doses of 150mg for one litre of water, which are 49.9g of caffeine for 330ml to measure the active effects of caffeine on mood and overall energy levels.

Negative attitude and feelings such as experiencing nervousness and anxiety tend to increase with dosage between (200-800mg) (Evans and Griffiths., 1991). If the right amount of caffeine dose is consumed, participants may experience positive outcomes both emotionally and cognitively. This is because both mood and arousal are manipulated by caffeine, which would influence individual expectation and performance. Hence, consuming caffeinated beverages has some form of expectation attached to their level of performance on a daily basis, as consumers expect these positive enhancing effects to help them with daily cognitive tasks and general functioning. This indicates that expectancy of caffeine consumption is associated with previous experience of consuming caffeinated beverages, as consumers are aware of possible physiological and psychological outcomes when they consume caffeine. The TPB model can distinguish whether learnt attitudes, beliefs, subjective norms and perceived behavioural control over the behavior can shape intentions to consume psychoactive drinks and whether these predictors also contribute to the level of expectancy effect. Depending on these factors, participants will shape their desire and intentions via expectations created, whether these expectations are positive or negative.

1.2.1.3 Expectations of caffeine consumption

Consumer attitude towards coffee and caffeinated products are dependent on what beliefs they hold for caffeinated beverages. The belief they have of caffeinated beverages can influence the consumer's attitude either positively or negatively. This is dependent on the consumer's previous experience or lack of experience of consuming caffeinated beverages. If the consumer holds a positive attitude of consuming caffeine, they will also have positive intentions and expected outcome. For instance, the expectation of consuming caffeine beverage before bedtime has been associated with preventing sleep and relaxation. Thus,

caffeine consumption is associated with the expectation to enhance mood, alertness and reaction time (James, 1991; Lieberman, Wurtman, Emde, Roberts and Coviella, 1987).

Dawkins et al (2011) conducted a study to explore the expectation of having consumed caffeine upon attention, reward responsivity and mood. Using a between subject, double-blinded design this study recruited eighty-eight participants who were allocated into drink type (caffeinated / decaffeinated coffee drink) and expectancy (told caffeinated drink / told decaffeinated drink) groups. The groups were matched for gender and age. The expectancy was manipulated by either informing the participants accurately or falsely that they will be consuming an ordinary caffeinated coffee drink or an ordinary decaffeinated coffee depending on what group they have randomly been allocated into. The participants' mood was assessed using the Profile of Mood State questionnaire (POMS), in short form including the four most relevant subsets (depression, fatigue, tension and vigour-activity) before they consumed any experimental beverage and at the end of the experiment. The tasks the participants completed were as follows in a fixed order; the standard computerised Stroop task that assessed the ability to inhibit automatic response; the Card Arranging Reward Responsivity Objective Test (CARROT) and POMS in short form. As the effect of motivation in caffeine studies has had very little research conducted, the Card Arranging Reward Responsivity Objective Test (CARROT; Al-Adawi & Powell, 1997) has been considered as test, which can measure motivation and psychomotor performance by giving participants an incentive of money to complete the task. This task required the participants to sort cards out across four trails using simple rule. The average speed of sorting the cards across two trails without reward is subtracted from the average speed across the two rewarded trails. Using this process the effects of caffeine or expectancy on reward responsivity can be explored (Dawkins et al., 2011). The findings from this study indicated that both caffeine and expectation of having consumed caffeine in the absence of actual caffeine, enhanced attention and psychomotor performance for both caffeine and decaf drink conditions (i.e., the average speed of sorting the cards out). The POMS questionnaire found that expectation of having caffeine had improved self-reported vigour-activity in both caffeine and placebo condition. Participants in the placebo condition who have the expectation of having caffeine had improved reward responsivity too. Thus, this study suggests that mood and performance can be affected by caffeine consumption and expectation of consuming caffeine in the absence of actual caffeine (placebo). Though coffee

is not considered to enhance responsivity, it may do via the process of associative learning as it was reported in Dawkins et al (2011) study which suggests participants use a mechanism of associative learning by pairing task with an incentive such as, taking a break with having a biscuit or in this case completing the CARROT task quickly and correctly will result in higher financial incentive. This concept requires further work before any association can be linked with any psychoactive beverage expectancy and reward responsivity. The series of studies in the present thesis aims to examine the effects of psychoactive stimulants caffeine and glucose independently and in combination to measure the actual and expectancy effects of experimental beverages along with offering a generous reward incentive of research credits for participating. Thus, the aims for the present series of studies are very similar to Dawkins et al (2011) experimental work, which expect to find an expectancy effect in the absence of psychoactive beverage (i.e., placebo condition) for mood and cognitive tasks when participants are under the impression they are consuming an active stimulant beverage.

Klaasen et al., (2012) investigated the effect of caffeine on working memory load-related brain activation in middle-aged men. The aim of this study was to determine whether caffeine affects working memory load activation during encoding and maintenance and retrieval phases of a working memory maintenance task, using functional magnetic resonance imaging (fMRI). This was a double-blind placebo controlled crossover design, which recruited twenty habitual caffeine male caffeine drinkers between the ages (40-61) and were administered (100mg) of caffeine. Participants were scanned following a workday during a non-withdrawn state when they had consumed caffeinated products. The findings indicated that acute caffeine administration was associated with increased activation in left and right dorsolateral prefrontal cortex during encoding working memory relative to placebo condition. Thus, these findings indicate caffeine has a direct effect on working memory and indirect effect via arousal modulation. Hence, the behavioural and fMRI findings were consistent with favourable effect of caffeine on higher working memory at higher level relative to caffeine related working memory enhancement. Thus this study reflects the beneficial effects of caffeine in habitual consumers without participants abstaining from caffeine, but does not indicate expectancy effect. However, if the participants were abstained from caffeine several hours before participating in this study, it would be expected that participants would experience negative withdrawal effects, which include headaches, mood swings and tiredness (Ozsunger et al., 2009). In this study it was concluded that participants

experiencing negative withdrawal effects crave caffeine, and therefore it would be expected that their performance would not enhance, if they were to complete a cognitive demanding task, in comparison to, if they were to consume caffeine, as they associate this to general enhancement in performance, which they have learnt from previous experience.

Recent researchers have started to use Magnetic resonance imaging (MRI) to examine the direct effects of caffeine consumption (Addicott, Yang, Peiffer, Burnett, Burdette & Chen et al. 2009). It was reported that acute ingestion of caffeine of 400mg significantly increased the blood flow to the middle and anterior cerebral arteries (Sigmon, Herning, Better, Cadet & Griffiths, 2009; Bendlin, Trouard & Ryan, 2007). For instance when participants were given 100mg of caffeine, they were given twenty minutes to digest caffeine before commencing any task. The MRI reported an increase in neural activity in the brain region dealing with attention-demanding cognitive functions during cognitive tasks that increased alertness, concentration and vigilance (Koppelstaetter et al., 2008; Lieberman, 2007). For this reason experiments 1-3 participants were given a twenty minutes rest and digestion period after drink consumption before completing any cognitive tasks or mood questionnaire.

Caffeine is a psychomotor stimulant affecting participants differently, whether it enhances performance or mood or both. In addition caffeine has also been associated with interacting with neural systems influencing motivation and reward. This effect is produced by the antagonising effect of adenosine on the mesocorticolimbic dopamine system (Ferre, 2010; Salamone et al., 2009; Nehlig, Armspach & Namer, 2010). A study conducted by Fillmore and Vogel-Sprott (1992), were participants had been equally divided into two groups, one being the treatment group who were receiving coffee and the other receiving decaffeinated coffee, this being the placebo group. Prior to administration of the beverage, the placebo group was informed that the caffeine improves their performance (this being the positive placebo condition) or they were informed that caffeine would impair their performance (this being a negative placebo condition) and their motor coordination. The findings from this study indicated that the positive placebo group illustrated greater improvement in motor skills compared to negative placebo group. This suggests that irrespective of the drink consumed the participants were manipulated by the information provided which also contradicts findings of other researchers that suggest information cannot manipulate participants' performance. Therefore, having positive beliefs of caffeine influenced the

expectancy effect. Subsequently, this study suggests that if a participant is a habitual caffeine consumer they are likely to experience a positive direct effect of caffeine upon performance irrespective of information, regardless of drink content, psychoactive effect or withdrawal reversal effect given. Whereas participants who are not habitual caffeine consumers would be manipulated by the information provided (i.e., '*caffeine enhances cognitive performance*') irrespective of drink content (Fillmore et al., 1992). This suggests that expectation plays different roles, which are perhaps dependent upon an individual's familiarity with caffeine, and what expectation they hold of caffeine in order for them to experience direct and indirect effects of consumption. The TPB questionnaire used in the last experiment would assess each component: (attitude, subjective norm, perceived behavior control, and intention). Having this information will examine the differences between participants, what knowledge they have previously have of psychoactive drinks, whether they are habitual consumers, whether branding influences their intentions, and overall what their beliefs are of psychoactive drinks. This would be accomplished by participants completing a TPB questionnaire prior to experiment, which would indicate participants' habits, beliefs, attitudes, and overall expectation of consuming psychoactive drinks in their daily life. This information from the TPB questionnaire will help determine what predicts the strength of expectancy effect.

1.2.2 Glucose Literature

1.2.2.1 The physical psychoactive effects of consuming glucose

In this section we explore the relationship between glucose and cognition, mood and how neural activity operates with the ingestion of glucose and the expectancy of consuming glucose. Glucose is one of the primary molecules that serve energy. Energy is produced when glucose oxidises through the process of metabolism, which produces carbon dioxide, water and some nitrogen compounds that releases energy in the form of adenosine triphosphate (ATP). Different regions of the human body require different volumes of energy. Glucose is transported to different parts of the body into cells. These cells have receptors on their surface that invite insulin hormone to create a chemical bond that releases energy. As a primary energy source in the human body it requires no digestion.

Glucose is required by the brain in order for all aspects of the human body to function normally. When the brain does not receive sufficient volumes of glucose the body will encounter negative and critical side effects due to there being neurochemical imbalances in the brain which can lead to depression, stress, low mood and poor cognitive performances. Thus, the neural activity in the human body requires energy derived from glucose (Sieber & Traystmen, 1992). This functions as follows; tryptophan is an amino acid, which is produced by proteins during digestion. Tryptophan is necessary for both cell growth and development and it is also the originator for the production of serotonin. Serotonin is a chemical (5-hydroxytryptamine, or 5-HT) derived from the tryptophan amino acid, which is found in the central nervous system.

1.2.2.2 The effects of different dosage of glucose on cognition and mood

Consuming a high dosage of glucose drink will inhibit rapid glucose depletion during cognitive demanding tasks. Sieber and Trastman (1992) explored how glucose impacts upon the human brain and it was reported that the major source of fuel for the brain is glucose, which is essential for everyday functioning of the central nervous system. The brain requires on average of (120g) of glucose per day to release energy.

It is also important to consider what dosage of glucose can enhance performance and mood significantly. Messier et al., (1998) investigated whether there was any relationship between glucose dose and verbal episodic memory in healthy young women. The uniqueness of this study was that the glucose dose was based on per kilogram of body weight. This study aimed to determine whether glucose ingestion modulated cognitive performance when there is a difference in participant glucose regulatory efficiency, which differs with individual participant weight. Thus, the dose response relationship between glucose ingestion and verbal episodic memory cannot be measured by glucose per (kg) of body weight (Messier, 1997; Salinas and Gold, 2005). Glucose cannot be administered according to participant body weight as glucose regulation efficiency and glucose metabolism differs in each individual and different body weights. The volume of glucose delivered to the brain will also differ in each individual, as there will be different rates of glucose employment of energy and circulating blood volumes, which can affect verbal episodic memory. In addition it has been acknowledged that consumption of glucose 300mg/kg dosage enhances cognition, in particular immediate verbal recall task relative to placebo condition (Messier et al., 1998).

Therefore the volume of glucose delivered to the brain was expected to differ between individuals, as there are a number of factors affecting glucose absorption in the brain such as, the different rates of glucose utilisation as an energy substrate and the differences in blood circulation. It was reported that the only significant glucose dose to enhance verbal episodic memory and immediate verbal recall of the first five items of a supraspan word list task was when 300mg/kg dosage was given relative to placebo and regardless of body weight. Thus any dosage higher or lower then 300mg/kg failed to enhance immediate recall performance (Messier et al., 1998). This may be due to the fact the every individual digests glucose differently at different rates depending on weight and muscle mass and on average it has been found that 300mg/kg dosage is the suitable dosage to identify glucose enhancing effects on cognition overall. However, it would also be important to note whether participants have consumed any other source of glucose prior to study as this would increase the volume of glucose (mg/kg). Hence, the volume of glucose in the experimental drinks in the present series of studies was approximately 50g. However, this was not measured per kilogram of a participant's weight but in line with the volume of glucose present in the branded energy drink Lucozade.

Cognitively demanding tasks have also been associated with increasing arousal levels which increase heart rate. Being placed in an ego threatening condition such as cognitively demanding task would involve somatic energy expenditure, which is generated by the musculature response. These processes involve high uptake of glucose, which results in lower glucose levels after completing a cognitive demanding task (Backs & Seljos, 1994; Carroll, Turner & Prasad, 1986; Kennedy & Scholey, 2000; Turner & Carroll, 1985). The cognitive tasks completed by the participants within in this thesis were; Bakan task, Recognition task, Immediate verbal free recall task, and the Two finger tapping task. All these tasks place participants in an ego threatening condition in which they are required to focus in order to perform well. The first time the participants complete these tasks, they are generally unfamiliar with task process and requirements, which would expectedly involve high somatic energy expenditure and high uptake of glucose. By the time the participants' complete the task the second, third or fourth time they are likely to be aware of the task requirements, irrespective of counterbalancing the cognitive tasks, therefore finding some of the tasks less demanding. As this would be considered as an implication for my studies,

it is important to counterbalance the order of cognitive task and drinks given to the participants.

There are many studies, which have found a beneficial relationship between the effects of glucose drink and cognitive performance in healthy adults and adolescents. The most common cognitive task assessed has focused on declarative verbal memory and furthermore, cognitive enhancement found in the reaction times task (Owens & Benton., 1994) and rapid visual information processing task (Benton, Owens & Parker.,1994; Donohoe & Benton., 1999). Research investigating the relationship between glucose ingestion and the effects it has upon cognition, typically comprises of two conditions, one being the experimental beverage which is made up of glucose powder (25g-50g) dissolved in water and lemon flavouring. The control beverage, this being the placebo drink, made up of water and artificial sweetener (aspartame or saccharine) and flavouring in order to match the experimental drink. Finger pricking process is used to measure blood glucose levels before and after beverage intake. Factors which can affect the cognitive enhancement after glucose ingestions are; age and gender (Craft et al., 1994; Riby et al., 2004), body weight (Sunram-Lea et al., in press) and glucose regulatory efficiency (Craft et al., 1994; Smith and Foster, 2008) which are all confounding variables. Age and gender have been controlled for within the series of studies present in this thesis as all participants were young healthy adults and there were no gender bias recruitment as the studies were advertised on a University Sona System where students and staff across different subject disciplines could access and participate. Although many students from psychology discipline are female this would suggest gender bias recruitment. However, participants who took part in the experiments were from combined disciplines and therefore there were males participating in the experiments.

Donohoe and Benton (1999) described a study where participants consumed either a placebo or glucose drink and were either requested to sit quietly or to complete a visual rapid information-processing task for ten minutes. Subsequently, it was found that the participants' glucose levels had decreased due to cognitive demanding task in comparison to participants requested to sit quietly. Previous studies have acknowledged that glucose drink consumption can enhance cognitive performance. There seems to be a relationship between the falling glucose levels and cognitive performance especially under high cognitive demands. Scholey, Harper & Kennedy (2001) conducted a study to explore

whether having a placebo controlled, double blind, balanced, crossover study can indicate that having highly cognitive demanding conditions can change blood glucose levels. The cognitively demanding tasks, which were assessed in this study, were; serial subtraction task (computerised Serial Seven task), short interval memory task and word retrieval task (verbal fluency). The findings indicated glucose consumption significantly improved performance on serial seven task and word retrieval task but no effect was found for word memory task. The findings from the control group indicated that the task serial seven had significant reduction in blood glucose in both drink conditions. This indicated that performance is dependent on drink condition as blood glucose levels depleted when participants completed difficult cognitive tasks irrespective of drinking active glucose drink in comparison to the placebo drink condition. Blood glucose levels also decreased for the placebo drink condition, which would have meant pre-existing glucose levels within the blood prior to experiment would have been used during the completion of the difficult task.

There is evidence that cognitive functioning is susceptible to task difficulty and therefore glucose ingestion does not always enhance performance (Kennedy and Scholey, 2000). For instance, a study conducted by Kennedy and Scholey (2000), found that glucose consumption did not improve performance on serial three task which is a task testing attention and working memory, where participants were required to count backwards in threes, comparative to the placebo condition. In contrast, glucose consumption was related to improvement in performance when the participants completed the seven series task of counting backwards in sevens in comparison to the placebo condition, indicating that glucose facilitates the more cognitively demanding task but not the less demanding task (Scholey et al., 2001). The cognitive tasks completed within the experimental studies in this thesis were, the Bakan task, Recognition task, Immediate verbal recall task and the Two-finger tapping task. The tasks' range from being less demanding (i.e., Two-finger tapping task) too being cognitively demanding (i.e., Bakan task) with the memory recognition and recall task falling in the middle. The more demanding the task the more likely there would glucose depletion.

There have been relatively few attempts to measure the effects of glucose ingestion on mood, although it is assumed by the general population that consuming high levels of glucose will reduce feelings of tiredness and irritability (Owens et al., 1997). In studies where mood is monitored after ingestion of glucose drink, the effect is relatively small (Benton & Owens,

1993a). Benton & Owens (1993a) established that the relative small effect of glucose on mood was associated to higher blood glucose levels within the normal range with lower self-reported tension and enhanced energy levels. Conversely, studies have found poorer mood among participants who have low blood glucose levels or who are hypoglycaemic in comparison to participants who have blood glucose in the normal range (Owens et al., 1997). Thus, in contrast compared to caffeine, there are fewer studies, which have found glucose-enhancing effects on mood, in amounts, which are used in energy drinks (Benton & Owens, 1993; Foster, Lidder & Sunram, 1998; Messier, Pierre, Desrochers & Gravel, 1998).

1.2.2.3 Expectation of consuming glucose

According to Messier and White (1984), the contents of saccharine placebo drink may be equally preferred as glucose, but the intakes of saccharine does not always achieve the same memory enhancing and sensorimotor effects as a glucose drink would. One study had compared memory recall in three separate groups, which were glucose group, water group and saccharine group. Findings indicated that the glucose group had remembered the words more successfully with both immediate and delayed free recall tests. Conversely, in all three groups the recognition performances for both lists were equally good as each other. This suggests the memory capacity was not influenced by glucose. Therefore given these findings for the experiments within this thesis, you would expect no effect of consuming glucose on recognition task but a significant effect found for the recall task overall. However, glucose did enhance the free recall memory performance in relation to the presumption condition (Foster et al., 1998).

According to Donohoe and Benton (2000), blood glucose levels for healthy individual's peaks after 30 minutes of ingestion of food which takes approximately two hours to decline to baseline levels. However, for individuals who have poor glucose regulation, glucose levels remain higher for longer. It has also been acknowledged that poor glucose regulation has been associated with age (Convit, 2005; Convit et al., 2003., Dahle et al., 2009; Kaplan et al., 2000; Lamport et al., 2009; Messier, 2005; Messier et al., 1997; Riby et al., 2004). This occurs as the brain glucose metabolism slows down the facilitation of glucose transport across the blood brain barrier, which results in memory impairment especially in older adults (Convit, 2005; Korol and Gold, 1998). Thus, poor glucose regulation would be a key factor to consider when conducting and analysing studies using older participants. In the present

thesis the age group recruited within the series of studies ranged between eighteen too thirty years to control for age a possible confounding factor.

In the Donohoe and Benton (2000) study, when participants completed cognitively challenging tasks there was a decline in blood glucose levels because the brain used glucose as a fuel resulting in lower levels of glucose in the peripheral blood circulation. This indicates that the brain requires glucose regularly in order to function effectively especially when participating in cognitive tasks. Hence, many studies have found similar trends that cognitively demanding tasks depletes glucose levels, as the brain utilises a large amount of energy whilst having low storage of glucose for the relative size of the human brain (Scholey et al., 2001; 2006; Donohoe and Benton, 1999b; Fairclough and Houston, 2004; Peters et al., 2004). Consequently, there is a lot of research examining the beneficial effects of glucose consumption upon cognitive performance in young healthy adults. These effects have been associated with direct impact on glucose load or in relation to changes in blood glucose levels found after glucose ingestion. As there is evidence that the consumption of glucose has been reported to enhance the following cognitive performances; Stroop paradigm (Benton, Owens & Parker, 1994), reaction times (Owens & Benton, 1994), rapid visual information (Benton, Owens & Parker, 1994; Donohoe & Benton, 1999), face recognition (Metzer, 2000) and serial subtraction (Kennedy & Scholey, 2000) just a few to name, indicates that glucose is a vital ingredient in our daily diet for energy and cognitive enhancement. Analysing research within placebo studies suggest there may also be an element of expectancy effect which can create enhancement in cognitive performance via manipulative information given to the participants prior to drink ingestion irrespective of drink ingredient, i.e. placebo beverage to be ingested (Green et al., 2001).

Another area to consider the effects of glucose consumption and expectancy would be to monitor initial mood and appetitive state prior to experiment. For instance, if a participant had consumed breakfast, lunch or small snack prior testing compared to abstaining from food and drinks containing glucose may perform differently as their blood glucose levels will range from high or low depending on their consumption prior to study. Feeling hungry or thirsty prior to an experiment would suggest consuming an experimental drink irrespective of drink content might enhance performance. It has been acknowledged that initial thirst can affect mood and cognition after drinking water (Rogers, Kainth, & Smith, 2001). A study by Neave et al., (2001) found when participants were initially more thirsty,

they performed significantly better on the vigilance task as alertness was enhanced by drinking water independently of initial thirst, whereas cognitive performance was unaffected, which may have been due to differences in timing of task restrictions (i.e., each task had different time frames to be completed within). Subsequently, Scholey, Sunram-Lea, Geer, Elliott & Kennedy (2009) conducted a double-blind, placebo-controlled study which investigated the influence of appetitive state on glucose enhancement of memory. This study recruited 120 participants who were requested to refrain from food and drink from 10pm the night before the study. Participants provided capillary blood glucose reading and completed a simple mood and appetite scale as baseline measures. Participants were either requested to ingest 200ml drink containing either 25g of glucose or 200ml sugar free orange cordial placebo drink within in five minutes. This was then followed by twenty minutes absorption period before the second blood glucose reading was taken followed by the mood and appetite scale. Following this they completed verbal memory task and psychomotor tracking task during word presentation. This study found participants who experienced high levels of thirst had enhanced memory following a placebo drink, in comparison with poorer memory when glucose was ingested among participants who were not thirsty. This study found some participants may be more susceptible to the glucose enhancement effect were other participants who experienced more thirst benefited from the placebo drink. Suggesting, some of the participants' performance may have been affected by initial thirst rather than active drink consumption, whereas, other participants benefited from having the active drink overall. The positive effects found for drinking placebo drink among thirsty participants may be due to reversing the negative effects on memory of feeling thirsty and dehydrated in comparison to their normal physiological levels. Feeling thirsty prior to ingesting an experimental drink could have either positive or negative expectancy effects on cognitive performance or mood, irrespective of drink content, which could be considered as a confounding variable. Henceforth, the last experiment included within the present thesis noted whether participants were thirsty prior to experimental testing.

Research papers have found that glucose consumption in the form of an energy drink has many effects such as, mood enhancement or reduction, improvement in cognition, blood glucose depletion during a cognitive demanding task, and possible expectancy effects (Fillmore et al., 1998). All these factors will be examined within the thesis to investigate whether consumption of glucose alone has a prominent effect on overall performance or in

combination of other psychoactive ingredients such as caffeine. In order to examine the actual effects of psychoactive stimulants, placebo expectancy studies would be conducted which measure the independent effects of glucose and in combination with caffeine as an energy drink. Furthermore, the effects of glucose and caffeine in combination will be examined in line with TPB model variables to predict expectancy by creating expectancy variables by looking at the difference between drink conditions 'given placebo and told they are consuming a placebo' versus 'given placebo and told they are consuming an energy drink'.

1.2.3 Placebo and Expectancy Literature

Placebo and expectancy effects often work hand in hand and in this section several research studies have been explored and discussed to give an overview of a possible relationship between placebo effect and expectancy effect. This section will commence with discussing research within placebo studies whereby a placebo effect is the outcome of ingesting a non-active substance (i.e., placebo pill for pain relief), which has a therapeutic effect on participant. This will be followed by a discussion about various studies, which have examined expectancy effects by examining the experienced likelihood of an outcome or an expected effect. Whereby, participants have a presumption of outcome response when they consume a particular a product or drink which are created by previous knowledge and experience influencing future behaviour. By the end of this section, we may be able to confirm and recognise the relationship between placebo and expectancy effects and therefore suggest a feasible hypothesis for the series of studies within the thesis by testing the consumption of laden energy drinks and non-laden energy drinks.

Placebo studies have contributed to medical research for many years. This has acknowledged the importance of the patient and physician relationship, in particular the persuasive influence and interpersonal skills, which encourage patients to believe in the treatment creating a positive expectation (Papakostas and Daras, 2001; Colloca et al., 2004; Oh, 1991; Shapiro, 1997). Consequently, deceiving patients in the use of medical placebo studies can affect physician and patient relationships in the future (Bailar, 2001).

The placebo effect is the outcome of consuming a substance with no pharmacological effect, but gives the impression to the participant that they are having the actual active substances,

which will catalyse a specific behaviour or response. The placebo effect creates a therapeutic effect, which has been practiced in medicine for centuries in order to please patients by modifying their beliefs (Shapiro and Shapiro, 1997). Placebo effects produce changes in health conditions such as; pain, depression, tension, anxiety, alcohol cravings, smoking, drug withdrawal symptoms asthma and many more which have all been corroborated with actual physiological changes such as in blood pressure, heart rate and bronchial constriction (Kirsch, 1990).

Research has also noted placebo features affecting placebo effects which play an important role in order for an effective placebo response to take place, such as; branding of a product versus non-branding (Branthwaite and Copper, 1981), the colour of the agent being consumed, whether it is a pill or drink (Schapira et al.,1970), the environment in which the placebo stimulus is given (Guess et al., 2002) and the method by which the placebo stimulus is consumed whether it is orally or via injection (Levine and Gordon, 1984).

1.2.3.1 Placebo effects research

There are many placebo studies, which have explored the effects of substances in relation to placebo expectancy effects. The next section discusses the various placebo studies, which are associated with expectancy effects and how these expectancy effects may be correlated to conditioning and previous experiences. Furthermore, introducing models, which provide an insight to placebo expectancy effects, follow this and how these models constitute towards mediating expectancy responses.

In pharmacological studies, which examine placebo effects, assess patients who suffer from severe pain by informing patients there will be reduction in their pain experienced when they consume a tablet (placebo-induced analgesia). This activates the neurotransmission of endogenic opioids in comparison to when these patients are informed that pain intensity will not reduce (placebo induced hyperalgesia) which creates high anxiety levels resulting in activating cholecystokinin receptors and opioids antagonists (Benedetti, 1997).

Many placebo studies have been conducted with Parkinson's patients these studies have indicated an expectation framework, which suggests that placebo effect is mediated by the reward circuitry (de la Fernandez et al., 2001; de la Fernandez and Stoessl, 2002; de la Fernandez et al., 2004). Reward expectation creates uncertainty, which may be linked to the

tonic activation of nigro-striatal dopaminergic neurons that project to the dorsal and ventral striatum and prefrontal cortices (Fiorillo et al., 2003).

Research has also noted in order for an effective placebo response the following features can create an expectancy effects such as; branding of a product versus non-branding (Branthwaite and Copper, 1981), the colour of the agent being consume whether it is a pill or drink (Schapira et al., 1970), the environment the placebo stimulus is given (Guess et al., 2002) and the method the placebo stimulus is consumed whether it is orally or via injection (Levine and Gordon, 1984). The study of nocebo effects is better understood as the opposite to placebo effect. Nocebo effects relates to the negative psychosocial context of the treatment being tested. Thus, whatever treatment the patient or participant receives will create negative expectations without the administration of any inert substance (Benedetti et al., 2007b; Benedetti, 2008). Research has been conducted which explored the field of pain and it was recognised that overall negative expectations caused an increase in pain (Koyama et al.,1998; Price, 2000; Dannecker et al.,2003) which activated the following regions of the brain in response to the expectation of pain, such as the anterior cingulate cortex (ACC), the pre-frontal cortex (PFC) and the insula (Chua et al.,1999; Hsieh et al.,1999; Ploghaus et al.,1999; Porro et al.,2002, 2003; Koyama et al., 2005; Lorenez et al., 2005; Keltner et al.,2006).

Kirsch (1997) claimed placebo effects could be very specific especially if the information provided to the participants is specific. Take for instance, verbal information affects placebo response in the direction of desired outcome irrespective of product being consumed. Suggesting side effects could be triggered by verbal suggestions (Kaptchuk et al., 2006). For instance, if a participant were incorrectly informed they are consuming a caffeine drink and will have better reaction time, but in fact they were given a decaffeinated drink, the information provided to them would manipulate their performance irrespective of drink ingredients (Fillmore, 1999).

1.2.3.2 Expectancy effects research

Expectancy effects play an important role in understanding placebo response, whereby placebo effects are believed to be mediated by both cognitive and conditioning via unconscious mechanisms although little is known about their role in different circumstances.

Whereas, expectancy effects are mediated by previous experience, learning and conditioning which evoke a placebo response (Oken, 2008). Expectancies can be shaped by reward, size and colour of product being consumed (Buckalew and Coffield, 1982; Blackwell, Bloomfield and Buncher, 1972). The phenomenon of expectations whether they are positive or negative modulates behaviour, which is dependent upon previous experiences, which influence our expectations whether, an outcome would be positive or negative. This theory guides individuals to the appropriate behaviour to ensure they receive reward and to avoid behaviour, which can possibly cause potential harm. Hence, in order to ensure future reward acquisition, this is mediated by the neuronal circuits linking to cognitive, emotional and motor responses (Kalivas et al., 1999; Mogenson and Yang, 1991; Tom et al., 2007). Nevertheless, expectancies modify experiences and perceptions of events therefore it is not just motivated behaviour.

When individuals undergo uncertainty this increases expectation levels which activates a phasic dopaminergic process, which is followed after a reward, and this effect is the strongest when a reward comes as a surprise (de la Fernandez 2004). Thus a reward circuitry model has been devised using a neurobiological placebo mechanism. This model proposes when positive verbal suggestion creates a reward possibility this activates cortical neurons, which send direct excitatory glutamatergic inputs to dopaminergic cell bodies with indirect inhibitory gamma amino butyric acid inputs. These direct and indirect routes create tonic activation (de la Fernandez et al., 2004). Furthermore, Schultz (1998) found that tonic activation also occurs in the prefrontal cortex, nucleus accumbens and caudate-putamen. There are a lot of supportive findings suggesting expectancy effect, the experienced likelihood of an outcome or effect can be measured in placebo studies which have been associated to the brain's reward and motivation circuitry (de la Fernandez et al., 2004). Whereas, behavioural effects from a placebo stimulant are dependent upon the level of certainty believed (Ploghaus et al., 2003).

Kirsch (1990) has found that if a patient has positive hopes, automatically they would have positive expectancy but this does not necessarily mean that the patient will gain what they hope for improvement. For instance, if a patient was undergoing impending venepuncture, they may hope that it will be painless but at the same time they expect to experience some moderate pain. When these patients are assessed for response expectancy in relation to pain (e.g. how much pain do you expect to feel?), it would be difficult to assess whether the

patient is reporting anticipated pain intensity or what they hope the pain intensity would be to their non-volitional response to the venepuncture procedure. The theory on hope suggests there are two components; (1) agency thoughts and pathway thoughts, which work together to develop a belief. This is when an individual works hard to produce desired outcome and develops strategies to achieve the desired outcome (Snyder et al., 2001). Therefore, an individual's response expectancies may be dependent on how optimistic or pessimistic they are. Suggesting non-volitional outcomes may be due to individual characteristics rather than situational cues (Snyder et al., 2001). Consequently, individuals who are more optimistic are more likely to expect more positive and less aversive outcomes compared to those who are pessimistic. Thus, for the present studies within this thesis, it would be expected that for those participants who are optimistic and envision enhanced cognitive performance after consumption of experimental beverage irrespective of drink content are likely to achieve desired outcome which would be associated by expectancy effect. However, if the participants' were pessimistic about both the experimental drink and their cognitive ability, they would meet their expectations of performing poorly. Hence, the placebo response in this case would be associated to the participants' preconceived expectations about the psychoactive drink effects and their personal experience. Therefore, the experiments in this thesis may indicate if participants' have positive experiences of consuming energy drinks, participants will relate these experiences to their past behaviour which would create positive expectancy outcome behaviour. It would be therefore important to distinguish whether there is a difference between psychoactive effects and expectancy effects on cognitive performance and mood by assessing the following drink conditions (i.e., 'given energy drink and told they are drinking a placebo drink' versus 'given placebo drink and told they are drinking a placebo drink') and examining expectancy effects (i.e., 'given placebo and told they are consuming a placebo' versus 'given placebo and told they are consuming an energy drink').

In contrast Rhudy and Meagher (2000) found that when negative feelings are experienced this activates the rostral anterior cingulate cortex and posterior cerebellum and inducing hypoalgesia. Thus, the conscious expectation stimulates the midbrain opioid output system and as a result having a placebo can benefit health conditions such as pain, depression and Parkinson's disease. Therefore, using a placebo-induced conscious expectation and belief,

develops a receptive field for the support, which go together with feeling safe (Fricchione and Stefano, 2005).

According to Fiorillo et al., (2003) prior to any expectation there is always a feeling of uncertainty and this is sustained by dopaminergic activation, which is maximised once we are aware, a reward follows. If the probability of reward is 0.5 then 29% of dopaminergic cells are tonically activated. Furthermore, after the reward, this is followed by phasic dopaminergic activation, which is stronger when a reward comes as a surprise due to high levels of uncertainty. Thus, high levels of uncertainty heighten the reward mechanisms in the brain circuitry model.

The majority of expectancy effect research has been conducted among patients and participants who substances abuse such as, alcohol, smoking or taking drugs. Expectancy studies exploring substance use and abuse such as alcohol have two different kinds of effects. The first being the determinant to why people consume alcohol, which is associated with the social learning theory. The second effect being the experiences and behaviours associated with drinking alcohol is due to the self-confirming nature of response expectancy (Rotter, 1954). Substance abuse studies have also used the TPB model to assess and explain the motivational determinants of behaviour (Azjen, 1991). According to the TPB model, the primary determinants of future behaviour are one's intention to perform the behaviour (*e.g. I intend to engage in binge drinking session tomorrow*). Intentions are predicted by three variables, attitude (the positive or negative evaluation of performing focal behaviour), subjective norms (are a person's perception of other people's opinion regarding their behaviour) and perceived behavioural control (refers to the person's sense of control over performing particular behaviour). The combination of all three variables assess the motivational determinants of binge drinking or substance abuse which is often associated with previous experiences, self-efficacy, beliefs and social learning which is related to expectancy response of consuming such substances (Adamson, Sellman & Framplan, 2009; Connor et al., 2007; Johnston &White, 2006).

There have been many studies that have contributed towards examining the effects of expectancy and pharmacology effects of consuming alcohol through the use of a balanced placebo design. Research using balanced placebo designs indicates that alcohol response expectancies can modify levels of social anxiety, alcohol cravings among alcoholics and

non-alcoholics, reduce aggressiveness and sexual arousal (Hull & Bond, 1986). Balanced placebo studies have helped researchers to develop treatment strategies, which aim to alter people's alcohol expectancies (Goldman, 1994). The central feature of expectancy challenge is the delivery of placebo alcohol to participants. It is often found in alcohol studies that when participants are incorrectly informed that they are consuming an alcohol beverage, they automatically start to experience effects, which are attributed to alcohol, even though they have consumed a placebo drink. Once participants are informed they were actually given a placebo drink, this then gives the participants the opportunity to reflect on associated behaviour and experiences related to alcohol consumption, which in fact was the placebo effect (Goldman, 1994). Both positive and negative outcome of expectancies predict alcohol intake (Jones, Corbin & Fromme, 2001). Thus, the expectancy challenge has become a useful tool in prevention and treatment programs in alcohol.

Eating behaviour is linked to expectancy concept, as it is the consumer who anticipates how and what they would feel after ingestion of particular food or drink (Rozin, 1989). For instance, it is likely that individuals will consume food and drink with the expectation that they will experience positive effects such as, relieving hunger and feeling satisfied (Michela & Contento, 1986; Shepherd, 1999). In contrast, expecting negative outcome from eating certain foods, e.g. food that is considered highly caloric which will result in weight gain, would be avoided due to the negative undesirable outcome (Michela & Contento, 1986; Rogers & Blundell, 1990; Shepherd, 1989).

Research has also been conducted within the nutritional field where expectancies focuses more on taste and sensory properties such as texture and smell and how prior sensory experiences affects future expectancies for taste (Cardello, 1995; Cardello & Sawyer, 1992; Conner & Booth, 1992). Sensory expectancies can be examined in the form of food and drink packaging, branding and labelling, which influence the sensory ratings of food (Bunting, 2001). Therefore, pointing out key differences between expectancy and attitudes, can determine future nutritional intake. This illustrates that expectancy has specific outcomes, which can be confirmed or disconfirmed by previous experiences. It is difficult to evaluate attitudes in the same way, as attitudes can be highly resistant to change.

Response expectancy on the other hand is the anticipation of an individual's automatic reactions to different situations and behaviours. For instance, a person may feel more alert

after having a cup of coffee, may feel intoxicated after consuming an alcoholic beverage or perhaps feel less pain after consuming medication. Such expected outcomes are considered as choosing a course of action to help a current situation (e.g. take medication to stop pain). Similarly response expectancies function in the same way as stimulus expectancies. The difference between response expectancy and stimulus expectancy is that, response expectancy has one key characteristic which stimulus expectancy does not have, that they are directly self-confirming (Kirsch, 1997). Whereby, stimulus expectancy is considered as expectancies that certain events or situations signal the possible occurrence of other events (e.g. a siren predicts the appearance of a police car; worsening of a smokers cough may be viewed as a predictor of lung disease: or the presence of a lump on the breast may be perceived as a sign of breast cancer). A stimulus expectancy response can be divided into two types based on their distinction between environmental circumstances and non-volitional responses (Kirsch, 1999). Thus, the stimulus response expectancy is the expectancy an individual places on the probable occurrence of a non-volitional response (e.g. dark clouds predict rain or watching a sad movie may make the individual cry) (Kirsch, 1999). Another example would be when students hold an expectancy of obtaining specific exam results. The stimulus expectancy may affect how much effort the student puts towards revision, which would indirectly affect their grades, but the expectancy itself will not have any direct effect on the exam results. Taking this understanding of stimulus expectancy, in the experiments within this thesis, there is a possibility that regular psychoactive drink consumers (i.e., caffeine and energy drinks) may expect to perform better on cognitive tasks and feel lot positive compared to participants who do not consume psychoactive drinks regularly.

In contrast people, who expect a cup of coffee to make them more alert, hold these expectations as they have previously experienced enhanced alertness after drinking caffeine. This affect has also been found when these individuals are given decaffeinated coffee, but this affect only occurs if the consumer is unaware that the beverage being consumed is actually a placebo (Kirsch & Weixel, 1988). Thus, feeling more alert after drinking decaffeinated coffee is an example of a placebo effect. This is because placebos generate response expectancies and response expectancies generate changes in experience. Having increased alertness after drinking decaffeinated coffee has been accompanied by corresponding changes in blood pressure and task performances such as cognitive and motor

tasks (Fillmore & Vogel-Sprott, 1992; Kirsch & Weixel, 1988). These changes in performances are not the same for all coffee consumers, as findings have indicated for some people there were no changes in task performance, which may be dependent on the individual's beliefs about the effects of caffeine rather than depending on just taste of caffeine. Hence, this verifies the mediating role of response expectancy in the creation of placebo effects.

Authors such as, Rogers, Edwards, Green and Jas (1992) and Rogers, Richardson and Elliman (1995) examined the relationship between coffee consumption and expectancy. Coffee is often associated with the concept of increasing alertness and concentration, which is considered as a positive expectancy because there is an expectation that coffee consumption, enhances cognitive and sensorimotor performance (Bradley & Petree, 1990). In contrast, coffee consumers would avoid caffeine intake late in the evening as this would set the expectation of feeling alert and full of energy when they desire to feel relaxed at this point in time in the evening, which would be considered as a negative expectation (Rogers et al., 1992; 1995). Therefore, drinking coffee can have both positive and negative expectations depending on the time of day e.g. morning, before an important task or late in the evening (Rogers et al., 1995).

Despite the large volume of literature on expectancy response, it is still unclear whether individual's hopes are associated with their expectations for non-volitional outcomes. Over time response expectancy literature has been associated with three psychological mechanisms which result in non-volitional outcomes which are; (1) placebo effects (Montgomery & Kirsch, 1996, 1997; Price, Milling, Kirsch, Duff, Montgomery & Nicholls, 1999); (2) the effects if pharmacological agents (Kirsch & Rasadino, 1993; Lansky & Wilson, 1981; Montgomery & Bovbjerg, 2000; Montgomery et al., 1998; Roscoe, Hickok & Morrow, 2000) and (3) expectancy suggestions (Montgomery, Weltz, Seltz & Bovbjerg, 2002; Schoenberger, Kirsch, Gearan, Montgomery & Pastyrnak, 1997).

1.2.3.3 Expectancy effect models

There are various models, which explain the process of expectancy. One of the popular widely used models today is the expectancy theory of motivation, which was developed by Vroom (1964) who explained the process in which individuals make decisions on

behavioural outcomes. The expectancy theory of motivation is represented as: (Motivation force = expectancy x instrumentality x valence) see Figure 1-2

Figure 1-2: Vroom's expectancy theory of motivation model

Motivation force is the direction of force guiding individuals to specific behaviour alternatives, which are suggested by various behaviour choices selected by the individual. The theory asserts individuals will select a behaviour, which has the greatest motivational force. Motivational force for behaviour, action or task is made up of three distinctive perceptions which are; expectancy, instrumentality and valence. For an example, expectancy is considered as the probability of hard work, effort and determination will lead to a good performance. Variables such as self-efficacy, goal difficulty and perceived control are all variables, which affect an individual's expectancy perception. Thus, past-experiences, self-confidence and perceived difficulty all play an important role in determining whether the expectancy of a desired performance will be achieved. Instrumentality is the belief that one can meet expectation and desired outcome. Variables such as, trust, control and policies can affect the instrumentality perception. If the individual meets expected desired outcome they will experience greater satisfaction. Finally the valence is the value an individual places on

the reward outcome and the variables are, needs, goals, value and preferences (Tien, 2000; Vansteenkiste et al., 2005). The three key functions of expectancy theory of motivation have been commonly used for motivation in work place (Campbell and Pritchard, 1976; Heneman and Schawb, 1972; Mitchell and Biglan, 1971).

The understanding behind Vroom's expectancy theory suggests that individual's beliefs about a situation in which they find themselves can lead to the consequence of a particular behaviour. Thus, this model represents the cognitive approach to understanding behaviour. The cognitive model of motivation has two assumptions, the first being that behaviour is rooted in the belief system, which involves attaining different behaviour alternatives (expectancy beliefs) in accordance to individual's belief about possible consequences of behaviour (instrumentality beliefs). The second assumption of the cognitive model of motivation is that these beliefs are derived from the environment in which they find themselves. Hence work related beliefs are influenced by the organisational environment in which individuals work creating particular work situations. According to Vroom (1964) in order for beliefs to effectively guide behaviour in particular work scenarios, there must be considerable association to reality. Environmental circumstances are incorporated with ones beliefs, which in general influence behavioural outcome. Vroom's work is closely related to Fishbein & Azjen (1975, 1980) original model the Reasoned Action Approach (RAA). The nature of RAA suggests that intention is the best single predictor of behaviour but it is also important to take skills and abilities as well as environmental factors (i.e., behavioural control) into account. Thus, people are considered to perform particular behaviour because they intend to do so as they have the requisite skills and abilities, and there are no environmental constrain to prevent them from carrying out their intentions. The RAA model was used for prediction of social behaviour only in the sense that people's behavioural intentions are assumed to follow in a reasonable, consistent and automatic manner from their beliefs about performing that particular behaviour (*i.e., I will stop smoking as it is bad for my health and my partner does not approve of me smoking*). The RAA is similar concept to Vroom's work, which also suggests beliefs and environmental cues within a workplace guide specific behaviour to achieve goals via motivation and intentions. Both concepts rely on individual expectancies of outcome behaviour and how to carry out such behaviour. These concepts are created by individual beliefs, attitudes, social pressures and environmental cues, which format individual expectancies. When these expectancies are

created, individuals develop a requisite plan to achieve their desired goal by carrying out specific behaviour (i.e., *I need to pass my exam, so I will drink coffee to stay alert and focused in the next few hours to revise effectively*).

The present thesis examines possible expectancy effects of consuming psychoactive drinks using a balanced placebo design. Participants' beliefs, habits, previous experiences, attitudes, subjective norms and perceived behavioural control are measured using a TPB questionnaire to examine whether such precursors of intentions and behaviour also predict the extent of expectancy effect prior to experimental testing. The TPB questionnaire should determine whether the constructs (attitude, subjective norms and perceived behavioural control) of TPB model predict intentions and whether the additional constructs included in the TPB questionnaire such as (beliefs, habits, past experience and self-identity) along with the original constructs can predict expectancy response.

Another model related to expectancy is the cognitive model of motivation, which represents the conditions to measure expectancy response to predict behaviour. Figure 1-3 below represents the general cognitive model: assumptions underlying cognitive theories of motivation (adopted from Ilgen, Peters & Campbell, Reference Note 1).

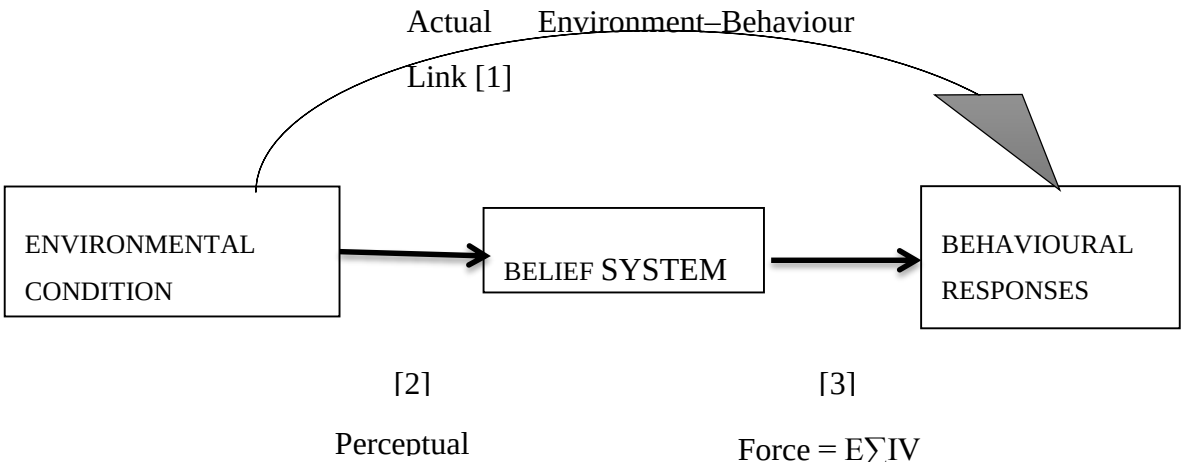

Figure 1-3 Represents the assumptions underlying cognitive theories of motivation (adopted from Ilgen, Peters & Campbell, Reference Note 1).

Link [1]: Environmental Conditions = Behavioural Response. This link represents the actual environmental conditions affecting the expected behavioural response, which telescopes

both assumptions made by Vroom's expectancy theory of motivation model. Link [2]: Environmental Conditions > Beliefs System. The second link represents the degree to which one's beliefs are based on actual environmental conditions. Link [3]: Belief System = Behavioural Response. The third link represents the translation of one's beliefs into behavioural responses.

The Mood Expectancy Model (MEM) was developed by Zeigler (2010), which is also associated to expectancy effects suggesting a mechanism which may lead to more or less effort of information processing depending on how positive or negative a person's mood is, as long as other factors within the environment are unrelated to mood, do not constrain levels of motivation and ability to be high or low (cf. Wegener & Petty, 2001).

Negative mood regulation (NMR) expectancies held by individuals, when faced with different manifestations of stress can often adopt different coping mechanisms, which can affect mood states. Successful mood regulation is associated with adaptive coping strategies (Folkman & Moskowitz, 2004; Rotter, Chance & Phares, 1972). Coping with stress can be difficult and individuals who use more active techniques such as; problem solving and have social support, are more likely to overcome stressful problem as they have a positive outlook and expect positive outcome (Holahan & Moos, 1986; Surmann, 1999). In contrast, avoiding supportive techniques creates negative outlook and outcome, which predicts negative behavioural outcomes such as higher levels of depression, anxiety problems and substance abuse (Cooper, Russell, Skinner, Frone & Mudar, 1992; Evans & Dunn, 1995; Hayes et al., 2004). The key feature which influences NMR expectancies is social learning theory (Rotter, 1954,1982; see Catanzaro & Mearns, 1999) theorising that interaction between behaviour and expectancy will lead to particular desirable outcome (see also Carver & Scheier, 1998). For an example, stress often leads to increase in negative emotions and expectancies, which can be considered as aversive, this often heightens through cognitive and behavioural action. Thus, if an individual has high expectations that they can cope with the stressful situation they are placed within, they naturally adopt the adaptive coping strategy. Whereas, having negative low expectations are less likely to seek help and support. These choices are manipulated by ones cognitive thoughts and values, which affect their expectations and behavioural outcome (Cantanzaro & Greenwood, 1994). Thus, some people find it easier to adopt maladaptive coping strategies rather than adaptive coping strategies. This concept may be found when participants are requested to complete cognitively demanding task (i.e.,

Bakan task) and are under the assumption they are consuming a non-active experimental drink whereby, the participants' find the task stressful which cause an increase in negative emotions and expectancies. Or just don't think they'll be any good at it because they are drinking the placebo drink, which effects overall performance as they have low self-efficacy.

Catanzaro's (1996) study reported that student's with low NMR expectancies were negatively influenced by anxiety during their exam. Conversely, students with high NMR experienced less ill effects such as anxiety during their exam. Thus, these findings indicate having higher NMR and beliefs can minimise negative moods, which can reduce anxiety symptoms developing. Having good coping mechanisms can also reduce effects of anxiety during ego threatening conditions or situations (Catanzaro et al., 2000).

1.2.3.4 Classical conditioning in relation to placebo and expectancy effects

Research demonstrates that placebo and nocebo effects stem from an active process in the brain, which is mediated by psychological mechanisms such as expectation and conditioning (Kennedy, 1961). There has also been further development providing a better understanding of neurobiological models like expectation-induced activation to the brain reward circuitry, the Pavlovian conditioning and causation of nocebo responses, which is associated to the anxiety mechanism. Having a better understanding of both psychology and neurobiology of placebo effects can indicate how the process of the central nervous system operates and how the placebo stimulus subsequently modify and shape peripheral physiology. As it is evidential that placebo effects stem from an active process in the brain, which are mediated by psychological mechanisms such as expectation, these expectations are shaped by beliefs, attitudes, subjective norms, perceived behavioural control and intentions (Azjen, 1991; Kirsch, 1992). Having salient beliefs can modify behavioural outcome (i.e., if a consumer has positive salient beliefs towards energy drinks, they believe by drinking a psychoactive drink this would improve their cognitive performance and therefore they are more inclined to have enhanced performance in comparison to negative salient beliefs). This is because it would be expected that via pre-exposure of energy drinks effects, the consumer would have positive salient beliefs in line with TPB model constructs which would predict intention and perhaps expectancy.

There are two main mechanism of placebo effects, expectation of reward and conditioning. The idea behind the expectation of a reward by a patient creates a positive belief of fast recovery. This type of treatment has been perceived as the most successful placebo effect (Benedetti et al., 2003a, 2003b). There has also been evidence of a biological change in when an individual expects a reward, which causes changes in the dopamine levels (De La Fuente-Fernandez, 2004). The second mechanism is the Pavlovian conditioning (Pavlov, 1927), suggests if the same product is consumed regularly and if there is an improvement in health, behaviour or other, this product will be conditioned to expect an improvement irrespective of actual ingredients i.e. placebo being consumed instead of actual active product.

Thus classical conditioning and expectancy of reward create a positive outcome, which can provide an understanding of the biological foundations for the placebo effect (Haour, 2005; Ader & Cohen, 1982). These two neurobiological processes might work together to create the final therapeutic outcome and in other occasions they may work separately depending on the placebo stimulus (Benedetti et al., 2005).

Conditioning methods can be conscious and unconscious, where conscious conditioning would be verbally induced expectations and unconscious would affect hormonal secretion (Benedetti et al., 2003). However, Benedetti et al (2003) found verbally induced expectations of analgesia and hyperalgesia to have an effective change in pain tolerance. They also tested the unconscious affects, which opposed verbal information on hormonal changes, and no effect was found. However, the unconscious association between medical injection (condition stimulus) and the pharmacological effect of sumatriptan (unconscious stimulus) resulted in a conditioned response affecting growth hormone and adrenocortical secretion. Thus it was concluded that when conscious expectation is involved, the conscious physiological pain and sensorimotor movements are malleable. Conversely, the placebo effect of unconscious physiology process is mediated by behavioural conditioning. Hence it is possible that behavioural conditioning and expectation contribute to the specified placebo effect. Though the relationship between expectation and conditioning is not clear, studies conducted within Parkinson's disease and pain, indicate that conditioning is mediated by expectations and that expectations do not affect conditioned response (Klinger et al., 2007).

The conditioning framework suggests that both the environment and behavioural stimuli are associated with voluntary and involuntary consumption of a pill, drug, or drink, which may

become a conditional stimulus (Ader, 1997). These conditioned stimuli can be provoked by the packaging of the stimulus being consumed, by the environment the stimulus is consumed in, the smell, the texture, whether it is consumed from a bottle, pill form or injection. Therefore it is vital to ensure there are no confounding factors interfering with a possible placebo effect and with repeated exposure this will create a conditioned response (Wolf, 1950; Skinner, 1953).

However, if learning was not associated with placebo effects, perhaps the placebo effect would not be as effective, irrespective of how the placebo stimulus was administered (Ader, 1997). Conversely, Wager and Nitschke, (2005) have found in many clinical trials and experiments that a placebo effect is more effective when patients and participants are continuously exposed to effective drug and psychoactive treatments creating positive response. Continuous conditioning links to associative learning, for instance, when a placebo stimulus is given to the client this would create a positive and effective placebo response. Thus, consciousness can be considered as another key feature effecting placebo response. In the present thesis, the latter experiment recruited habitual consumers of energy drinks and caffeine to assess whether there is a difference between learned expectancy from past experience of consuming such beverages on expected intentions and performance. The three experiments prior to the last experiment held no restriction to habitual or non-habitual consumers of psychoactive drinks, therefore a comparison could be conducted to measure whether participants from experiment 4 had greater learned expectancy compared to the earlier experiments where participants previous drinking behaviour was not part of the inclusion criteria.

In contrast Byerly (1976) believes there are two theoretical understandings, which can explain the placebo effect; the mentalistic theory and the conditioning theory. The mentalistic theory sets an expectation of potential outcome, which is the primary basis for the placebo effect. The conditional theory suggests that the outcome is dependent upon previous experience and exposure, which is associated to learning process. Both these theories can work hand in hand but also exclusively, suggesting that they work independently or together depending in the circumstance the placebo stimulus has set (Kirsch, 1997).

1.2.3.5 Predicting expectancy effects using the Theory of Planned Behaviour Model

Behaviours people perform in their daily lives can have profound impact on their health and in general everyday choices and judgements. Such behaviours are associated to social environments we interact with or come across, which are associated with associative learning and past experience. In order to understand each of the key social constructs, which affect our daily behaviour, a conceptual framework has been developed which examines each construct and predicts future behaviour. The determinants of behaviour can be clearly identified using the model Theory of Planned Behaviour that was developed by Azjen (1991). The TPB is a theoretical approach that has been used to predict health behaviours (Azjen, 1991). The TPB posits that an individual's behaviour is driven by an individual's attitude, subjective norms and perceived behavioural control, which together shape and individual's intentions and behaviour. Socio-demographic factors influence all the key components which influence behaviour such as; attitude, social norms and perceived behavioural control via the formation of intentions. The actual barriers moderate behaviour regardless of intention. Socio-demographic factors include age, gender, education, ethnicity, nationality and socio-economic status. Attitudes towards behaviour include beliefs about behaviour evaluation of possible outcome behaviour (e.g. drinking coffee leaves a bitter taste in mouth) and on cognition (e.g. consuming coffee will improve my performance). Thus, the outcome evaluation the individual creates is important as this can affect intentions and outcome behaviour, which affects expectancy towards the psychoactive drink (e.g. if I do not drink coffee my performance will be poor).

Social norms are made up of beliefs about others. This is influenced by how social pressure influences the individual's views (e.g. my peers all drink energy drinks) and motivation to comply with social norms (e.g. I think it is important that I drink energy drinks, as all my peers enjoy drinking energy drinks). Social norms refers to pressure from family, friends, peers and social pressure more broadly, such as pressure from media and marketing (e.g. the advert suggests people I admire would expect me to drink such drinks, or that I people I admire drink them themselves and that's why they are cool/clever/ good at sports), such advertising affects beliefs and views towards the product and creates some form of an expectancy from the product accordingly.

Perceived behavioural control is one's perception of the difficulty of performing behaviour, regardless of this belief is true or not. Perceived behavioural control has two elements; belief about external factors (e.g. I cannot purchase energy drink at University) and the beliefs about internal factors (e.g. I don't have the time to drink coffee every morning before I start work). These internal factors are considered as self-efficacy. The perceived behavioural control for participants taking part in the studies within this thesis, the internal factor would be (e.g. I cannot perform to the standards I want without consuming an energy drink).

Actual barriers to behaviour refer to all objective barriers that effect how a person performs a particular behaviour irrespective of the individual's beliefs about the barriers. For instance, an individual believes that they cannot purchase an energy drink at their University, when in fact they can. The distinction between actual barriers and what the individual actually believes is important as this barrier may or may not exist in reality which will affect expectancy of outcome behaviour.

Intentions are simply the expectation of what the individual hopes to perform in order for desired behavioural outcome. Thus, outcome behaviour refers to whether or not the individual actually performs to their expectation (e.g. I will consume an energy drink before my exam). Using this concept of TPB model, the following predictors of expectancy of drinking psychoactive beverages will be tested; attitudes, subjective norms, perceived behavioural control, beliefs, habits, past behaviour and self -identity.

This thesis intends to examine the predictors of expectancy effects, there will be several mini studies testing the association between placebo and expectancy effects keeping in mind previous research findings. As there are two main mechanisms considered in order for a placebo effect to occur, one is the reward expectation and the other is pre-conditioning. This suggests that if an individual creates a positive belief about a possible desired outcome they can achieve, the sudden urge and anticipation causes changes in the dopamine levels in order for the desired outcome to follow. Conditioning mechanism on the other hand also plays an important role. This concept suggests if the same product is consumed on a regular basis and beneficial outcomes are achieved, the product will be conditioned to expect an improvement irrespective of actual ingredients every time the product is ingested i.e. placebo being consumed instead of actual active product. This affect also is noted about the features affecting placebo effects which also play an important role in order for an effective placebo

response to take place, such as; branding of a product versus non-branding as the consumers become conditioned to the packaging of a product irrespective of taste and quality.

The phenomenon of expectations whether they are positive or negative modulates behaviour, which is dependent upon previous experiences, which influence our expectations whether an outcome is positive or negative. It has been acknowledged that future reward acquisition is mediated by neuronal circuits linking cognitive, emotional and motor responses, which determine outcome behaviour. Thus, experience of uncertainty can enhance expectation levels, which activate a phasic dopaminergic levels followed after a reward, and this effect is the strongest when a reward arrives as a surprise (de la Fernandez 2004). Conversely, if a participant has never consumed a caffeinated beverage before, but is informed their performance will be enhanced by caffeine intake and it would be expected that the outcome achieved would be positive surprise to the participant.

Eating behaviour and mood works hand in hand as individuals often hold specific expectancy of how they may feel after consuming certain food and drink. Thus, if participants are pre-conditioned to certain energy drinks and or are habitual coffee consumers or do not like the taste of coffee, they automatically create an expectation of how they will feel after the consumption of a specific beverage or product. If they have a positive view about consuming laden energy drinks and caffeine they generally are expected to have positive changes in their mood and cognition in comparison to negative experiences and expectations.

The understanding that has been derived from the concept that placebo and expectancy effects can be very specific especially if the information provided to the participants is specific. This idea of specific information will be tested at latter stage via verbal and written information about specific energy drinks in this thesis. It would therefore be expected that depending on whether the information provided to the participant is positive or negative will affect their performance outcome irrespective of the drink content. Similarly, branding and label information conditioning is tested at latter stage in the thesis examining whether conditioning of branding and specific information affects the participant's performance and the desired outcome. In contrast participants, who expect a cup of coffee to make them more alert, hold these particular expectations as they have previously experienced enhanced alertness after drinking caffeine. These affects are also found when individuals are given

decaffeinated coffee, but this affect only occurs if the consumer is unaware of the beverage being consumed is actually a placebo. Thus, this thesis will explore whether expectancy effects exists on the basis that participants are preconditioned to the idea that energy drinks and psychoactive ingredients enhance performance, or do participants perform in accordance to specific information provided to them irrespective of drink content. Hence, the studies conducted in this thesis will explore and confirm whether there is a relationship between placebo and expectancy effects or whether the outcome from consuming laden and non-laden drinks is the causation of the actual psychoactive stimulants being consumed.

1.2.4 Labelling, Marketing & Perceptions Literature

Beliefs and expectations are shaped by experiences, previous knowledge, and attitudes, which often influence consumers' judgements of products. For instance, consumers often believe purchasing an item, which is at a lower cost, is consequently perceived a lower quality and poor performance product compared to a product, which is priced at higher value (Gerstner, 1985; Huber and McCann 1982; Rao and Manroe 1989). The impact of beliefs and expectation extends to the consumption of experiences, whether this is positive or negative experience, depending on how highly reputed the product being consumed. For instance consumers may find energy drinks taste better when they labelled under a highly reputed brand such as Lucozade or Redbull, in comparison to unlabelled drinks or unrecognisable brands. Labelling and marketing of food and beverage products all play an important role by influencing the consumer. The information the consumers extract from the labelling and marketing can either create a positive or negative perception, which sets an expectation of what the product can deliver and how it will make an individual feel. There are many external and internal stimuli, which integrate to create such expectations. Thus, the broad question that is addressed is whether beliefs, attitudes, subjective norms, perceived behavioural control and expectations held of consuming psychoactive drinks affect not only judgements of consumption experience and intention to buy and to consume such drinks, but behavioural outcome. This could be assessed using the TPB model by measuring the effects of each construct to predict expectancy response.

There are substantial studies that report people's sensory experiences are determined not only by bottom-up processes which are impacted by external stimuli on individual's sensory organs, and are also influenced by the top-down process, such as, individual desires and

expectations (Williams, 2007). There are many studies, which measure the importance of top-down processes, as it is often used in branding and labelling of food and drink. The expectations triggered by the information such as labelling and branding generally affect consumer's preferences, for instance; cola (McClure et al., 2004), nutrition bars (Wansink et al., 2000), coffee (Olson and Dover, 1978) and yogurt and cheese spreads (Wardle and Solomons, 1994). All these studies use the top-down approach by comparing the differences in expectation between control treatments with no information about the product being consumed with information about the product, which are the cues for expectations prior to sampling the product. For an example, McClure et al (2004) investigated changes in people's views and perceptions when they consumed a beverage with information and labelling and without information and labelling. In this study participants were asked about their drinking experience of 'coca cola' drink and it was found that participants had indicated positive drinking experience when they were exposed to a labelled drink compared to when they were exposed to non-labelled drink were participants' showed negative emotional experience attached to the consumption of the experimental drink. This could be due to taste or personal experiences. However, when a blind taste test was conducted between Pepsi and Coca-Cola, people preferred Pepsi but when they were given the drinks with branding and all packaging they chose Coca-Cola. This indicates branding and labelling plays an important role in choice and selection of a product. This also indicates that consumers are likely to vote for highly reputed brands over mediocre brands, as they have associated positive and higher expectancy from reputed brands regardless of taste and functioning of a particular product. Another classic study was conducted by Allison and Uhl (1964) investigated the difference between beer choices in two conditions. One condition was the control treatment where no label or information was on the beer bottles and the second condition was the beer bottles were labelled. This study found that the difference between the two conditions indicated a top-down process, which influences evaluation of the stimulus (i.e., participants perceptions towards beer consumption were influenced by expectation, existing beliefs and cognition). Suggesting participants who consume beer regularly would be familiar with taste and effect of beer irrespective of information and labelling on bottle compared to participants who do not drink beer regularly as their perceptions and expectations would be shaped by the information and labelling on the experimental beer bottle.

Information and labelling can influence expectation through the top-down process directly by affecting perceptions and decision making by clouding previous knowledge, experience, developing an experimental demand affect or the need of image consistency. For an example in Allison and Uhl (1964) study, this would be understood through the assumption that participants selected beers, which they were aware of and would normally purchase. They selected beer which they believed would be the *right beer* to select during the study in order to maintain consistency with their self-image, as their sensory perceptions are indirectly affected by the top-down process (Snyder and Uranowitz, 1978; Cohen, 1981; Stangor and McMillan, 1992; Cowley and Janus, 2004). Acknowledging the effect of top-down process, this would be considered within the present thesis to measure expectancy effect for psychoactive beverages by examining participants' beliefs and habits using the TPB questionnaire.

However, the top-down process is also dependent on the intensity and level of attention given to the taste and information of the product consumed or purchased in respect to previous experience. This process is better understood using the affective expectation model (AEM), which was developed, by Wilson and Klaaren (1992). The AEM posits that the affective expectations encourage a readiness to perceive either positive or negative experiences. Thus, when individuals encounter particular experience they often substitute expectations for the attributes associated with the product. If the expected valence differs from the true valence, in retrospect the AEM predicts individuals would fail to detect the basic discrepancy. For instance, if participants were informed prior to a movie that the movie will be awful, this information would prevent the participants evaluating the true merit of the movie. Conversely, if the participants have negative expectations of the movie it is possible they may actively exert effort to avoid perceiving the actual attributes of the experience (Klaaren, Hodges, and Wilson, 1994; Geers and Lassiter, 2005). Returning to Allison and Uhl (1964) study, if the participants had negative expectations prior to the consumption of the experimental beer drink, the participants were found to consume the beer quickly irrespective of brand and ignored their perceptions of taste in order to avoid anticipated negative flavour. Suggesting, participants' taste buds may have triggered different expectation and taste experience, which may have been associated with previous experience of beer consumption.

Similarly, if participants were given positive or negative information about specific energy drinks before consumption, this would prevent the participants creating personal expectations as they have already developed an expectation based on given information. However, if the participants are familiar with the energy drink due to previous experience and somatic knowledge, this would indirectly trigger top-down process, which would affect individual desire and expectation. Thus, the AEM suggests experiencing unfamiliar or ambiguous products will create incorrect assimilation of the experience with expectation in comparison to when an individual is familiar with the product, as expectations may directly affect the perceptions consumers have when they are presented with the stimuli (Lee, Frederick, and Ariely, 2006). This indicates an association with previous experience and expectation, which is determined by the individual's sensory perceptions of that particular experience. This is interpreted by the brain from the information provided during consumption of the product which links to the process of decision making and specific characteristics of the individuals as assumed by the AEM.

The expectations associated with how much we like and enjoy certain food and drink is a good predictor of consumer behaviour (Cardello, Schutz, Snow & Lesher, 2000; Tuorila, Cardello & Lesher, 1994). For instance, it has been reported that positive expectation about consuming a particular soft juice increases the actual rated likeness of the same juice (Cardello & Sawyer, 1992). Conversely, if there is greater difference between the expected and actual stimulus taste produces affects, which are considered as a surprise and unfamiliar expectation from the beverage, leading to a contrast effect rather than assimilation (Deliza & Macfie, 1996). Similarly a study conducted by Yeomans et al., (2008) presented participants with frozen salmon mousse as an ice-cream which the participants expected to be sweet in flavour but the actual liking was less in comparison to when the same salmon mousse was presented to them as savoury dish. Thus, suggesting that there is a discrepancy between expectation and liking of the actual ingredient, which may lead to an exaggerated, dislike response (Yeomans, Chambers, Blumenthal & Blake, 2008). Thus, in the present thesis there is a likely chance that participants recruited for the experimental studies may have a preference to either sweet or bitter tasting beverages as glucose and caffeine drinks have very distinct flavours. In order to prevent discrepancies between the two stimulant ingredients all the experimental drinks were developed to taste as an energy drink which was

made apparent to participants' prior recruitment so that they were aware of the flavouring of experimental drink taste prior to testing.

There are many external factors, which influence tasting experience, liking and expectancy of food and drinks such as; branding of product (Di Monaco, Cavella, Di Marzo & Masi, 2004), country the product is produced in (Caporole, Policastro, Carlucci & Monteleone, 2006), how the product is produced and perceived ingredients (Lee, Frederick & Ariely, 2006). Expectations of food and drink products are often found to remain stable but expectations can be modified as a result of certain experiences (Lee et al., 2006). Our experience of different flavours, textures, odours and taste all derive from the multisensory integration of the specific uni-sensory information when we consume food and drink (Auvray and Spence, 2007; Prescott, 2004). It has been recognised that cognitive, environmental, learned and contextual factors affect general perception and interpretation of sensory information registered (Lee et al., 2006; Wansink et al., 2000; Yeomans et al., 2008). Many studies have reported colour of food or beverage as being the sensory factor and labels with information on the product representing the cognitive or contextual factors, which play an important role, influencing our flavour experience (Clydesdale 1993; Lee et al., 2006; Wansink et al., 2000; Zampini et al., 2007).

There has been vast research indicating that colour of food and drink affect human perception (Christensen, 1983; DuBose et al., 1980; Duncker, 1939; Johnson and Clydesdale, 1982; Levitan et al., 2008; Zampini et al.., 2007). For instance a study conducted by DuBose et al., (1980) instructed participants to identify fruit flavours of drinks that incorporated a range of combination of different colour flavours which were congruently paired (e.g. red colour paired with cherry flavour and incongruently paired (red colour paired with lime flavour). In this study it was reported that participants often misidentified a number of drinks when they were paired incongruently as their decisions were influenced by the colour of the drink rather than the flavour of the drink. Similarly, Hall (1958) conducted a similar study that found participants were unable to identify the flavours of the sherbets if they were uncoloured or coloured incongruently (e.g. pink colour with pineapple sherbet). Thus, the findings from these studies suggest that colour of a drink or food item influencing decision making may be due to associative learning which is due to the awareness of such products that have become a part of the environment we live in (Clyesdale, 1993; Duncker, 1939; Maga, 1974; Spence, 2002; Wheatley, 1973). Energy drinks are often associated with

being orange or yellow in colour whereas coffee is generally associated with being brown in colour. Participants in the present study consumed experimental drinks containing caffeine and glucose as a combination and independently, which were presented as an energy drink (i.e., orange/yellow in colour). The colour of the experimental drinks in the present thesis may have influenced participants overall performance as the experimental drink colour may have triggered somatic beliefs of previous knowledge or past experience of consuming energy drinks.

Labelling also modulates flavour perception (Lee et al., 2006; Makens, 1965; Olson and Dover, 1978; Wansink et al., 2000, 2005; Wardle and Solomons, 1994; Goerlitz & Delwiche, 2004). Thus, it has been acknowledged the likely explanation why labelling has an impact on hedonic and sensory responses to food and drink is due to the expectation created by the information listed on the labelling (Cardello & Sawyer, 1992; Deliza & Macfie, 1996; Kahkonen & Tuorila, 1998; Levin & Gaeth, 1988; Schifferstein et al., 1999; Sheen & Drayton, 1988; Wolfson & Oshinsky, 1966). For instance, Wolfson & Oshinsky (1966) conducted a study with astronauts asking them to taste the same drink but with two different labels printed on the drink bottle either as (space food or unknown). It was reported that the astronauts had higher hedonic ratings when they consumed the drink with the label (space food) compared to drinking from the label (unknown) irrespective of the fact that the drink content was the same. Similarly, Wansink et al., (2000) presented the participants with food with a label (soy) or no label and it was reported the participants described the food to be less tasty and flavoursome and grainy texture for the product with the label (soy) in contrast to the exact same food item, which had no label. Thus, indicating an expectancy effect can occur through the manipulation of information on the label, which modulate cues and create associative recall from previous experience of consuming that product or awareness of what the product would taste like.

Robinson et al (2013) examined the influence of recent tasting experience in expected liking for foods by running two different studies. Study one examined whether a disappointing experience results in changes to expected liking one day and one week after tasting. This study found that, expecting liking was reduced after one day after disappointing hedonic experience, however, this was not found for one week after. The second study explored whether the frequency of previous exposure of eating food can establish whether disappointing hedonic experiences results in change to expected liking. This study reported

previous exposure to food moderated, as expected liking of an infrequent eaten food was reduced but this was not expected liking for a frequently eaten food. It was concluded that expected liking of particular food products can be influenced by dis-confirmatory hedonic experiences. However, these effects would be dependent on past experience and the past frequency exposure of these particular food products. Hence, having previous exposure and preference to food and drink products can affect overall tasting experience and expectation compared to having no previous experience. Therefore, it is important that participants recruited for placebo expectancy studies have had some previous experience of consuming psychoactive beverages such as caffeine, glucose and energy drinks in general in order to measure possible expectancy effects. If participants have no previous experience of consuming coffee or energy drinks, they will not have any previous knowledge to create intentions and expectancies compared to those participants who are familiar with outcome responses of consuming psychoactive drinks. Conversely, recruiting participants with no previous exposure to psychoactive drinks would indicate whether caffeine and glucose have psychoactive effects on cognitive performance and mood irrespective of previous experience of consuming such beverages.

Thus, substantial studies have reported combined methods to estimate consumers integrated reactions either or for both intrinsic information or affective branding and labels (Acebron and Dopico, 2000; Beriain et al., 2009; Cardello and Swayer, 1992; Carr et al., 2001;Wansink and Painter, 2001; Wansink et al., 2002) and extrinsic information such as nutritional information, where the product was developed, branding, price and packaging etc. (Caporale et al., 2006; Carneiro et al., 2005; Enneking et al., 2007; Goerlitz and Delwiche, 2004; Kahkonen et al., 1996; Kahkonen et al., 1997; Mueller and Szolnoki, 2010; Wansink, 2003; Wansink and Park, 2002). The understanding, which is derived from previous research, is that if consumer's expectations are not sufficiently matched with the product consumed, this creates dissatisfaction (Deliza and Macfie, 1996). Thus, the assimilation effect of increasing the expected liking of a product could be an advantage to commercial food and drink suppliers, as consumers would associate enhancement in cognitive performance and mood when they consume energy drinks containing caffeine and glucose.

1.3 The Present Research

As this research consists of series of small studies, this research systematically investigated the various psychological factors that can affect the performance and the mood enhancing effects of energy drinks other than the actual psychoactive nature of ingredients present in the drink. Although many studies have examined the independent psychoactive effects of caffeine and glucose and in some cases in combination, only a few have explored the effects of possible expectancy effects of consuming psychoactive ingredients caffeine and glucose on overall performance and mood (Green et al., 2001 and Dawkins et al., 2011). The present research investigates the key differences between drink conditions (*given energy drink and told they are consuming energy drink,* with *given energy drink and told they are consuming a placebo*) verse (*given placebo drink and told they are consuming an energy drink,* with *given a placebo drink and told they are consuming a placebo drink*), this comparison looked the actual psychoactive effects of the drinks only. This research examined the effects of information given to the participants prior drink consumption (i.e., either told correctly or incorrectly what they are consuming), this analysis would indicate whether any effects derived are due to information given which creates an expectancy effect or are due to the actual psychoactive drink ingredients consumed irrespective of information given prior ingestion. The final part of this research was extended using the TPB model to, (1) predict future intentions of consuming energy drinks, and (2) predict expectancy effects in mood and cognitive performance. Using the TPB model to predict future intentions of energy drink consumption and predict expectancy effects in mood and performance has not previously been investigated. Thus, this is a new and novel model to use to predict possible expectancy effects.

This thesis commences by examining the psychoactive effects of caffeine and glucose individually and in combination as an energy drink in order to rule out any differences between caffeine and glucose upon cognition, sensorimotor movements and mood, and how they work together in combination as an energy drink. Secondly, the present research aims to investigate whether expectancy effects enhance performance and mood and if this is due to previous exposure, familiarity, positive manipulative information about the drink and branding of products. Or has this enhancement in performance arisen due the actual psychoactive ingredients of the drink, suggesting expectancy plays no role in the

enhancement of a beverage. Furthermore, the third part of this study introduces and evaluates 'The Theory of Planned Behaviour Model' which predicts outcome behaviour and expectancy responses. This model can be utilised to predict expectancy responses for habitual and non-habitual consumers of psychoactive ingredients (caffeine and glucose), and measure how the constructs within the TPB model effect expectancy desires and overall behaviour and responses.

Thus, the thesis has composed chapters for each study looking at the effects of psychoactive drinks on cognition and mood. Chapter 2 provides methods information on material such as questionnaires and cognitive tasks used, equipment and ingredients required to produce the psychoactive drinks and their placebos. Chapter 3 through to Chapter 6 discusses each study, which is listed below. The overall discussion and conclusion can be found in Chapter 7.

1.3.1 The independent effects of caffeine and glucose on cognition and mood (Chapter 3)

Aim: Experiment 1, examines caffeine and glucose independently using within subjects placebo design without any form of manipulation. This study should indicate the actual effects of the psychoactive ingredients of caffeine and glucose on performance (cognitive and sensorimotor movements) and mood. All participants will consume active caffeine, active glucose, placebo caffeine and placebo glucose drinks. There are four drink conditions in total whereby, no information about the drink content is given to the participants' prior ingestion. In order to measure these effects the hypotheses have been listed below under each experiment within this chapter.

1a. Participants will exhibit faster tapping times on the two-finger tapping task and make a greater number of hits on the Bakan task in the caffeine conditions compared to the glucose conditions, but this advantage will be limited to active caffeine condition.

1b. Participants will have enhanced attention in the glucose drink condition for the Bakan task and they will recall greater number of correct words on the Immediate verbal recall task compared to the caffeine drink condition.

1c. It is expected that when participants consume either psychoactive stimulant drinks (caffeine and glucose) the mood component from the POMS questionnaire that would increase is vigour and the components that would decrease are fatigue and tension.

1.3.2 Placebo expectancy effects in the relationship between energy drink (caffeine and glucose) on cognition, sensorimotor movements and mood (Chapter 4)

Aim: Experiment 2 examines the effects of consuming an energy drink containing (caffeine and glucose) as a combination on cognition, sensorimotor movement and mood, and whether this is mediated by expectancy when participants consume the placebo beverage. This study is different to Experiment 1, as the psychoactive ingredients are measured in combination unlike Experiment 1 where they were measured independently. This experiment design investigates the interaction between the psychoactive effect and information, which measures the expectancy effect. This would be analysed by examining the main effects of active versus placebo ingredients: (*given energy drink and told they are consuming an energy drink,* with *given energy drink and told they are consuming a placebo drink)* by comparing with the drink conditions *(given placebo and told they are consuming an energy drink,* with *given placebo and told they are consuming a placebo drink*). A further analysis would measure the effects of information given (i.e., correct or incorrect to what they are actually given) which would measure the main effects of possible expectancy effects for the drink conditions (*given energy drink and told they are consuming an energy drink* with *given placebo drink and told they are consuming an energy drink)* by comparing these drink conditions with (given energy drink and told they are consuming a placebo drink, with given a placebo drink and told they are consuming a placebo drink).

The expectancy effect of consuming energy drinks (caffeine and glucose) would be measured using balanced placebo design and presenting participants with manipulating information. For instance, this experiment investigated whether consuming psychoactive ingredients caffeine and glucose as a combination creates an expectancy effect i.e., comparing the effects when *participants are given placebo drink but informed they are*

consuming an active drink, and *when they are given a placebo drink and informed they are consuming a placebo drink*. The psychoactive effect versus the placebo effect was examined for the drink conditions *'given the active drink but informed it is the placebo drink'*, and for *'given the active drink and informed they are consuming the active drink'*. The psychoactive effect was also investigated which compared the drink conditions, '*given energy drink and informed they are drinking a placebo drink*' with '*given placebo drink and informed they are consuming a placebo drink*'. These effects have been assessed to measure what expectancy effects are created which may enhance cognitive performance and mood. It was hypothesised that:

2a. Blood glucose levels will be significantly higher post drink in comparison to pre-drink, but this increase will be limited to the active glucose drink condition.

2b. Participants will exhibit faster tapping times on the two-finger tapping task, make a greater number of hits on the Bakan task, recognise words correctly at a fast speed and have enhanced ability to recall more words from the recall task when participants are told they are consuming an active condition compared to told placebo condition. Thus, the main effect of information (told active / placebo) will influence the actual effect of the active ingredient, but it is plausible that it might be an interaction effect (i.e., being told active only helps in the presence of the active ingredient).

2c. There will be an interaction between ingredients and information, such that performance on the cognitive tasks will be highest for the active ingredient condition where the participants are told they are receiving the active ingredient. (This tests for expectancy effect). When given active ingredient condition where the participants are told they are receiving the active ingredient compared to when they consuming a placebo drink and informed they are drinking a placebo drink. (This hypothesis tests for a psychoactive effect).

2d The mood subscales tension and fatigue levels will decrease, and vigour activity levels will increase for the active ingredient condition where the participants are told they are receiving the active ingredient. (This hypothesis tests for an expectancy effect). This tests for expectancy effect). When given active ingredient condition where the participants are told they are receiving the active ingredient compared to when they consuming a placebo drink and informed they are drinking a placebo drink. (This hypothesis tests for a psychoactive effect).

The psychoactive effect was also investigated which compared the drink conditions, 'given energy drink and informed they are drinking a placebo drink' with 'given placebo drink and informed they are consuming a placebo drink' on cognitive performance and mood, suggesting there would be an overall psychoactive effect of consuming energy drink irrespective of information given.

1.3.3Effects of drink presentation on cognition and mood (Glass versus Branded Bottle) (Chapter 5)

Aim: Experiment 3 examines the extrinsic factor, which was to consume the experimental beverage from a branded Lucozade bottle and from a glass with no information. This would be tested using four different conditions (active drink in a branded bottle, placebo drink in a branded bottle, active drink in glass and placebo in glass) to measure whether drink presentation, irrespective of drink content affects overall cognitive performance and mood to examine whether this is triggered by expectancy response.

The analysis for this experiment would examine the main effects of active drink and placebo drink from a bottle with the same experimental drinks from a glass. The analysis will determine whether there is main effect of active ingredients and whether the drink presentation influences expectation, irrespective of drink ingredients. Thus, any interaction found would indicate whether effects found are due to active ingredients irrespective of drink presentation, or visa-versa. It was hypothesised that:

3a. There will be a main effect of ingredient, such that participants consuming active ingredient either from a glass or bottle they will have enhanced **cognitive performance** whereas consuming a placebo drink from a glass or bottle will not have an enhancing effect on overall performance for the active ingredient condition compared to the placebo ingredient, testing an expectancy effect).

3.1a. There will be a main effect of ingredient such that participants consuming active ingredient either from a glass or bottle they will have enhanced **mood**, whereas consuming a placebo drink from a glass or bottle will not have an enhancing effect on overall mood

(i.e., the mood subscales tension and fatigue levels will decrease, and vigour activity levels will increase for the active ingredient condition compared to the placebo ingredient, testing an expectancy effect).

3b.There will be a main effect of information (told active / told placebo), such that participants told active will have higher **cognitive performance** for told active compared told placebo, testing an expectancy effect).

3.2b. There will be a main effect of information (told active / told placebo), such that participants told active will have higher **mood improvement** for told active compared told placebo, testing an expectancy effect. (i.e., the mood subscales tension and fatigue levels will decrease, and vigour activity levels will increase when told active compared to when told placebo).

3c. There be a difference between drink consumption from a glass versus bottle irrespective of drink ingredient on overall **cognitive performance**. The main effect of drink presentation measures expectancy effect such that participants consuming from a branded bottle would perform better compared to drinking from a glass irrespective of ingredient.

3.3c. There be a difference between drink consumption from a glass versus bottle irrespective of drink ingredient on overall **mood**. The main effect of drink presentation measures expectancy effect such that participants consuming from a branded bottle would enhanced vigour experienced and decreased tension and fatigue experienced post consumption compared to drinking from a glass irrespective of ingredient.

1.3.4The placebo expectancy effects measured using the Theory of Planned Behaviour Model (Chapter 6)

The Theory of planned behaviour model (TPB) predicts that planned behaviours are determined by behavioural intentions largely influenced by an individual's attitude towards a particular behaviour (i.e., *drinking energy drinks would make me feel: stimulated*), subjective norms encasing the execution of that behaviour (i.e., *my friends think I should drink energy drinks frequently*) and the individuals perceptions of their control over that behaviour (i.e., *I do not believe I can perform well without drinking energy drinks*) (Azjen,

1975). The constructs within the TPB model can be used in a novel way to predict future intentions of consuming a psychoactive beverage and furthermore, to predict expectancy effects in mood and cognitive performance.

Aims: Experiment 4 intends to examine whether participants beliefs, past experience, attitude, habits, subjective norms, perceived behaviour control, intentions and self-identity, play a role in predicting expectancy response when consuming a psychoactive drink. The phenomena of expectations are either positive or negative, which can modulate behaviour depending on participants' experiences and expectations of consuming psychoactive beverages. Acknowledging the constructs in TPB to investigate psychoactive drinking behaviour, to measure which constructs are the stronger predictors of intentions and expectancy effects in cognition and mood, and which constructs have no impact on these expectancy effects.

The final experiment adopts a similar design to experiment 1 by investigating the interaction between the psychoactive effect and information, which measures the expectancy effect. This would be analysed by examining the main effects of active versus placebo ingredients: (*given energy drink and told they are consuming an energy drink,* with *given energy drink and told they are consuming a placebo drink)* by comparing with the drink conditions *(given placebo and told they are consuming an energy drink,* with *given placebo and told they are consuming a placebo drink*). A further analysis would measure the effects of information given (i.e., correct or incorrect to what they are actually given) which would measure the main effects of possible expectancy effects for the drink conditions (*given energy drink and told they are consuming an energy drink* with *given placebo drink and told they are consuming an energy drink)* by comparing these drink conditions with (given energy drink and told they are consuming a placebo drink, with given a placebo drink and told they are consuming a placebo drink).It was therefore hypothesised that:

4a. There will be a main effect of ingredient (active / placebo) such that participants will exhibit faster tapping speed for the two-finger tapping task, recall more words during the immediate verbal recall task and recognise more words correctly and promptly when the active drink is consumed compared to when the placebo drink condition.

4.1a. There will be a main effect of ingredient (active / placebo) such that participants will experience mood improvement (vigour will increase were tension and fatigue levels will decrease) for the active drink is consumed compared to when the placebo drink condition.

4b. There will be a main effect of information (told active / told placebo) whereby participant will exhibit enhanced cognitive performance when they are told they are consuming an active drink irrespective of ingredient, indicating an expectancy effect.

4.2b. There will be a main effect of information (told active / told placebo) whereby participant mood will improve (vigour will increase, tension and fatigue will decrease) when they are told they are consuming an active drink irrespective of ingredient, indicating an expectancy effect.

4c. The TPB model components (attitude, subjective norms, perceived behavioural control and intentions) and the additional components included in the questionnaire (belief, habit, past behaviour and self-identity) as measured by the TPB questionnaire will predict the variance in the above expectancy effect (that is, the variance in the amount of difference between given placebo told energy drink and given placebo drink told placebo drink).

Chapter 2: Materials & Apparatus

This chapter includes information on the questionnaires, cognitive tasks and materials used in the series of short studies discussed in this thesis. This thesis is a quantitative research and the questionnaires and cognitive tasks have been selected to measure the effects of consuming psychoactive beverages (caffeine and glucose) and how the consumption of such beverages affects the participants' performance.

2.1 **The Questionnaires**

Two questionnaires were used in this thesis, which measured mood and the constructs from Theory of Planned Behaviour model to predict expectancy response. The mood questionnaire Profile of Mood State was used as a baseline measure for all the series of studies included in this thesis. The Theory of Planned Behaviour questionnaire was designed to examine prediction of variance in expectancy effect when psychoactive beverages (caffeine and glucose) were consumed.

2.1.1 The Profile of Mood State Questionnaire (POMS)

McNair, Lorr & Droppleman (1992), designed this questionnaire. The POMS questionnaire is anchored at each end with the statements 'Not at all' to 'Extremely'. The moods rated were on six subscales which were; fatigue-inertia, anger-hostility, vigour-activity confusion-bewilderment, depression-dejection and tension-anxiety. This questionnaire is composed of 65 items scored by participants on a five-point Likert scale. The 65 adjectives were rated on 5-point scale 0= not at all; 1=a little; 2=moderately; 3=quite a bit; 4=extremely on how each participants feels 'Right now'. The six subscales range scores are as follows: tension and anxiety (9 items, score range: 0 – 36), depression (15 items, range 0-60), anger (12 items, range 0-48), vigour (8 items, range 0-32), fatigue (7 items, range 0- 28) and confusion (7 items, range 0 -28). The total mood disturbance (TMD) can be calculated by, adding the subscales (tension, anger, depression, anger, fatigue and confusion) and subtracting vigour (range: 0- 200).

[***The abbreviation for this questionnaire is POMS***]

The POMS questionnaire is ideal for this research to predict and indicate the effects of consuming psychoactive beverages (caffeine and glucose) on mood. Green at al., (2001) used the POMS questionnaire to measure the correlation between mood and blood glucose levels before and after consuming the experimental beverage. **Please see appendix (1) for this questionnaire**.

2.1.2 The Theory of Planned Behaviour Questionnaire (TPB)

The Theory of Planned Behaviour model (TPB), was constructed by Fishbein & Ajzen (1991). The original constructs from this model (i.e., attitude, subjective norms, perceived behavioural control and intentions) were included along with additional constructs (belief, habit, past behaviour and self-identity) to create a TPB questionnaire to predict expectancy response of consuming psychoactive beverages. This questionnaire was used in Experiment 5 (Chapter 6). [***This questionnaire is abbreviated as TPB***].

All items were measured on 7 Likert –type scale with "strongly agree" to "disagree" as scale end points. Some items within this questionnaire were reverse coded to reduce anchoring effects and automatic response set. For details on design and reliability analyses for this questionnaire please see below.

TBP questionnaire consists of 35 questions that have been split into 8 constructs (attitude, subjective norms, perceived behavior control, intentions, past behavior, habit, belief and self-identity). These constructs measure participant's response on a 7-point likert scale. Scoring for the constructs (attitude, subjective norms, perceived behavior control and intentions) been recoded so that the question has negative endpoints on the right, so that the scores then consistently reflect a greater level of control for the target behavior. It is important that these items have high internal consistency. The scoring range was as follows: Past behavior (questions 1 and 35, range 0-7) measuring frequency of target behaviour. Attitude (questions 2-7, range 0-7), habit (questions 8-13, range 0-7), belief (questions 14-

18, range 0-7), subjective norm (questions 19-23, range 0-7), perceived behavior control (questions 24-29, range 0-7), intentions (questions 30 -32, range 0-7) and self-identity (questions 33-34, range 0-7). The scoring for each item was calculated by totaling the response circled on the questionnaire on the 7-point likert scale and reversed the scores for the constructs (attitude, subjective norms, perceived behavior control and intentions) and calculating the mean score for each construct.

The questions were constructed to measure participants; past behaviour, attitude, habit, belief, subjective norms, perceived behaviour control, intentions, self-identity using a 7 - point Likert. Before any analysis took place for this questionnaire, a test reliability analysis was conducted where questions with low inner consistency were removed by conducting the principle components analysis. The purpose of conducting a principle components analysis was to find a small set of linear combinations of the covariates that are uncorrelated with each other. Principal components analysis is a method of data reduction. This will avoid the multi-collinearity problem. Conducting principle components analysis would ensure that the linear combinations chosen have maximal variance. Thus, a good regression design chooses values of the covariates that are spread out. Therefore, the questions that were removed after conducting the principle components analysis have been listed below under the question categories (i.e., perceived behavioural control and belief) were self-identity questions were split into two individual constructs. Cronbach's alpha of (0.7) is considered acceptable, however, there are some constructs included which have low reliability were included (past behaviour, belief and self-identity) in the final analysis which may have implications for the inferences made. The questionnaire commenced in asking questions in the following order;

Past behaviour – the Cronbach's alpha (α) was 0.67 for the following items: (on average, how often over the last 6 months have you consumed energy drinks) and (frequency of how many times you normally consume 330ml bottle for energy drinks a day and in week) on scale ranging from (Never – 4/6 times a week).

Attitude – the Cronbach's alpha (α) was 0.82 for all the items in the questionnaire, therefore no question were removed from the analysis. The questions which measured attitude were: (*To me, drinking energy drinks frequently is..*), (*Drinking energy drinks would make me feel..*), (Energy drinks taste good), (*My attitude towards drinking energy drinks is..*), (*My attitude towards drinking energy drinks is..*), (*I believe the claims made on energy drinks in*

adverts by branded companies such as (e.g. Lucozade) are correct / true..) measured on a 7 point Likert scale varying from: extremely negative-extremely positive, strongly disagree – strongly agree, definitely false-definitely true.

Habit - the Cronbach's alpha (α) was 0.87 for all the items in the questionnaire, therefore no question were removed from the analysis (*I cannot function without consuming energy drinks*), (*I cannot function cognitively and physically without consuming 1 energy drink a day.*.), (*I feel fatigue without consuming my daily psychoactive (caffeine and glucose) beverage.*.), (*I feel stimulated every time I consume energy drinks*..), (*I feel content when I consume my daily psychoactive (caffeine and glucose) beverage.*.), (*I experience withdrawal symptoms if I do not consume caffeine.*.) on a 7 point Likert scale strongly disagree-strongly agree.

Belief – the Cronbach's alpha (α) was 0.66 for the following items (Drinking energy drinks regularly will make me feel cognitively smarter (intelligent)..), (Drinking energy drinks will make me feel happy..), (Drinking energy drinks will have an effect on my performance..), on a 7 point Likert scale strongly disagree-strongly agree. Question (16) Feeling cognitively smarter (intelligent) on my course / module would be: (Bad 1 2 3 4 5 6 7 Good) was removed to increase inner consistency for belief from Cronbach's alpha (α) of 0.54 to 0.66.

Subjective Norm – the Cronbach's alpha (α) was 0.89 for all the items in the questionnaire, therefore no question were removed from the analysis. The questions which measured subjective norms were: (*Most people who are important to me think that I should drink energy drinks frequently*..), (*Generally, members of my family think that I should drink energy drinks frequently.*.), (*Generally, my friends think that I should drink energy drinks frequently*..), (*I like to do what my friends think that I should*..), (*Most famous personalities I admire claim to drink energy drinks and they promote this in adverts that we should drink energy drinks.*.) on a 7 point Likert scale unlikely – likely.

Perceived behavioural control – the Cronbach's alpha (α) was 0.76 for the following items: (I do not believe I can perform well without drinking energy drinks..), (I need to drink energy drinks to stay awake in my lecture..), (I am confident that I can drink energy drink at least 3 times in the next 7 days..), (*I am confident that I will perform my best in the cognitive tasks when I drink the experimental beverage*..) on a 7 point Likert scale strongly disagree –

strongly agree. Question (25) *Energy drinks are easily available to me (Strongly disagree 1 2 3 4 5 6 7 Strongly agree)* was removed to increase inner consistency for perceived behavioural control from Cronbach's alpha (α) of 0.69 to 0.76.

Intentions – the Cronbach's alpha (α) was 0.80 for all the items in the questionnaire, therefore no question were removed from the analysis. The questions which measured subjective norms were: (*I intend to drink energy drinks in the next 7 days*..), (*Over the next 7 days, it is likely I will consume an energy drink*..), (*Over the next 7 days my main way of staying alert will be to consume energy drink*..), on a 7 point Likert scale definitely will – definitely will not.

Self-identity the Cronbach's alpha (α) was 0.52 for the following items: (*I am someone who consumes energy drinks to stay alert.)* and (*I am the kind of person who drinks energy drinks…)* on a 7 point Likert scale likely-unlikely. Although the Cronbach's alpha (α) was not as strong as the other constructs within the questionnaire both questions (33) *I am someone who consumes energy drinks to stay alert* (Unlikely 1 2 3 4 5 6 7 Likely) and (34) *I am the kind of person who drinks energy drinks* (Unlikely 1 2 3 4 5 6 7 Likely) were kept as removing either question would reduce the inner consistency further. Therefore, self-identity was split into two constructs as self-identity (1) and self-identity (2) for questions (33) and (34) respectively.

Please see appendix (2) for this questionnaire.

2.2 Cognitive Performance Tasks

In order to assess working memory capacity, attention and sensorimotor speed the following cognitive tasks were adopted: Bakan task, Recognition task, Immediate verbal free-recall task and Two-finger tapping task. Cognitive assessment battery tasks were presented to participants via a 486 MHz PC running MEL v.2 (Psychology Software Tools Inc., Pittsburgh, PA, USA) with a 33cm colour monitor. These particular cognitive assessments were used because previous studies have found a relationship between psychoactive

beverage consumption, cognitive ability and sensorimotor movements (Glade, 2010; Smith and Foster, 2008; Hewlett & Smith, 2007; Riby et al., 2004). A list of the cognitive tasks used for each experiment can be found in (Table 2-1).

2.2.1The Bakan task

This was designed by Bakan (1959) and is a six minutes long visual analogue task. Participants are presented with a continuous stream of single digits (1-9), which appear one at a time in the centre of the visual display unit monitor. The participants are required to detect a sequence of either three odd numbers or three even numbers occurring consecutively. The stimulus exposure was 600ms with no inter-stimulus interval and forty-eight potential correct targets. The scoring for this task involved calculating the mean number of correct hits (maximum correct hits of 8) per block (with maximum of 6 blocks per set) as a range. The dependent measure was the number of correct hits made over the course of the task. Green et al (2001) found glucose consumption enhanced the number of correct hits made in the Bakan task. Similarly, Elliman et al (2010) found consumption of caffeine also enhanced performance on the Bakan task. For this reason the Bakan task was selected for the series of experiments conducted within this thesis to measure the effects of caffeine and glucose independently and in combination on the Bakan task.

2.2.2 The Recognition Memory task

This was an adaptation of the Sternberg (1966) recognition memory task as used by Green et al., (2001). Whereby, words presented in this task were similar to the words used in Sternberg's list. Participants were presented with a list of twenty words in a randomised order. The list was presented at one word per second and these made up the stimulus lists. After the participants were presented with the stimulus list they were then presented with a probe recognition set of forty words. This comprised of the original stimulus list words and twenty new words from a filler list. The filler stimuli were matched for length and frequency of occurrence in written English with the test items (Green et al., 2001). The participants were required to decide whether the word being presented was from the original list or not. This was assessed by pressing either key (1) if it was in the original list or key (3) if it wasn't.

The dependent variables were the total number of correct words recognised from the stimulus list and from the filler list, also taking into account the correct response time (recognition speed in ms) to make the correct decision only. There was no data recorded for incorrect recognition. Thus, this task yielded two outcome measures, these being the response times to make correct recognition decisions (ms) and the number of words correctly recognised as being presented in the memorised lists (maximum words to be recognised correctly 40). Green et al (2001) study found glucose administration improved recognition speed relative to placebo drink condition. The recognition task was also used in Scholey et al (2012) study, which also found glucose consumption enhanced recognition memory. As this thesis examines the effects of psychoactive ingredients such as glucose, the series of experiments will also test whether participants' recognition memory improves with active beverage relative to placebo beverages.

2.2.3 The Immediate Verbal Free Recall task

This used monosyllabic nouns from Kucera-Francis (1982) wordlist. In this task the participants were presented with two lists of twenty words. The first list was presented at one word every one second and the second list was presented at one word every two seconds. The participants were given 4 minutes after each list to recall and write down as many words as they could recall from that list. The dependent variable was the total number of words recalled correctly within the four minutes from each list, with maximum number of 20 words to be recalled from each list. Many researchers have used this test widely. Having two stimulus lists presented at different word presentation speeds allows the researcher to compare the difference between the numbers of words recalled from each presentation list. For an example if words are presented for 2 seconds per word on the screen, participants are likely to recall more words from this list compared to 1 second word presentation list. For instance, Foster et al (1998) found glucose administration improved verbal recall relative to placebo condition. Therefore in the series of experiments within this thesis it has been hypothesised that on consumption of psychoactive drinks participants will recall more words relative to non-psychoactive drinks.

2.2.4 The Two-Finger Tapping task

This task has been used to measure sensorimotor function in various studies e.g. Green et al. (2001). Participants were required to alternately tap the keys (1) and (2) on a numeric keypad as quickly as possible using the index and middle fingers of their dominate hand. The dependent variable was the mean tapping speed taken for the participant to tap each key 150 times, i.e. a total of 300 key presses. The data from this task analysed the mean number of (taps/ms). The scoring for this task was as follows: (the average speed for each block was calculated automatically within task software) this was then inputted into SPSS to calculate mean score per condition. This task has been used in Green et al (2001) study to assess whether consumption of glucose enhances sensorimotor movement and whether placebo condition could mediate expectancy effect. Green et al (2001) study did not find any significant findings suggesting possible expectancy effects or faster reaction time. However, Donohoe & Benton (2000) found glucose consumption improves reaction time on this task. Caffeine consumption has enhances sensorimotor movements (Hewlett & Smith, 2007). Current research has indicated that both caffeine and glucose improve reaction time on sensorimotor tasks. As the Two-finger tapping task measures sensorimotor movement, this task would be ideal to assess participants' reaction time using within subjects balanced placebo design experiments.

Table 2-1 List of cognitive tasks used for each experiment

Experiment No:	**1**	**2**	**3**	**4**
(Corresponding chapter)	**(Ch. 3)**	**(Ch. 4)**	**(Ch. 5)**	**(Ch. 6)**
Bakan task (mean correct hits / 6 Blocks)	✓	✓	✓	
Immediate verbal recall task (mean words correctly recalled from a presentation list of 20 words)	✓	✓	✓	✓
Two-finger tapping task (mean speed of taps/ms) for a maximum of 300 taps.	✓	✓	✓	✓
Recognition task (mean words correctly recognised (maximum words of 40) and the mean speed of correct recognition ms)		✓		✓

Table 2-2 Representing studies which have assessed the relationship between psychoactive drinks on cognitive and sensorimotor movements.

Study	Outcomes of tests	Tests used in thesis which have similar paradigm to previous studies measuring vigilance, attention, memory and reaction times	Psychoactive ingredient measurement (g) & absorption time given	How long participants abstained from psychoactive ingredients prior experiment
Giles et al (2012)	Energy drinks were administered to participants containing caffeine, glucose and taurine. It was found that caffeine enhanced executive control and working memory, and reduced simple and choice reaction time. Taurine increased choice reaction time but reduced reaction time in the working memory tasks. Glucose alone slowed choice reaction time. Glucose in combination with caffeine, enhanced object working memory and in combination with taurine, enhanced orienting attention. Limited glucose effects may reflect low task difficulty relative to subjects' cognitive ability. Caffeine reduced feelings of fatigue and increased tension and vigour. Taurine reversed the effects of caffeine on vigour and caffeine-withdrawal symptoms.	The Bakan task, The Recognition task, Two-finger tapping task and the Immediate verball recall task (mean words correctly recalled from a presentation list of 20 words)	Participant's drinks consisted of 200mg of caffeine, 50g of glucose and 200mg of taurine in the active drinks. Participants were given 30 minutes to digest drink.	Participants taking part in the experiment were all habitual caffeine consumers and were requested to abstain from caffeine for 24 hours prior testing.
Elliman et al (2010)	Participants completed four experimental test sessions in which there cognitive performance and self-reported mood was assessed. On two of these sessions, they ingested a caffeine drink prior to testing and on the other two they ingested a caffeine free placebo drink. In one of each drink conditions, subjects were accurately informed as to the nature of the drink prior to testing and on the other they were informed that they had been given the other drink .Found task caffeine enhanced performance and improved mood, but only when participants were accurately told they were receiving it. When decaffeinated coffee was given, performance was poorer, irrespective of expectancy.	Bakan task	The experimental drink was formulated with either caffeinated (200 mg of caffeine) or decaffeinated granular instant coffee (Sainsbury Full Roast) made up with 170 ml of warm (not hot) water and 30 ml whole milk. No sugar or artificial sweeteners were present in the drinks. Participants consumed the experimental drink within a three minute period and rested for twenty minutes	All of the participants were habitual coffee drinkers, defined as drinking more than one cup of caffeinated coffee per day for a period longer than 6 months. Participants were required to abstain from consuming from 10 p.m. the evening before testing in order to ensure comparable baseline caffeine levels.
Koppelstaetter et al., (2008) & Lieberman, (2007)	The MRI reported an increase in neural activity in the brain region dealing with attention-demanding cognitive functions during cognitive tasks which increased alertness, concentration and vigilance	Bakan task	Participant consumed 100g of Caffeine and were given 20 minutes for the experimental drink to Digest.	Participants were abstained from drinking caffeine 2 hours prior testing. It was found that habitual consumers encountered withdraw effects from abstaining and on consumption their performance enhanced.
Hewlett and Smith (2007)	Reported that caffeine enhanced vigilance and reaction time in both habitual and non-habitual caffeine consumers.	Bakan task Two-finger tapping task	Caffeine (250mg)	Participants were abstained from caffeine for 30 hours. Habitual consumers encountered withdrawal effects and on upon consumption of caffeine performance and mood improved.
Green et al (2001)	Glucose administration was found to improve performance on the Bakan task relative to the placebo drink. There was also improvement in the recognition memory speed	Bakan task, Recognition task	50g of glucose was consumed and participants were given 30 minutes to digest the experimental drink	Participants were requested to abstain from any food and drink containing glucose 8 hours prior experimental testing.
Donohoe and Benton (2000)	This study found those with higher peak blood glucose performed worse on the vigilance task. For glucose measured during testing, a higher baseline blood glucose level was associated with faster reaction times, and the faster the falling of blood glucose the quicker the decision times.	Bakan task Two-finger tapping task Recognition task	50g of glucose were consumed by participants and they were given 20 minutes of absorption time for experimental drink.	Participants were requested to abstain from any glucose containing food and drink 2 hours prior experimental testing.

2.3 Materials

The additional equipment required for the experiments included:

- Rubber gloves for protecting hands and preventing spread of any infections when taking blood samples from the participants for hygiene purposes. (Experiment 2, Chapter 4 measured blood glucose levels at baseline and after drink consumption in order to assess whether blood glucose levels increase after experimental drink consumption, irrespective of drink content and whether increased blood glucose levels had any association with cognitive performance).
- Alcohol wipes for disinfecting the surface of fingers before taking blood samples.
- Accu-Chek Compact Glucose Monitoring System (Roche Diagnostics) to measure glucose levels. This was accomplished by finger pricking the participants five minutes before and twenty minutes after the experimental beverage was consumed.
- Pentium II pc running MEL v. 2 (Psychology software tools Inc. Pittsburgh, PA USA) with a 33cm monitor was used in order for the participants to complete the cognitive the tasks.

2.3.1 Experimental Drinks

All the experimental beverages were made in the laboratory kitchen using the ingredients listed in (Table 2-3). Each drink was made up to a total volume of 1L. The materials and apparatus used for making the beverages were:

- Electronic weighing scale to measure the weight of glucose powder, decaffeinated coffee granules and citric acid granules.
- A pipette to measure flavouring essences and food colourings for the beverage.
- 1 litre cylinder to measure water and measuring out 330ml of the experimental beverage for each participant.
- Caffeine tablets, which consisted of 50mg of caffeine per tablet as the active ingredient and sorbitol and magnesium stearate as the other inactive ingredients.

- Saccharine tablets, which were made up of sodium bicarbonate, sweetener (saccharine), sodium carbonate, tartaric acid, anticaking agents (stearic acid, magnesium stearate) and acacia (tableting aid).

Table 2-3 List of ingredients for the experimental beverages

ENERGY DRINK (GLUCOSE & CAFFEINE)	**GLUCOSE DRINK**	**CAFFEINE DRINK**
151.5g Glucose powder 150mg Pro plus Caffeine (3 tablets) 6x Saccharine tablets 3ml of Lemon flavouring 2g of Citric acid 1 litre of water 1ml of yellow colouring	151.5g Glucose powder 6x Saccharine tablets 3ml of Lemon flavouring 2g of Citric acid 1 litre of water 1ml of yellow colouring	150mg Pro plus Caffeine (3 tablets) 6x Saccharine tablets 3ml of Lemon flavouring 2g of Citric acid 1 litre of water 1ml of yellow colouring
PLACEBO ENERGY DRINK	**PLACEBO GLUCOSE DRINK**	**PLACEBO CAFFEINE DRINKS**
9g of Aspartame 6x Saccharine tablets 3ml of Lemon flavouring 2g of Citric acid 1 litre of water 1ml of yellow colouring	9g of Aspartame 6x Saccharine tablets 3ml of Lemon flavouring 2g of Citric acid 1 litre of water 1ml of yellow colouring	6x Saccharine tablets 3ml of Lemon flavouring 2g of Citric acid 1 litre of water 1ml of yellow colouring

The experimental drinks were made up of 1 litre of water to start off with in a beaker and the ingredients in the table for each drink condition. Caffeine and glucose drinks were taste matched with caffeine and glucose placebo drinks in experiments 2, 3 and 4. For experiment, there were distinctive differences in sweetness and bitterness between caffeine and glucose drinks and their placebos beverages. The breakdown of glucose and caffeine has been listed below for the experimental drink conditions:

- 330ml of energy drink consisted of 50g of glucose and 49.5mg of caffeine.
- 330ml of glucose drink consisted of 50g of glucose only.
- 330ml of caffeine drink consisted of 49.5mg of caffeine only.

Participants were requested to refrain from consuming any food or drink containing caffeine and glucose two hours prior testing in order to maintain consistency at baseline and to ensure that participants were not in an obvious withdrawal state during experiment.

2.3.2 Counterbalancing experimental drinks

A Latin square matrix was used to preserve balance by designating each drink condition to be administered once in each ordinal position (i.e., 1^{st}, 2^{nd}, 3^{rd}, 4^{th}) and for each treatment to follow every other treatment equality each experiment has the (4) drink conditions. As this is a repeated measures design is a design where repeated measurements are made on the same participant. Thus, one common way to assign treatments to participants is to use a Latin square design. An advantage of this design for a repeated measures experiment is that it ensures a balanced fraction of a complete factorial (that is, all treatment combinations represented) when subjects are limited and the sequence effect of treatment can be considered to be negligible. Please see Latin square designs for each experiment for each drink condition.

Experiment 1 examined the independent effects of active caffeine and glucose and their placebos and the Latin square for this experiment can be viewed Latin square 1. Experiment 2 and 4 had the same drink conditions and the counterbalancing for drink conditions can be seen by Latin square 2. Experiment 3, on the other hand examined the effects of drink presentation (branded bottle and glass) on performance, please see Latin square 3 design. Similarly, the same Latin square design was adopted for cognitive tasks with drink conditions, please see Latin square design for each experiment in the design section for each study.

Latin square design 1

Table 2-4 Representing Latin square design 1

EXPERIMENTAL SESSIONS	**DRINK CONDITIONS**			
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C

Key: A = Active caffeine drink / B = Active glucose drink / C = Placebo caffeine drink / D = Placebo drink

Latin square design 2

Table 2-5 Representing Latin square design 2

EXPERIMENTAL SESSIONS	**DRINK CONDITIONS**			
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C

Key: A = (given energy drink /told energy drink)/ B = (given energy drink/ told placebo) / C = (given placebo drink / told placebo)/ D = given placebo drink/ told energy drink)

Latin square design 3:

Table 2-6 Representing Latin square design 3

EXPERIMENTAL SESSIONS	**DRINK CONDITIONS**			
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C

Key: A =(given energy drink / glass)/ B = (given energy drink/ branded bottle) / C = (given placebo drink / bottle)/ D = given placebo drink/ glass).

2.3.3 Additional documents for experimental work

For each experiment please see the following appendix for information sheet given prior sign up to the study, the consent form and the information given prior ingestion of experimental drink for manipulation purpose. Please see (**Error! Reference source not ound.**).

2.4 General procedure

The general procedure for all experiments varied for drink content, however the structure and timing was similar to the schedule below:

- Participants were seated in the experimental chamber and given the information sheet which informed participants what to expect from experiment. This was followed by completing the consent form.
- Participants completed POMS questionnaire
- They then were given experimental drinks (active / placebo) depending on what session they are completing in line with Latin square.

- After ingestion of experimental drink (participants were given five minutes to drink experimental beverage). Participants were given twenty minutes break for experiments 1-3 and thirty minutes break for experiment 4 for digestion.
- After ingestion participants completed all cognitive tasks using a counterbalance design. Completion of cognitive tasks took approximately twenty-five minutes.
- Participants then completed the POMS questionnaire at the end of the experimental session.
- In the final session participants were debriefed and awarded credits for participating in the experiment.

CHAPTER 3: Experiment 1

3.1 Introduction

3.1.1 Independent effects of psychoactive ingredients caffeine and glucose

There is currently a great deal of research interest looking at the beneficial effects of mood and cognitive performance when psychoactive ingredients such as caffeine and glucose are consumed (Green et al., 2001). This chapter examines the psychoactive effects of the psychoactive ingredients (i.e., caffeine and glucose) independently on mood, cognitive performance and sensorimotor movements. Mood, sensorimotor movements and cognitive performance are believed to be influenced by the consumption of the psychoactive ingredients caffeine and glucose (Lieberman, 2007).

The aim was to establish and analyse the effects of the psychoactive ingredients, caffeine and glucose using a balanced within-subject design. The effects of caffeine and glucose were examined using a double blinded methodology. This method was adopted in order to measure the active effects of each psychoactive ingredient without manipulating expectancy and overall performance. This experiment measured mood before and after beverage consumption using the POMS questionnaire. The cognitive tasks conducted were; Bakan task and Immediate verbal free recall task. Sensorimotor movement was measured by the Two-finger tapping task. This chapter will commence by discussing the effects of caffeine and glucose independently on cognition, sensorimotor movement and mood, followed by experimental aims and hypotheses.

3.1.2 Measuring the effects of caffeine on cognition, mood and sensorimotor movements

The studies described in this chapter investigated the effects of caffeine on mood, cognitive performance and sensorimotor movements. Caffeine is a psychoactive ingredient, which has

been associated with energy boosting properties (Higgins et al., 2010). Caffeine is an adenosine receptor antagonist. It has mild psychomotor stimulant properties via its blockade of adenosine's inhibitory mechanisms. Consumption of caffeine has various behavioural effects, which include both positive and negative effects on mood and performance. Caffeine consumption has been associated with improvements in mood such as, a reduction in depressive symptoms (Childs & de Wit, 2008), increased 'happiness' (Amendola, Gabrieli, & Lieberman, 1998), and decreased anxiety (Quinlan, Lane, & Aspinall, 1997), although there are conflicting findings with respect to anxiety (Broderick & Benjamin, 2004). Broderick and Benjamin (2004) found that the effects of consuming caffeine on mood indicated that caffeine can lead to increased anxiety in both normal individuals and even more likely increased anxiety in individuals with existing anxiety disorders. In addition, studies have found consuming caffeine also increased levels of self-reported alertness and decreased levels of self-reported fatigue and sleepiness (Lieberman, Tharion, Shukitt-Hale, Speckman, and Tulley, 2002).

Glade (2010), found that studies using placebo-controlled trials with objective measures confirmed that ingestion of caffeine can produce significant improvements in general alertness, reaction time, short-term memory, vigilance, reasoning, response accuracy and attention. Many marketing companies use such information to advertise caffeine as a psychoactive ingredient, which can enhance physical and psychological performance, which may be associated with pre-expectancy effect of consuming caffeinated beverages.

Other studies have also investigated the effects of caffeine on performance and have found that caffeine improves vigilance and psychomotor performance (e.g. Rees, Allen, & Lader, 1999; Wesensten, Killgore, & Balkin, 2005). A review on thirteen studies found that when participants consumed caffeine, participants significantly indicated improvement for visual analogue of the Bakan vigilance task (Bakan, 1959), with enhancement in both number and speed of correct detections, and recognition task (Sternberg, 1966), concluding caffeine ingestion increases information processing and cognitive performance (Nehlig, 2004). Cognitive and sensorimotor movement measures were recorded in the present study in this chapter have been selected to keep in line with previous research, which has found significant improvement for the Bakan task and psychomotor movement.

3.1.3 Measuring the effects of glucose on cognition, mood and sensorimotor movements

The human brain relies on glucose as its primary source of energy (Sieber & Traystman, 1992). The ingestion of glucose has been observed to facilitate cognitive performance and mood in recent years (Messier, 2004). There have been relatively few attempts to measure the effects of glucose ingestion on mood, although it is assumed by the general population that consuming high levels of sugar / glucose will reduce feelings of tiredness and irritability (Owens et al., 1997). Compared to caffeine, there are fewer studies, which have found glucose enhancing effects on mood, in amounts, which are used in energy drinks (Benton & Owens, 1993; Foster, Lidder & Sunram, 1998; Messier, Pierre, Desrochers & Gravel, 1998).

However, recent research has quantified 'mental energy' in terms of physical work, or energy output (Cook & Davis, 2006). O'Conner (2006) defined mental energy as the following primary dimensions: cognition, mood, the intensity of feelings of energy or fatigue, and the motivation to achieve or complete a task. Lieberman (2007) proposed a method of assessing mental energy via measuring mood using POMS questionnaire as the subscales vigour and fatigue are closely related with mental energy. Measuring cognitive tasks such as the ability to sustain attention (i.e., Bakan task), reaction time (i.e., Two-finger tapping task) and vigilance tasks (i.e., Recognition task and the Immediate verbal recall task (mean words correctly recalled from a presentation list of 20 words)). Accordingly, the present experiment is in line with Lieberman (2007) suggestion of measuring mental energy by assessing the latter tests and self-reported mood.

An increase in blood glucose levels to the brain has been associated with facilitating cognition and this phenomenon has been identified as the 'glucose memory facilitation effect' (Foster et al., 1998). Studies, which explore the effects of glucose on memory facilitation generally, employ placebo designs, in which participants consume artificial sweetener (aspartame or saccharine) to prevent participants detecting any difference between the taste of the active and placebo beverage. Donohoe and Benton (2000), suggest in order to measure changes in glucose, participants are required to fast for at least two hours prior testing, so that baseline blood glucose measure can be recorded followed by a second and third reading after drink consumption and task completion. They have suggested that

between ten too thirty minutes is a suitable glucose absorption time before blood glucose levels return to the baseline measure. Participants should commence cognitive tasks within this time period. The Experiment in this Chapter is in line with Donohoe & Benton (2000) study whereby, drinks are made to prevent participants detecting any difference between active and placebo beverages. Furthermore, participants will be given twenty minutes to digest the experimental beverage before they commence cognitive tasks.

It has been shown that oral glucose ingestion can enhance some aspects of cognitive performance, which include: short-term memory, long-term memory, spatial awareness and logic, but findings for such cognitive performance, which are not consistent (Gorby et al., 2010). This inconsistency in cognitive performance may be due to differences in age groups, the design of the study (Meikle et al., 2004), measuring changes in cognitive tasks where participants' attention is divided, and where the tasks have different levels of difficulty (Kennedy and Scholey, 2000; Scholey et al., 2001; Sunram-Lea et al., 2002). There have been a number of factors put forward in literature, which modify the effectiveness of glucose as the cognitive enhancer. It is important to take into account previous research findings over the years, which have investigated participant glucose regulatory efficiency. Confounding factors such as age (Craft et al., 1994; Riby et al., 2004), gender (Craft et al., 1994) and glucose regulation (Craft et al., 1994; Smith & Foster, 2008) need to be considered before experimental work commences. For this reason in the present study in this chapter factors such as age and gender have been controlled for by recruiting healthy young adults studying at the university and also participants with poor glucose regulation have been excluded from the study to keep within the experimental criteria.

Previous research also supports the notion that glucose facilitates cognitive functioning such as: working memory (Hall et al., 1989; Kennedy and Scholey, 2000; Meikle et al., 2004; Reay et al., 2006; Scholey et al., 2001; Sünram-Lea et al., 2002b, 2004), visuospatial long-term memory (Sünram-Lea et al., 2001, 2002a,b), visuospatial functioning (Scholey and Fowles, 2002), verbal episodic memory (Scholey et al., 2009a), verbal fluency (Donohoe and Benton, 1999a), attention (Benton, 1990; Meikle et al., 2004; Reay et al., 2006), face recognition (Metzger, 2000), and semantic memory (Riby et al., 2006). Moreover, many studies have examined glucose independently and in combination with other psychoactive ingredients such as caffeine (Scholey and Kennedy, 2004), ginkgo biloba (Scholey and Kennedy, 2004) and ginseng (Reay et al., 2006; Scholey and Kennedy, 2004), which have

indicated positive cognitive enhancing properties. The cognitive tasks which will be tested in this experiment are the Immediate verbal free recall task and the Bakan task as this is in keeping with the above previous research methodology.

3.2 Aims and hypothesis

Taking into consideration the research behind the two psychoactive ingredients, caffeine and glucose, it is necessary to explore these two ingredients independently and acknowledge what beneficial effects these ingredients may have on mood and cognitive performance without any form of manipulation.

This chapter aims to establish the difference between the stimulating effects of caffeine and glucose as compared to placebo beverages. Experiment 1 examines caffeine and glucose independently using a within-subjects balanced placebo design. This study is a simple comparison between psychoactive drinks and placebo drinks only. Prior experiment participants are informed they will be given the following drinks across the four experimental conditions: active caffeine, active glucose, placebo caffeine and placebo glucose drinks to assess the difference between psychoactive effects and non-psychoactive effects on mood and cognitive performance. Participants were informed the experimental drinks were be randomly administered to them with no information further information given during each experimental session. The outcome variables included perceived mood and cognitive function, the latter being assessed with a battery of computer based measures assessing memory, attention, visuospatial processing and sensorimotor movements by measuring reaction time.

The hypotheses for Experiment 1 were the following:

1a. Participants will exhibit faster tapping times on the two-finger tapping task and make a greater number of hits on the Bakan task in the caffeine conditions compared to the glucose conditions, but this advantage will be limited to active caffeine condition.

1b. Participants will have enhanced attention in the glucose drink condition for the Bakan task and they will recall greater number of correct words on the Immediate verbal recall task compared to the caffeine drink condition.

1c. It is expected that when participants consume either of the psychoactive stimulant drinks (caffeine and glucose) the mood component from the POMS questionnaire that would increase is vigour and the components that would decrease are fatigue and tension.

3.3 METHOD

3.3.1 Participants

Thirty-six participants aged (18-55) completed the balanced placebo-controlled, counterbalanced, within-subjects design for Experiment 1, which was approved by Aston University School of Life and Health Sciences Ethics Committee. The power analysis conducted for this study gave a sample size of 34 for the effect size of (f = 0.25) and power of (0.80). As this study recruited 36 participants the sample size was acceptable. Participants were recruited via advertisement on Aston University Sona system. Participants were all undergraduate students studying Psychology at the University and as part of their course requirement they must accumulated credits to pass the module. Prior to recruitment, an exclusion criterion was noted on the advert participants signed up on. The exclusion criterion has been placed because of the high glucose and caffeine content of the experimental beverages and thus participants excluded were those with: diabetes or other glucose regulatory problems, phenylketonuria, glucose intolerance, and pregnancy. Design for Experiment 1

This was a double blinded, within-subjects design and each participant took part in four different conditions in a counterbalanced order (please see Table: 3-1). To account for fatigue effects and fresh response to ingested substances, participants were requested to attend four consecutive sessions in the same week (e.g. Monday, Tuesday, Wednesday and Thursday). There were four conditions and all participants took part in the following conditions: given psychoactive caffeine, given placebo caffeine, given psychoactive glucose and placebo glucose drinks. All the drinks were produced to taste and look the same in each condition (*please see Chapter 2, for details of drink ingredients)*. No information about the experimental beverages was given to the participants prior to drink consumption. Information about the experiment was given to the participants during recruitment and on both the information sheet and consent. Participants' were informed they will be given the

following drinks across the four experimental conditions: active caffeine, active glucose, placebo caffeine and placebo glucose drinks which will be randomly administered to them with no further information given about what they are consuming during each experimental session.

Participants completed a Profile of Mood States (POMS) questionnaire before drink consumption and after completing the battery of cognitive tasks. The cognitive tasks took place after the experimental drink had been consumed and the participants had a twenty minutes break sitting quietly in the experimental chamber. All four conditions and the order of cognitive tasks were counterbalanced to prevent order effect of drink conditions and cognitive tasks. Please see Table: 3-1 for information on counterbalancing drinks and cognitive tasks for each session.

Table: 3-1 Counterbalance order for drinks and cognitive tasks

	CONDITION.1	CONDITION.2	CONDITION.3	CONDITION.4
COGNITIVE TASKS ORDER	GIVEN GLUCOSE	GIVEN CAFFEINE	GIVEN PLACEBO GLUCOSE	GIVEN PLACEBO CAFFEINE
1ST	BAKAN TASK	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	BAKAN TASK
2ND	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	BAKAN TASK	IMMEDIATE VERBAL FREE RECALL TASK
3RD	TWO-FINGER TAPPING TASK	BAKAN TASK	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK

3.3.2 Procedure

After written informed consent, participants completed the POMS questionnaire followed by the experimental beverage and were given five minutes to drink the experimental

beverage with a twenty minute break during which time they were asked to sit quietly in the experimental room. After the twenty minutes break, participants commenced the battery of cognitive tasks: Bakan task, Immediate verbal recall task and Two finger tapping task. This was followed by the POMS questionnaire. Finally, the participants were debriefed.

3.4 RESULTS

3.4.1 Experiment 1

All analyses were conducted to test the null hypotheses by examining whether there were any mean differences between active and placebo drinks. This study measured the psychoactive effects only. The analyses commenced by assessing hypotheses 1a-1c by conducting a repeated measures analysis of variance to examine the psychoactive effects only by comparing the drink conditions (active drinks versus placebo drinks) for both caffeine and glucose independently. For the cognitive tasks a 2x2 ANOVA repeated measures analysis was conducted with caffeine drink conditions (active/placebo) and glucose drink conditions (active /placebo) as within subjects factors. For the POMS subscale a 2x2x2 ANOVA repeated measures was conducted with time (before/after), caffeine drink conditions (active/placebo) and glucose drink conditions (active /placebo) as within subjects factors.

3.4.2Cognitive Performance Analysis

The mean and standard deviations for all cognitive tasks are presented in (Table 3-2) for all drink conditions. The analyses of variance for caffeine and placebo caffeine drink conditions and for glucose and placebo glucose drinks are presented (Table 3.3)

Table 3-2: Mean & Standard deviation for the cognitive tasks for both caffeine and glucose drink conditions (n 36)

	CAFFEINE DRINK MEAN (S.D)	**PLACEBO CAFFEINE DRINK MEAN (S.D)**	**GLUCOSE DRINK MEAN (S.D)**	**PLACEBO GLUCOSE DRINK MEAN (S.D)**
BAKAN TASK (MEAN HITS / BLOCK)	3.47 (1.01)	3.73 (1.12)	3.77 (1.46)	3.48 (1.04)
TAPPING TASK (TAPPING SPEED IN MS)	278.88 (62.06)	264.04 (50.85)	276.37 (69.62)	275.09 (62.84)
WORD RECALL TASK (TOTAL RECALLED/ 20)				
1 SECOND PRESENTATION	7.92 (1.71)	7.61 (2.23)	7.94 (1.93)	7.89 (2.09)
2 SECOND PRESENTATION	10.31 (2.03)	10.42 (2.61)	10.69 (2.04)	11.31 (2.96)

The analyses for the cognitive tasks have separate to analysis to measure the effects of caffeine and glucose independently along with their placebos.

Table 3-3: A 2x2 Anova's for the cognitive tasks when active caffeine, active glucose and their placebo drinks were consumed (n 36)

	F (Degrees of freedom)	**P**	**Partial Eta Square**
Bakan task			
INGREDIENT (CAFFEINE /GLUCOSE)	0.024 (1, 35)	0.579	0.001
CONDITION (Active/Placebo)	0.015 (1, 35)	0.903	0.000
INGREDIENT * CONDITION	5.927 (1, 35)	0.020	0.145
Tapping task			
INGREDIENT (CAFFEINE /GLUCOSE)	0.280 (1, 35)	0.600	0.008
CONDITION (Active/Placebo)	0.795 (1, 35)	0.379	0.022
INGREDIENT * CONDITION	0.713 (1, 35)	0.404	0.020
Verbal recall (1)			
INGREDIENT (CAFFEINE /GLUCOSE)	0.001 (1, 35)	0.986	0.001
CONDITION (Active/Placebo)	0.006 (1, 35)	0.937	0.000
Verbal recall (2)			
INGREDIENT * CONDITION	1.514 (1,35)	0.227	0.041
INGREDIENT (CAFFEINE /GLUCOSE)	4.907 (1, 35)	0.003	0.123
CONDITION (Active/Placebo)	0.956 (1, 35)	0.335	0.027
INGREDIENT * CONDITION	0.903 (1, 35)	0.349	0.025

Key: * = interaction

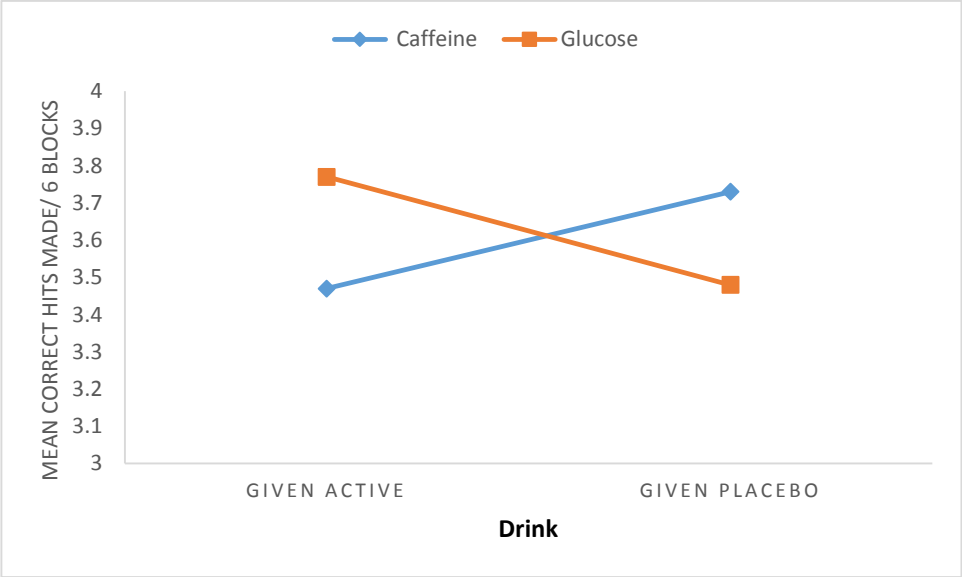

Figure 3-1 Representing the interaction between active and placebo drinks on the Bakan task.

The analysis of variance indicated that there was a significant ingredient x condition interaction for Bakan task; $F(1, 35) = 5.927$, $p < 0.05$, such that, in the active conditions, participants made a greater number of hits for glucose compared to caffeine, whereas in the placebo condition this pattern reversed. . There were no other significant interactions found for the other cognitive tasks.

3.4.3 POMS Questionnaire Analysis

The POMS questionnaire was administered before and after drink consumption. The six subscales were analysed separately (see Table 3.4) for mean and standard deviation and for the 2x2x2 ANOVAs outcome for caffeine and glucose only the significant outcomes have been listed below (see Table 3.5). The complete analysis can be found in appendix

Table 3-4 The mean affective mood state scores and standard deviation comparing all experimental drink conditions (n36)

MOOD	TIME	CAFFEINE DRINK MEAN (S.D)	PLACEBO CAFFEINE DRINK MEAN (S.D)	GLUCOSE DRINK MEAN (S.D)	PLACEBO GLUCOSE DRINK MEAN (S.D)
TENSION	BEFORE	4.83 (2.62)	3.53 (2.44)	3.42 (2.55)	3.72 (2.01)
	AFTER	4.31 (2.39)	3.86 (2.92)	2.94 (2.65)	3.64 (2.45)
DEPRESSION	BEFORE	2.36 (3.02)	1.94 (2.51)	1.86 (2.84)	1.97 (2.43)
	AFTER	1.69 (2.25)	1.89 (3.07)	2.19 (4.37)	1.75 (2.36)
ANGER	BEFORE	2.58 (2.02)	1.83 (3.07)	1.14 (2.29)	2.67 (1.94)
	AFTER	1.50 (2.25)	1.89 (2.79)	2.00 (5.50)	1.86 (1.15)
VIGOUR	BEFORE	11.58 (4.25)	10.61 (5.00)	12.25 (4.08)	12.72 (4.75)
	AFTER	13.06 (6.14)	10.28 (5.89)	9.36 (5.55)	13.19 (4.75)
FATIGUE	BEFORE	5.69 (3.02)	5.39 (3.03)	4.83 (2.66)	5.03 (1.81)
	AFTER	4.42 (2.32)	4.58 (2.58)	4.33 (2.75)	4.22 (2.24)
CONFUSION	BEFORE	5.56 (2.93)	5.47 (2.61)	5.03 (2.50)	4.61 (4.61)
	AFTER	5.33 (2.46)	4.53 (2.14)	4.06 (2.14)	3.53 (1.96)

Table 3-5: 2x2x2 Anova's for active caffeine and glucose and their placebo drinks for each POMS subscales (n 36)

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Ingredients (Caffeine vs Glucose)	13.630 (1, 35)	0.001	0.280
Time*Condition	9.579 (1, 35)	0.004	0.215
ANGER			
Time*Ingredient	13.743 (1, 35)	0.001	0.282
VIGOUR			
Time*Conditions	15.047 (1, 35)	0.000	0.301
FATIGUE			
INGREIDENTS (Glucose vs. Caffeine)	48.146 (1, 35)	0.000	0.579
CONFUSION			
Time (Before/After)	8.098 (1, 35)	0.007	0.188

Key: * = interaction

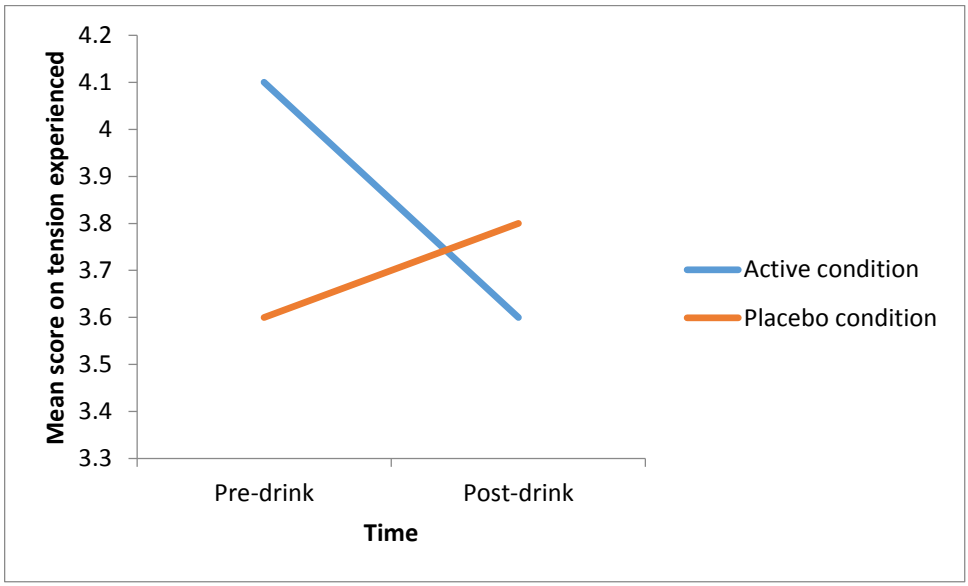

Figure 3-2 Representing the interaction between active drinks and placebo drinks for the tension experienced

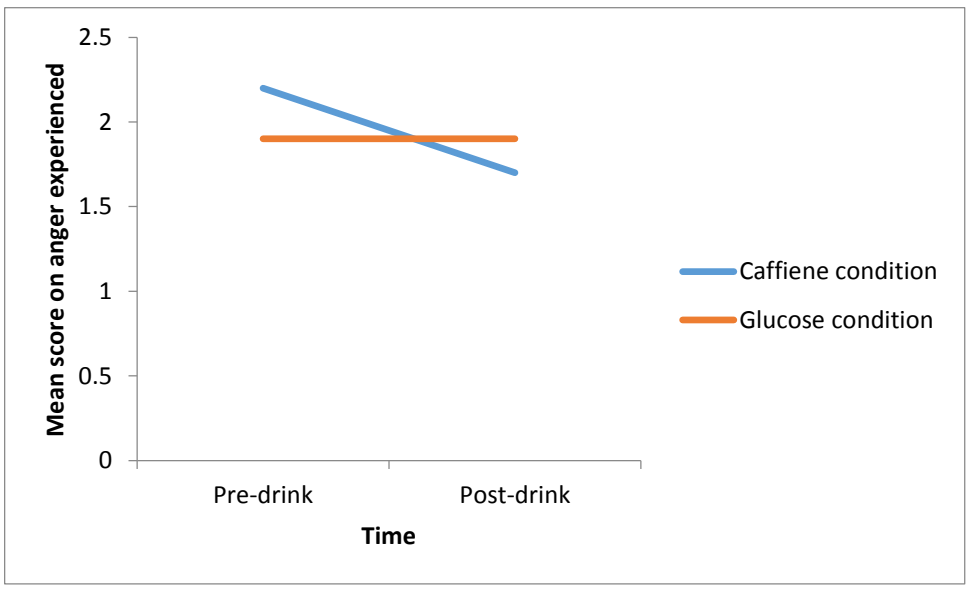

Figure 3-3 Representing the interaction between caffeine and glucose condition on anger experienced

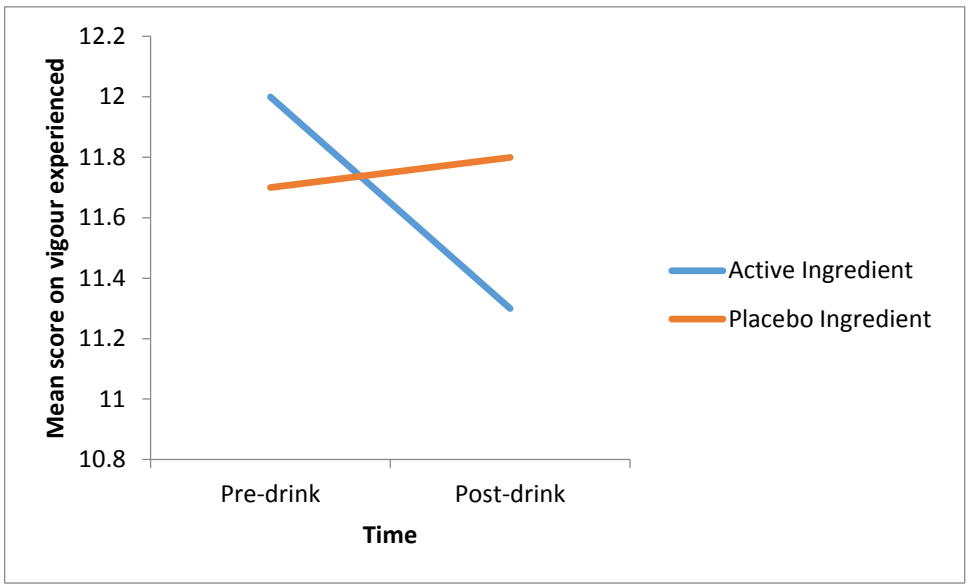

Figure 3-4 Representing the interaction between time and condition on vigour experienced

The analysis variance for mood subscale 2x2x2 can be found in Appendix (4.2). Table (3.5) represents findings that are significant only. The analysis of variance found significant interaction for tension experienced between time and condition (active vs. placebo) ($F(1, 35) = 9.579$, $p < 0.01$) indicating that regardless of drink the active drink reduced tension see figure (3.2) for interaction. There was significant interaction found for anger between time and ingredients (caffeine and glucose drink conditions ($F(1, 35) = 13.743$, $p<0.01$) indicating overall drink consumption of caffeine and caffeine placebo decreased anger experienced whereas, glucose and glucose placebo drink conditions increased anger experienced post drink, see figure (3.3) for interactions. There was a significant interaction found for vigour experienced between time and condition (active vs. placebo) ($F(1, 35) = 15.047$, $p< 0.01$) indicating that vigour is decreased during the active drink condition overall see figure (3.4). The findings suggest although the mean scores pre and post drink for caffeine consumption indicates a slight increase in vigour from (11.58) to (13.06) whereby glucose had a dramatic decrease post consumption from (12.25) to (9.36), which may be driving the interaction.

Thus, these significant interactions suggest that hypothesis 1c was accepted for active drinks reducing tension but rejected for increasing vigour as neither of the active drinks indicated significant increase post consumption. Hypothesis 1c was also rejected for the mood subscale fatigue as there were no other significant interactions found ($p>0.05$).

3.5 Discussion

The general aim of Experiment 1 was to investigate the psychoactive effects of consuming caffeine and glucose independently on cognition and mood. The findings from the present study indicated that consuming active caffeine drink enhances attention for the Bakan task in comparison to consuming the active glucose drink. Overall caffeine and glucose had no significant effects on cognitive performance. Mood was affected by active drinks overall in comparison to placebo drink conditions.

Experiment 1 had hypothesised that participants will exhibit faster tapping times on the two-finger tapping task and make a greater number of hits on the Bakan task in the caffeine conditions compared to the glucose conditions, but this advantage will be limited to active caffeine condition. It was found that caffeine had no significant effect on sensorimotor movements. However, there was indication that attention memory was enhanced when caffeine drinks were consumed. Thus, experimental the hypothesis (1a) was accepted for this experiment. Research has suggested that consumption of caffeine enhances reaction time, for instance, Glade (2010) found that studies using placebo-controlled trials with objective measures have confirmed that ingestion of caffeine can produce significant improvements in general alertness, reaction time, short-term memory, vigilance, reasoning, response accuracy and attention. This was found in the present study and therefore taking these findings into consideration, it is vital to explore the effects of psychoactive ingredients caffeine and glucose further by having larger participant sample, which may indicate clear differences between caffeine and glucose and any essence of expectancy effect that may exist.

The reasons why there may not have been any significant effects found for caffeine consumption on sensorimotor movements, may be due to the fact unlike previous research, participants recruited for this experiment may not be habitual caffeine consumers. For instance, Nehlig (2004) found that habitual caffeine consuming participants had displayed

significant improvement in performance on the Bakan task, with improvements to both number and speed of correct detections compared to non-habitual caffeine consumers. This was due to the fact caffeine increases level of information processing and performance on working memory tasks among habitual consumers as they encounter withdrawal effects. This view has been supported by, James and Rogers (2005) who have found beneficial effects of caffeine can be attributed to the reversal of the withdrawal effects as non-caffeine drinkers cannot suffer from caffeine withdrawal or deprivation and therefore it is difficult to assess the actual effects of caffeine on performance and mood without withdrawal effects taking place. Another reason may be due to time of day, although all experimental testing took place between 8.30am -12pm. There is a possibility that some participants who were tested after 10am may have consumed caffeine or glucose containing beverages or food, which would affect overall performance and mood.

The second hypothesis for this experiment predicted participants will have enhanced attention in the glucose drink condition for the Bakan task and they will recall greater number of correct words on the immediate verbal recall task compared to the caffeine drink condition. Hypothesis (1b) was rejected as there was no significant improvement across all cognitive tasks when glucose drinks were ingested overall. Previous research has indicated that consumption of glucose enhances cognitive performance. For instance, Smith, Riby, van Eekelen & Foster (2010) discussed glucose enhancement of human memory, a comprehensive research review of the glucose memory facilitation effect, and reported that there is abundant research to support the concept that in certain conditions, glucose can enhance memory in healthy individuals. Green et al (2001) study which examined the placebo expectancy effects of glucose on cognition and mood found glucose consumption had positive effects on memory as participants recalled more words in the Immediate verbal recall task for two second presentation list compared to one second word presentation list. This effect was found when participants were aware they consuming the active glucose drink. Perhaps in the present study if participants were made aware of drink content, their performance may have been influenced by the information given prior consumption, which would measure expectancy effect rather than actual drink effects.

The third hypothesis predicted that when participants consume either of the psychoactive stimulant drinks (caffeine and glucose) the mood component from the POMS questionnaire that would increase is vigour and the components that would decrease are fatigue and

tension. In the present experiment it was found that consuming the experimental drinks whether it was active or placebo had increased overall vigour experienced and reduced tension and fatigue levels. There was a significant interaction found between time and active ingredient consumption for the mood subscale tension. This indicated active drink condition reduced tension overall. Although the mean scores for tension indicated overall tension reduced post caffeine consumption, suggesting an actual psychoactive effect. Thus, hypothesis (1c) was accepted whereby, tension levels decreased when active caffeine was consumed only, as this was not the case for the glucose drink conditions. There was also significant interaction found between time and condition (active vs. placebo) indicating vigour decreased in the active condition, which may have been directed by the dramatic decrease in glucose active drink. Thus, hypothesis (1c) was rejected whereby neither of the active drinks increased vigour experienced significantly overall. Similarly, it was found that fatigue levels decreased when participants consumed the placebo glucose drink, although there was no significant interaction found for fatigue and time-point and drink conditions. These findings were not expected, which suggest an expectancy effect may exist as participants mood was not directly affected by the psychoactive drink overall. As this experiment was not designed to examine expectancy effect, a similar study can be conducted but with manipulative information prior drink consumption using a balanced placebo design to measure expectancy effect. The overall mood for both experiments did not indicate consistent significant changes in mood (i.e., tension, vigour, or fatigue) after drink consumption.

Additionally, it was found in the present experiment that consuming caffeine reduced anger levels giving a significant interaction between active drink and post drink effect. The interaction showed that consuming caffeine was significantly different from the effect of consuming placebo for the before and after effect on anger levels. Indicating that participant's anger levels reduced when they consumed the caffeine drink whereas there was a marginal increase in anger when participants consumed the placebo drink. Furthermore, for the glucose drink condition, there was a significant interaction between placebo drink and anger levels, as participants experienced less anger after consuming the placebo glucose drink in comparison to the active glucose drink, where anger levels increased. The findings are somewhat ambiguous as participants' mood improved overall when they consumed the placebo drinks compared to the active drinks suggesting further work is required to assess

possible expectancy effect. This could be further assessed by presenting participants with manipulative information, which correctly and incorrectly informs them of drink content across four drink conditions (i.e., ‘given placebo drink and informed they are consuming a placebo drink’ versus ‘given a placebo drink and informed they are consuming an energy drink’). Presenting participants with manipulative information would either induce expectancy effects or confirm the actual psychoactive effects irrespective of manipulative information given prior ingestion.

3.6 Conclusion

In conclusion, the present experiment has indicated equivocal evidence for improvements of cognitive performance and mood from ingestion of caffeine and glucose. Caffeine and glucose consumption affect participants differently, which may be due to either previous exposure or awareness of the effects of psychoactive effects of caffeine and glucose. Although there were more correct hits made over the course of Bakan task when caffeine drink was consumed, it is difficult to explain whether this effect was either memory or motor performance. Taken as a whole, the results offer little convincing and consistent support that caffeine consumption enhances cognition and mood among healthy young adults, which may have been associated with psychoactive effect. Although there was no psychoactive effect found, participants were feeling calmer after consuming the experimental beverages and having a twenty minute absorption time where they simply sat quietly. Perhaps having twenty minutes of relaxation time may have affected overall mood and performance irrespective of drink content. Therefore, it would be ideal to conduct a balanced placebo design which examines expectancy effect as well as the psychoactive effect of caffeine and glucose in combination as an energy drink on cognition and mood via manipulation of information provided to participants prior drink consumption.

CHAPTER 4: Experiment 2

4.1 Introduction

4.1.1 Placebo expectancy effect of an energy drink (caffeine and glucose) on cognition, sensorimotor movements and mood

This study investigated the expectancy effect of energy drinks consisting of the combination of both caffeine and glucose on cognition, sensorimotor movements and mood. The previous experiment explored the effects of caffeine and glucose independently and showed there was no significant psychoactive effect of caffeine and glucose. This chapter investigated whether consuming psychoactive ingredients caffeine and glucose as a combination creates an expectancy effect i.e., comparing the effects when *participants are given placebo drink but informed they are consuming an active drink,* and *when they are given a placebo drink and informed they are consuming a placebo drink*. The psychoactive effect versus the placebo effect was examined for the drink conditions *'given the active drink but informed it is the placebo drink',* and for *'given the active drink and informed they are consuming the active drink'*. The psychoactive effect was also investigated which compared the drink conditions, '*given energy drink and informed they are drinking a placebo drink*' with '*given placebo drink and informed they are consuming a placebo drink*'. Furthermore, blood glucose levels were recorded at baseline and after drink consumption to assess whether there was any association between blood glucose levels and experimental drink consumption.

There is a lot of research examining the effects of psychoactive ingredients caffeine and glucose on cognitive performance. Caffeine and glucose have been examined together which has found enhanced reaction times and improvement in both verbal memory and sustained attention in various studies (Adan and Serra-Grabulosa, 2010). Experiment 1 in this thesis examined the effects of caffeine and glucose independently which was unsuccessful in portraying significant psychoactive effects of caffeine on mood and cognitive performance overall. Glucose had enhanced participants' attention levels for the Bakan task with no other

significant effects on cognitive performance or mood. As energy drinks are usually marketed as a combination of both glucose and caffeine, it was therefore important to examine the effects of both psychoactive ingredients caffeine and glucose as a combination as an energy drink and examine whether there is a relationship between energy drinks and expectancy on mood and cognition. One of the main issues with Experiment 1 was that placebo and actual psychoactive effects may have both been occurring because no information was given to them on the day of testing about drink content. Although participants were made aware they would be consuming active and placebo drinks across the four experimental conditions on the information and consent forms, they may have created pre-expectancies which could have been masking any psychoactive effects. Thus, the design adopted in Experiment 2 will tease out the separate effects more effectively than Experiment 1 by informing participant's prior consumption what they are consuming.

Energy drinks have become very popular over the past few years with over half the student population in higher education consuming them at least once a month (Malinauskas, Aeby, Overton, Carpenter & Barber-Heidal, 2007). It has been reported that the most universal reasons why students consume energy drinks are to maintain alertness, reduce symptoms of hangover, increase energy, to help with driving and to prevent sleepiness (Attila and Cakir, 2011; Malinauskas et al., 2007). Previous research has also suggested that energy drinks enhance sensorimotor speed, behaviour, and reduce levels of fatigue (Alford et al., 2001; Horne and Reyner, 2001; Howard and Marczinski, 2010; Kennedy and Scholey, 2004; Smit et al., 2004).

It has been acknowledged by Scholey and Kennedy (2004) that consuming an energy drink with combined ingredients caffeine, glucose, ginseng and ginkgo biloba improved memory and attentions in comparison to measuring effects of each ingredient alone. Several studies have also found correlations between blood glucose levels and cognitive performance (Brooke & Toogoode, 1973; Hall et al., 1989; Manning et al., 1990; Foster et al., 1998). Thus, in Experiment 2, blood glucose levels were measured to see if there was any association between blood glucose levels and cognitive performance.

According to Kirsch (1997) consumption of psychoactive beverages such as energy drinks have specific expectations, which trigger physiological and psychological reactions, which tend to be independent of the psychoactive substance ingested. These types of reactions and

behaviour tend to be examined via a balanced placebo design (e.g. participants are given an active drink and informed they are consuming a placebo, or given a placebo drink and informed they are given a placebo drink), the information given prior consumption would be either correct or incorrect to assess possible expectancy effects. These expectations are generally unambiguous especially if the information provided to the participants is specific (i.e., this drink contains caffeine and glucose which will enhance your memory). It is therefore important to adopt a balanced placebo design to measure the true effects of energy drinks or possible expectancy effects of consuming energy drinks on cognitive performance and mood. Although, Experiment 1 used a balanced within-subjects design, participants were not given direct information on experimental day's prior consumption about what they are consuming. This information was left oblivious on experimental testing days to measure the random effects and comparison between active drinks and placebo drinks. However, by not providing information on drink on experimental days, participants may have created pre-expectancies, which gave overall effects of drinks rather than comparison. For this reason, Experiment 2 will assess the difference between active and placebo drink conditions by giving drink information to participants before experimental beverage consumption.

4.2 **Aims & Hypotheses**

The purpose of Experiment 2 was to examine the effects of consuming an energy drink containing caffeine and glucose as a combination on cognition, sensorimotor movement and mood and whether there is evidence of an expectancy effect.

The expectancy effect of consuming energy drinks (caffeine and glucose) would be measured using balanced placebo design and presenting participants with manipulating information. For instance, this experiment investigated whether consuming psychoactive ingredients caffeine and glucose as a combination creates an expectancy effect i.e., comparing the effects when *participants are given placebo drink but informed they are consuming an active drink*, and *when they are given a placebo drink and informed they are consuming a placebo drink*. The psychoactive effect versus the placebo effect was examined for the drink conditions *'given the active drink but informed it is the placebo drink'*, and for *'given the active drink and informed they are consuming the active drink'*. The psychoactive effect was also investigated which compared the drink conditions, '*given energy drink and*

informed they are drinking a placebo drink' with '*given placebo drink and informed they are consuming a placebo drink*'. These effects have been assessed to measure what expectancy effects are created which may enhance cognitive performance and mood. It was hypothesised that:

2a. Blood glucose levels will be significantly higher post drink in comparison to pre-drink, but this increase will be limited to the active glucose drink condition.

2b. Participants will exhibit faster tapping times on the two-finger tapping task, make a greater number of hits on the Bakan task, recognise words correctly at a fast speed and have enhanced ability to recall more words from the recall task when participants are told they are consuming an active condition compared to told placebo condition. Thus, the main effect of information (told active / placebo) will influence the actual effect of the active ingredient, but it is plausible that it might be an interaction effect (i.e., being told active only helps in the presence of the active ingredient).

2c. There will be an interaction between ingredients and information, such that performance on the cognitive tasks will be highest for the active ingredient condition where the participants are told they are receiving the active ingredient. (This tests for expectancy effect). When given active ingredient condition where the participants are told they are receiving the active ingredient compared to when they consuming a placebo drink and informed they are drinking a placebo drink. (This hypothesis tests for a psychoactive effect).

2d The mood subscales tension and fatigue levels will decrease, and vigour activity levels will increase for the active ingredient condition where the participants are told they are receiving the active ingredient. (This tests for expectancy effect). When given active ingredient condition where the participants are told they are receiving the active ingredient compared to when they consuming a placebo drink and informed they are drinking a placebo drink. (This hypothesis tests for a psychoactive effect).

4.3 METHOD

4.3.1 Participants

Twenty-three participants aged (18-30) completed the balanced placebo-controlled, counterbalanced, within-subjects design for the study, which was approved by Aston University School of Life and Health Sciences Ethics Committee. The power analysis conducted for this study gave a sample size of 34 for the effect size of (f = 0.25) and power of (0.80). As this study recruited 23 participants the sample size was not sufficient to indicate possible expectancy effects. Participants were recruited via advertisement on Aston University Sona system. Participants were all undergraduate students studying Psychology at the University and as part of their course requirement they were to accumulate credits to pass the module. Prior to recruitment, an exclusion criterion was noted on the advert participants signed up on. The exclusion criterion had been placed because of the high glucose and caffeine content of the experimental beverages. Participants who were excluded included those with: diabetes or other glucose regulatory problems, phenylketonuria and pregnant.

4.3.2 Design for Experiment 2

This was a double blinded, within-subjects design, where participants were placed in each of the four conditions using a counterbalanced design (please see Table 4-1). As this was a repeated measures design, participants were requested to attend four consecutive sessions in the same week (e.g. Monday, Tuesday, Wednesday and Thursday) at the same time. There were four conditions and all the participants had participated in the following conditions: (given psychoactive energy drink and given placebo drinks). The participants were presented with manipulative information before they consumed the psychoactive ingredients (caffeine and glucose) and placebo drinks. This method was adopted to examine whether participants' performance can be enhanced by the psychoactive ingredients (caffeine and glucose) drink or whether the manipulative information triggered an expectancy effect.

Participants completed the POMS questionnaire before drink consumption and after completing the battery of cognitive tasks. The battery of cognitive tasks took place after the experimental drink had been consumed. During this wait the participants were asked to sit quietly in the experimental chamber. All four conditions and order of cognitive tasks were counterbalanced to prevent order effect of drink conditions and cognitive tasks. Please see (Table 4-1) below for information on counterbalancing drinks and cognitive tasks for each session.

Table 4-1 Counterbalance order for drinks and cognitive tasks

	CONDITION.1	CONDITION.2	CONDITION.3	CONDITION.4
COGNITIVE TASKS ORDER	GIVEN ENERGY DRINK AND TOLD THEY ARE CONSUMING ENERGY DRINK	GIVEN ENERGY DRINK AND TOLD THEY ARE CONSUMING NON-ENERGY DRINK	GIVEN PLACEBO DRINK AND TOLD THEY ARE CONSUMING NON-ENERGY DRINK	GIVEN PLACEBO DRINK AND TOLD THEY ARE CONSUMING ENERGY DRINK
1ST	BAKAN TASK	RECOGNITION TASK	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK
2ND	RECOGNITION TASK	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	BAKAN TASK
3RD	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	BAKAN TASK	RECOGNITION TASK
4TH	TWO-FINGER TAPPING TASK	BAKAN TASK	RECOGNITION TASK	IMMEDIATE VERBAL FREE RECALL TASK

4.3.3 Procedure

After written informed consent, participants completed the POMS questionnaire. Blood glucose levels were recorded before drink consumption. Following this participants were given the experimental beverage and were allowed five minutes to drink the experimental beverage with a twenty minute break during which time they are asked to sit quietly in the experimental room. After the twenty minutes break, participant's blood glucose levels were recorded for the second time and final time. Participants then commenced the battery of cognitive tasks: Bakan task, Recognition task, Immediate verbal word recall task and Two-finger tapping task. This was followed by the POMS questionnaire and finally, the participants were debriefed.

4.4 RESULTS

ANOVAs were conducted to measure the comparisons set out to examine expectancy and psychoactive effects for mood and cognitive tasks. A 2x2x2 ANOVA was conducted for POMS subscales with Time (before and after) drink consumption, Drink (active / placebo) and Information (told active drink/told placebo drink) measuring possible expectancy effect as within-subject factors. 2x2 ANOVA was conducted for all the cognitive tasks with drink (active/placebo) and Information (measuring expectancy effect) as the within-subject factor. The analysis section will commence with assessing the effects of blood glucose levels on drink consumption, followed by assessing hypotheses 2b – 2d consecutively.

4.4.1 Blood glucose levels

Blood glucose levels were measured before drink consumption and twenty minutes after drink consumption. The mean and standard deviation has been represented in (A 2x2 Anova was selected as there would be no effect of information (told active/told placebo) on blood glucose levels.

Table: 4-2). A 2x2 two-way within subjects repeated measures ANOVA was conducted to measure only the increase in blood glucose levels post drink consumption, with blood glucose levels (before and after drink consumption) and drinks type (active or placebo) as

within-subject factors (see Table: 4-3). A 2x2 Anova was selected as there would be no effect of information (told active/told placebo) on blood glucose levels.

Table: 4-2 Representing the mean and standard deviation for blood glucose levels (mmol/l) at baseline and after twenty minutes of digesting the experimental beverage of each test session for all experimental drink conditions (n 23)

	GIVEN ENERGY DRINK TOLD ENERGY DRINK MEAN (SD)	**GIVEN ENERGY DRINK TOLD PLACEBO DRINK MEAN (SD)**	**GIVEN PLACEBO DRINK TOLD PLACEBO DRINK MEAN (SD)**	**GIVEN PLACEBO DRINK TOLD ENERGY DRINK MEAN (SD)**
BEFORE DRINK	5.11(1.07)	5.18 (0.96)	5.29 (0.82)	5.3 (0.79)
AFTER DRINK	7.45 (2.06)	7.5 (1.74)	5.84 (1.26)	5.44 (0.93)

A 2x2 repeated measures ANOVA was conducted to analyse blood glucose levels in the active and placebo conditions before and after drink ingestion.

Table: 4-3: 2x2 Anova for blood glucose levels before & after drink consumption.

	F (DEGREES OF FREEDOM)	P	PARTIAL ETA SQUARE
TIME (BEFORE / AFTER DRINK)	19.085 (1, 22)	0.000	0.465
INGREDIENTS (ACTIVE / PLACEBO)	19.397 (1, 22)	0.000	0.007
TIME * INGREDIENTS	17.654 (1, 22)	0.000	0.037

The results of the ANOVA demonstrated that there was a significant main effect of ingredients, such that blood glucose levels were significantly higher following glucose drinks (Mean=6.3, SD=1.45) than placebo (mean=5.4, SD=0.95); $p < 0.01$. However, this needs to be considered in the light of the significant interaction time x ingredients interaction, which indicated that prior to drink consumption blood glucose levels were higher in the placebo condition (Mean=5.3, SD=.81) compared to active condition (Mean=5.14, SD=1.0), but were significantly higher following glucose drinks (Mean=7.48, SD=1.9) than placebo (mean=5.64, SD=1.1); $p < 0.01$.

The following section has been split into conducting analysis to measure whether the hypotheses for this experiment are accepted or rejected.

4.4.2 Measuring the effects on cognitive performance and sensorimotor movement only

A repeated measures 2x2 ANOVA was conducted for all cognitive tasks to measure the psychoactive effect of consuming placebo and active drinks how manipulative information affects overall performance. A 2x2 ANOVA within subject repeated measures with: Drink (active/ placebo) and Information prior consumption this being (told active drink / told

placebo drink) as factors for the Bakan task, Recognition task, Immediate verbal recall task and Two-finger tapping task as within subjects factors. For the mean and standard deviation for cognitive tasks for all drink conditions (see Table 4-4) and for ANOVA (see Table 4-5). The complete analysis variance outcomes conducted for POMS subscale can be found in Appendix (5.3). The significant findings can be found in Table (4.5). The 2x2x2 analysis of variance conducted for POMS subscales and it was found that there three significant interactions. There was a significant interaction between time (pre-drink/post-drink) and information (told active / told placebo) given prior ingestion ($F(1,22) = 4.963$, $p<0.05$) indicating that tension levels decreased when participants were given active drink and told active but increased when given active told placebo (see Figure 4.2). It is difficult to confirm a possible expectancy effect as there were no significant main effects found for the factors time and information given. There was a significant interaction found for confusion for time and information given ($F (1, 22) = 6.071$, $p <0.05$) and there was a significant main effect of drink ingredients (active / placebo) giving ($F (1, 22) = 8.879$, $p <0.01$) indicating psychoactive effect overall irrespective information given prior ingestion, hence no expectancy effect found (see Figure 4.3). However, figure (4.3) does not indicate a significant interaction between (time*ingredients) indicating a weak psychoactive effect on confusion experienced. There were no other significant interactions found ($p> 0.05$). Thus, hypothesis 2c was rejected as the subscales (fatigue and vigour) did not indicate significant psychoactive effects. However hypothesis 2b was accepted for tension decreasing post consumption of active drinks. Hypothesis 2c was rejected as no expectancy effect was found.

Table: 4-4: The mean & standard deviation for the cognitive tasks for all drink conditions (n 23)

	Given energy drink told energy drink	Given energy drink told placebo drink	Given placebo drink told placebo drink	Given placebo drink told energy drink
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Bakan task (hits / Blocks)	4.15 (1.39)	4.32 (1.42)	4.33 (1.51)	4.32 (1.66)
Tapping task (ms/ tap)	296.14 (84.85)	284.10 (67.56)	276.91 (52.79)	294.93 (78.17)
Recognition memory (RT in ms)	907.03 (242.86)	905.35 (200.83	892.44 (302.53)	854.87 (209.95)
Recognition Memory score (out of 40)	32.79 (2.97)	31.87 (4.58)	32.30 (4.30)	32.65 (4.74)
Verbal recall (out of 20)				
1 second presentation	6.30 (2.79)	6.87 (3.36)	6.30 (2.65)	.43 (3.21)
2 second presentation	7.78 (2.83)	7.39 (3.71)	8.78 (3.78)	8.43 (3.78)

Table: 4-5: Representing 2x2 ANOVAs for the cognitive tasks when energy drinks & placebo drinks were consumed for drink conditions (n 23)

	F (DEGREES OF FREEDOM)	**P**	**PARTIAL ETA SQUARE**
TAPPING TASK (MS)			
INGREDIENTS(ACTIVE /PLACEBO)	4.242 (1, 22)	0.051	0.162
INFORMATION (TOLD ACTIVE/ TOLD PLACEBO)	0.407 (1, 22)	0.530	0.018
INGREDIENTS * INFORMATION	0.208 (1, 22)	0.653	0.009
VERBAL RECALL (OUT OF 20) 1 SECOND PRESENTATION			
INGREDIENTS(ACTIVE /PLACEBO)	0.189 (1, 22)	0.668	0.009
INFORMATION (TOLD ACTIVE/ TOLD PLACEBO)	0.449 (1, 22)	0.510	0.020
INGREDIENTS* INFORMATION	7.243 (1,22)	0.013	0.248
2 SECOND PRESENTATION			
INGREDIENTS(ACTIVE /PLACEBO)	0.001 (1, 22)	0.973	0.010
INFORMATION (TOLD ACTIVE/ TOLD PLACEBO)	2.814 (1, 22)	0.108	0.113
INGREDIENTS * INFORMATION	0.619 (1, 22)	0.440	0.027

Key: * = interaction

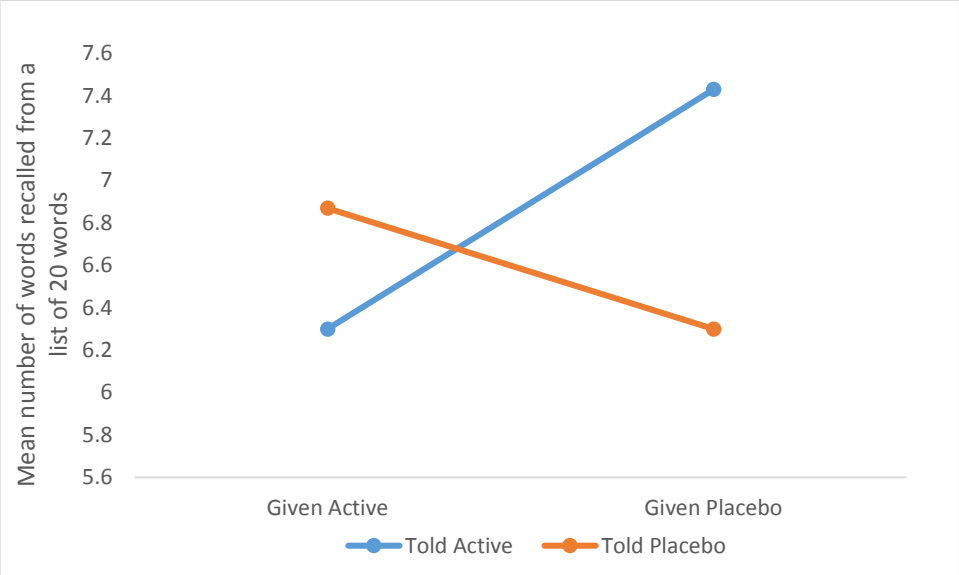

Figure 4-1Representing the interaction between active and placebo drinks on the task omeddiate verbal recall task for 1 second word presentation

The overall analysis variance outcomes for all cognitive tasks can be found in Appendix (4.2) as the Table (4.5) above represents the significant outcomes only. The analysis of variance conducted for each cognitive task indicated that there was only one significant interaction found for Immediate verbal recall task for the 1 second word presentation between ingredients (active / placebo) and information given (told active / told placebo) giving ($F(1, 22) = 7.243$, $p < 0.05$) indicating a possible expectancy effect as participants recalled more words GP/TA indicated by Figure (4.1). There was a marginal significant main effect found for the two-finger tapping task ($F(1, 22) = 4.242$, $p = 0.05$). No other significant interactions or main effects found ($p > 0.05$)

The analysis of variances indicated that there were no significant main effects of consuming the energy drink on cognition and no significant effect of information given prior ingestion, therefore no expectancy effect found for the Bakan task, Two-finger tapping task, and the Recognition task, therefore hypothesis 2b and 2c was rejected for these cognitive tasks. That is, there was no significant expectancy effect over and above any psychoactive effect on the cognitive tasks. However, there was a significant expectancy effect found for immediate verbal recall task, whereby consuming a placebo drink and told they are consuming an active drink enhanced performance, for the 1 second word presentation.

4.4.3Measuring the effects on mood subscales only

The mean and standard deviation for the six subscales for mood see Table: 4-6). A 2x2x2 repeated measures within subjects ANOVA was conducted to analyse POMS subscales individually with the within subjects factors were Time (pre and post drink) and Drink (active / placebo) and Information (told active/ told placebo) prior consumption were the repeated measures see (Table: 4-7).

Table: 4-6: The mean affective mood state scores and standard deviation for all experimental drink conditions (n 23)

MOOD	TIME	ACTIVE DRINK/TOLD ACTIVE MEAN (S.D)	ACTIVE DRINK/ TOLD PLACEBO DRINK MEAN (S.D)	PLACEBO DRINK/TOLD PLACEBO MEAN (S.D)	PLACEBO DRINK /TOLD ACTIVE MEAN (S.D)
TENSION	BEFORE	4.39 (3.39)	4.43 (3.65)	5.39 (3.76)	3.70 (3.14)
	AFTER	3.30 (2.32)	5.22 (4.66)	4.87 (4.16)	4 (4.12)
DEPRESSION	BEFORE	4.30 (6.18)	3.91 (5.74)	4.30 (6.94)	2.87 (4.07)
	AFTER	2.70 (4.89)	3.17 (5.06)	3.91 (4.95)	2.91 (4.48)
ANGER	BEFORE	2.52 (4.04)	3.57 (4.45)	4.13 (5.68)	2.91 (3.52)
	AFTER	2.57 (3.76)	3.09 (4.34)	3.26 (4.23)	2.57 (4.13)
VIGOUR	BEFORE	12.61 (6.79)	11.70 (7.21)	10.43 (5.27)	11.83 (5.84)
	AFTER	13.00 (6.08)	11.13 (7.29)	10.74 (8.76)	10.78 (5.65)
FATIGUE	BEFORE	4.13 (4.21)	5.09 (4.79)	5.35 (3.66)	4.74 (4.78)
	AFTER	3.96 (4.39)	4.04 (3.90)	4.17 (3.89)	3.44 (3.68)
CONFUSION	BEFORE	4.74 (3.58)	4.70 (2.88)	7.22 (3.18)	5.22 (2.56)
	AFTER	4.61 (3.33)	4.83 (2.64)	6.30 (3.48)	4.96 (2.76)

Table: 4-7 Representing 2x2x2 ANOVA for energy drink & placebo drink conditions for each of the POMS subscales (n 23)

	F (DEGREES OF FREEDOM)	**P**	**PARTIAL ETA SQUARE**
TENSION			
TIME*INGREDIENTS*CONDITION	4.963 (1, 22)	0.036	0.184
FATIGUE			
CONDITION (TOLD ACTIVE/ TOLD PLACEBO)	9.103 (1, 22)	0.006	0.293
CONFUSION			
DRINK	6.071 (1, 22)	0.022	0.216
TIME	8.879 (1, 22)	0.007	0.288

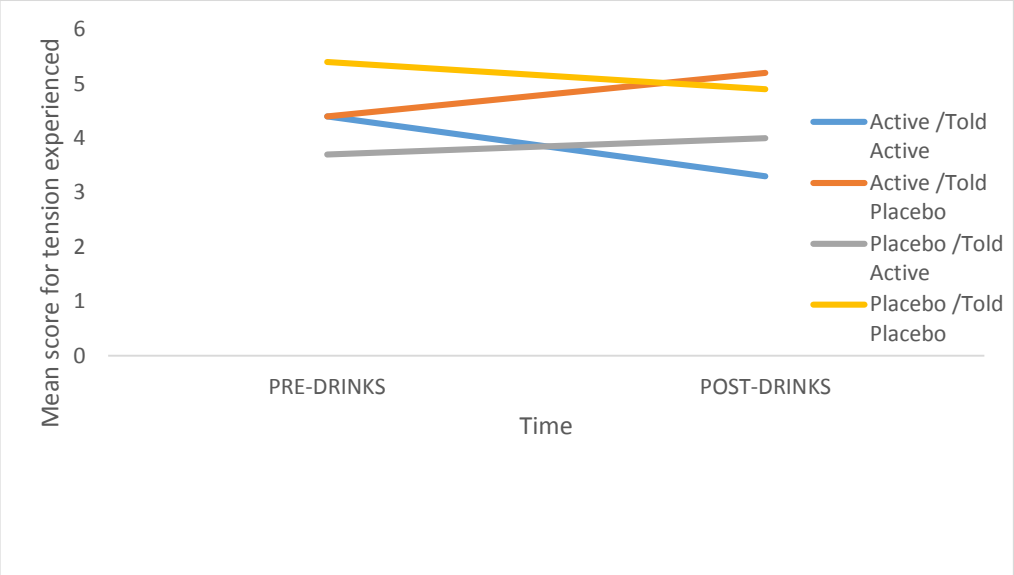

Figure 4-2 Representing the interaction between time, ingredient and condition on tension experienced.

The complete analysis variance outcomes conducted for POMS subscale can be found in Appendix (5.3). The significant findings can be found in Table (4.5). The 2x2x2 analysis of variance conducted for POMS subscales and it was that there was only one significant interaction found which was for the mood subscale tension. Analysis of tension data revealed that there was a significant interaction between time (pre-drink/post-drink), ingredients (active /placebo) and condition (told active / told placebo) ($F(1,22) = 4.963$, $p<0.05$) see figure (4.2) however, there was a increase in tension experienced post drink when given active/told placebo indicating an expectancy a possible expectancy effect. For the placebo drink conditions, given placebo/told active there was a marginal increase in tension and for given placebo/told placebo there was slight decrease post-drink. There were no significant main effects found for time, ingredient or information ($p>0.05$).

There were no other significant interactions found ($p> 0.05$). Thus, hypothesis 2d was rejected as the subscales (fatigue and vigour) did not indicate significant expectancy effects. However hypothesis was accepted for tension indicating a possible expectancy effect, thus hypothesis 2d was accepted for tension mood subscale.

4.5 DISCUSSION

The present study two expectancy effects for the mood subscale tension and there was a significant expectancy effect found for the immediate verbal recall task (1 second word presentation) and information effect for the mood subscale tension. There were no other psychoactive effects found in the present study on cognitive performance and mood overall that distinguish between psychoactive effects and expectancy effects. These effects may have been difficult to acknowledge as the power analysis indicated that a minimum of thirty-four participants was required whereas this experiment only recruited twenty-three participants. Thus, the observed power analysis conducted for this study gave observed effect size (Cohen's d = 0.5); probability levels of (0.05) and an observed power of (0.19) indicating the sample size were not sufficient.

The analysis for the Bakan task illustrated the number of correct hits made fluctuated with no readily interpretable pattern across the course of a test session. However, when a placebo was ingested there was a gradual decrease in the number of correct hits made. The findings from this study for the Bakan task are not directly comparable to the results of the Green et al (2001) study which found glucose administration improved performance on Bakan task relative to the placebo drink. It is also inconsistent with results from the Benton et al (1994) study, which examined the effects of glucose on cognitive function. There was no significant expectancy effect found for the drink conditions ‘given placebo told energy drink’ and ‘given placebo drink and told they are consuming energy drink’. There was no significant difference between the drink conditions ‘given energy drink and told energy drink’ and ‘given energy drink and told they are consuming placebo drink’ which measured psychoactive effect versus placebo effect and there was no psychoactive effect found for drink conditions ‘given energy drink told they are consuming a placebo drink’ versus ‘given placebo drink and told they are consuming a placebo drink’. These findings are consistent throughout the present study suggesting either participants may have detected taste difference between the drink conditions or the information given had no impact on performance.

Hypothesis 2b and 2c had predicted that participants would show enhanced performance on the cognitive tasks (Bakan task, Two-finger tapping task, Recognition task and immediate

verbal recall task) under the active ingredient. Hypothesis 2c predicted there would be an interaction between ingredients and information, such that performance on the cognitive tasks will be highest for the active ingredient condition where the participants are told they are receiving the active ingredient. Thus, Immediate verbal recall task indicated that more words were remembered in the active drink condition than the placebo drink conditions overall. There was indication of possible expectancy effect found for 1 second presentation as participants recalled more words for the drink condition *given placebo told active* and there seems to a psychoactive effect for the drink condition *given active told placebo* as the information given had no effect on performance, or on the other hand the information given had a reverse effect on performance, were participants tried harder to recall more words. This suggests that the ability to recall more words was due to the information provided to the participants' prior beverage consumption, which may have influenced participants to work harder to recall words.

Generally everyone's instincts are to perform their best on tasks especially when individuals are under the impression there is no external support available to help them. Similarly, the participants may have taken the information given prior consumption and felt that they need to concentrate harder as they have been informed the drink they are consuming is less efficacious. This may also be associated to individual differences whereby, participants pre-existing beliefs or habits about energy drinks, caffeine or glucose consumption may have on overall performance. It would be important to distinguish the difference between the two variables by perhaps not providing any information to the participants, but by comparing drink presentation (i.e., glass versus branded bottle) in a future study and testing whether the beverage is the initial cause of particular performance.

Advertising generally builds an expectation of consuming a product and it is these expectations, which tend to influence individual beliefs, attitudes and often individuals fall into peer and advertising pressure to purchase a product on the basis of their expectation and how it affects others. Conversely, it was acknowledged that participants recalled more words when the word was presented for two seconds over the course of the task. However, given that no expectancy effect or psychoactive effect was found, it is important to explore this matter further by comparing drink presentation versus drink content (i.e., active drink in bottle versus active drink in glass, with placebo drink in bottle versus placebo drink in glass)

to measure whether significant expectancy effect occurs when participants are presented the placebo drinks in branded bottle compared to when an active drink is consumed from a glass.

There was a reverse effect found instead of expectancy effect for sensorimotor movement for the Two-finger tapping task, which has not been found in previous expectancy studies. It was found that participants tapped faster when they were under the impression they are drinking a placebo drink irrespective of drink content. Previous research has found caffeine as a psychomotor stimulant-affecting participant's differently as the expectation of caffeine effects can influence both mood and performance. A study conducted by Fillmore and Vogel-Sprott (1992), conducted a balanced placebo experiment, which examined the effects of caffeine and placebo drinks on performance. It was found that providing positive information to placebo group (i.e., this energy drink is an active drink which will enhance your performance and mood) illustrated greater improvement in motor skills compared to negative placebo group (i.e., this placebo drink will not enhance your performance and mood). This suggests that irrespective of the drink consumed the participants were manipulated by the information provided. Therefore, having prior positive beliefs of energy drinks encouraged participants to tap slower compared to when they were under the impression they having a placebo drink were they tapped faster, suggesting a reverse effect. Taking this into consideration, perhaps such positive effects could be created by presenting participants with drinks in branded bottle.

Hypothesis 2d predicted the mood subscales tension and fatigue levels will decrease, and vigour activity levels will increase for the active ingredient condition where the participants are told they are receiving the active ingredient. This tests for expectancy effect), when given active ingredient condition where the participants are told they are receiving the active ingredient compared to when they consuming a placebo drink and informed they are drinking a placebo drink. (This hypothesis tests for a psychoactive effect). Thus, hypothesis 2d was accepted for the subscale tension as an expectancy effect was found for tension indicating a significant interaction between time, ingredient and condition. Participants tension levels had reduced when they were 'told active' (regardless of actual drink) and increased when 'told placebo' (regardless of actual drink) suggesting participants were influenced by the information given irrespective of actual drink. There were no other significant main effects or interactions found for the recognition task in this study.

4.6 Conclusion

In conclusion the present study was unable to successfully accept all hypotheses, although there was some indication that the active energy drink improved mood in comparison to the placebo drink conditions indicating psychoactive effect. As it is apparent the sample size recruited for this experiment was not sufficient as the power analysis conducted gave a sample size of thirty-four for the effect size of (f = 0.25) and power of (0.80). As this study recruited twenty-three participants the sample size was not sufficient to indicate possible expectancy effects. Furthermore, the observed power analysis conducted for this study gave observed effect size (Cohen's d = 0.5), probability levels of (0.05) and an observed power of (0.19) indicating the sample size were not sufficient. Thus, in order to observe significant effects it is important to have suitable sample size.

Although, there was evidence of significant expectancy effects for immediate verbal recall task for 1 second word presentation and for the mood subscale tension, the findings are ambiguous due to the small sample size. However, these expectancy effect findings indicate that information and participant's belief plays an important role in predicting overall performance and mood. There was a significant reverse effect found for sensorimotor task the two-finger tapping task, as it was acknowledged participants tapped faster when they were under the impression they are having placebo compared to when they were informed they are consuming an energy drink. Participants tapping performance fluctuated greatly with their belief that they either were or were not receiving an energy drink. Participants tapped faster when they were under the impression the energy drink will no longer help their sensorimotor movement suggesting a reverse effect or nocebo effect. This suggests participants beliefs about the experimental drinks where influenced by the positive and negative information given about the drink being consumed and the effects it may have on their overall performance and mood. Such expectations of energy drinks can influence participants overall beliefs and attitudes towards the experimental drink efficacy.

Taking the current findings into consideration, it would be important to do further research comparing energy drinks and placebo drinks by measuring whether drink presentation (glass versus branded energy drink bottle) affect cognitive performance and mood without additional information. This may distinguish whether participants create expectancy beliefs

that drinking from a branded bottle would enhance their cognitive performance in comparison to drinking from a clear glass with no information irrespective of drink content.

CHAPTER 5: Experiment 3

5.1 Introduction

5.1.1 The effects of drink presentation on cognitive performance, sensorimotor movement and mood of experimental drink consumption from a glass versus from a branded bottle

The present chapter explores the difference between experimental drink presentation (*glass* versus *branded bottle*) and whether drink presentation creates an expectancy effect, irrespective of drink content. The previous two experiments examined the psychoactive and expectancy effects of consuming psychoactive ingredients caffeine and glucose on cognition and mood, which found ambiguous results. The understanding derived from the previous two experiments was that, participants might have pre-existing beliefs, which create expectancy effects. Often beliefs are created by our environment and social settings, which shape individual beliefs, attitudes and expectations (Kirsch, 1991). The question addressed in this chapter was whether beliefs and expectations participants' hold towards energy drinks is influenced by the marketing strategy and branding, which may affect the participant's judgement and subjective consumption experiences. For instance, research has found consuming an energy drink that was purchased for a lower price and from a non-familiar branding, would lead to judgements of lower quality and less favourable taste experience in comparison to purchasing a highly reputed branded energy drink at a higher price by the participants (Gerstner, 1985; Huber and McCann 1982; Rao and Manroe 1989; McClure et al., 2004). In the present experiment participants will consume the experimental drinks from a branded Lucozade bottle and from a glass to assess whether familiar branding affects participants judgement and expectation.

There has been a lot of research, which has examined placebo effects that have conveyed false beliefs about psychoactive or medication to patients and participants'. These placebo

effects create positive benefits of a product or medical treatment in question, such as relieve pain, mental illness and depression (Stewart-Williams and Podd, 2004; Montgomery and Kirsch, 1996; Kirsch and Sapirsten, 1999). According to Kirsch (2004) there is growing acceptance of expectations as the basic concept for placebo effects, which has led to the understanding that beliefs lead to placebo effects, and expectancy effects mediate this. For instance, when an individual receives a product, treatment or in this case an energy drink, which they assume, is an active drink, their salient beliefs about the drink activate the response expectancies or anticipation of the subjective and behavioural outcome or consequence of consuming a particular product, treatment, or drink ingested.

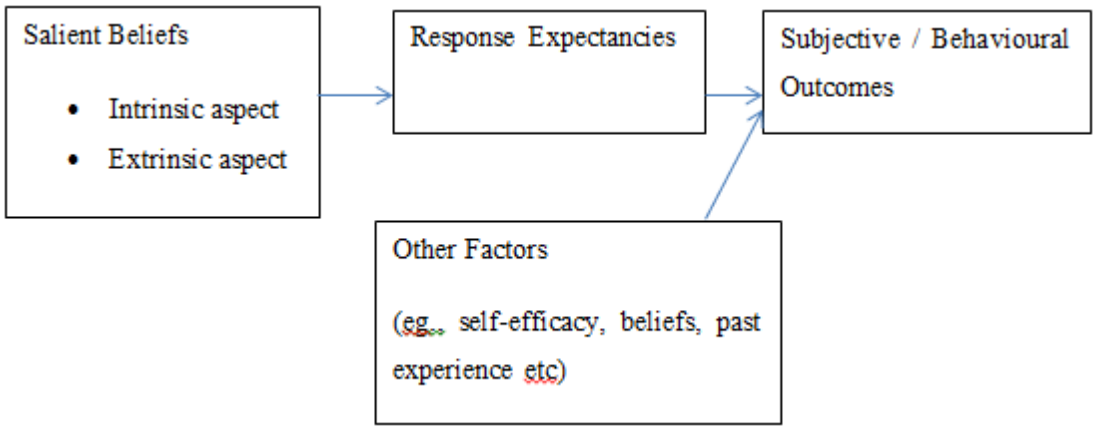

Figure 5-1: Framework for placebo effects

Figure 5-1 explains the process in which placebo effect can be created. The salient beliefs are the specific beliefs an individual creates and has towards a treatment or in this case the energy drink. These beliefs can be associated to intrinsic aspects of the energy drink of being either positive or negative side effects, yielding a particular placebo effect (Hahn, 1997). Similarly, the extrinsic aspect shapes the salient beliefs making the placebo effect either stronger or weaker depending on what the individual's beliefs are towards the brand of the drink (i.e., Lucozade energy drink) they have consumed or about to consume (Kaptchuk et al., 2000). The subjective or behavioural outcome depends on the strength of the activated expectancies, which are often mediated by other factors such as self-efficacy, beliefs (Kirsch, 1985), knowledge and past experience about product or active ingredient consumption or usage (Vogel-Sprott, 1992). The process in which expectancies are elicited result in the placebo effect, which can be either conscious or non-conscious.

Shiv, Carmon and Ariely (2005) found that product specific beliefs differ in different countries, resulting in different expectancies and subsequent behavioural effects. For instance, the drink malted Horlicks, is considered in UK a as beverage which helps consumers sleep better and relax which is generally consumed in the evening. In other countries such as India, the same beverage is consumed in the morning because it is marketed as a drink that promotes mental agility (Yadavar, 2013). Such salient beliefs are dependent on how the product is marketed which often is found to influence the nature of the response expectancies and subsequently affect subjective or behavioural outcomes.

Carmon, Shiv and Ariely (2005) conducted a study in which they presented participants with an energy drink and showed the participants the list of ingredients within in the energy drink. The participants were also informed the price of the drink which was either bought for the regular price or discounted price. The stimulus details would therefore trigger particular salient beliefs. For instance, a participant's intrinsic beliefs would be triggered when they read the list of ingredients within the energy drink, whereas the brand name and cost of the energy drink would trigger the extrinsic cues about the product, either in a positive way or negative way. The aim of this study was to explore whether participants beliefs and knowledge about energy drinks would impact on their overall exercise experience. Carmon et al (2005) found that participants in the reduced price condition rated their workout-intensity as lower than those in the regular price condition and indicated that they were more fatigued versus those in the regular-price condition. It was also found that not a single participant answered affirmatively whether the price of the beverage affected their overall workout. Various salient beliefs along with other factors therefore trigger expectancy responses, which in turn affect the overall performance. Having manipulating factors such as list of ingredients, price and branding can affect participants differently depending on how familiar the participants are with such information. Thus, when individuals have a specific knowledge or belief about a product, or in this case about the energy drink, it would be expected that this belief would overall affect the expectancy response, which would then affect behavioural outcome. Some participants may consider that the energy drink branding as not reputable and therefore it will not have the same effect on their physical performance. Similarly, if the drink is price marked at a higher value, they may consider the drink to be more effective overall (McClure, Samuel, Jiam, Damon, Kim, Montague and Read, 2004).

In Experiment 1 and 2, we explored the independent and combination effects of caffeine and glucose on cognition and mood. Experiment 1 analysis found that caffeine consumption had a significant main effect on immediate verbal recall which was not hypothesised and that glucose had a significant main effect on the Bakan task. It was also found that consumption of active drinks containing (caffeine and glucose) positively enhanced vigour activity and reduced fatigue levels after drink consumption. Experiment 2 was designed to measure the effects of caffeine and glucose as a combination on cognition, sensorimotor movements and mood, and if this was mediated by expectancy. Expectancy effect was introduced into the experiment by presenting the participants with manipulating information regarding the experimental beverages (i.e., 'given placebo drink and informed they are consuming an energy drink' compared with 'given placebo drink and informed they are consuming a placebo drink'). It was found there was a significant reverse effect found for Two-finger tapping task were participants' tapped faster when they were 'given placebo drink and informed they are consuming a placebo drink' which has not been found in previous research. The findings from the latter experiment suggested participants may create salient beliefs of their performance and the information given prior consumption influences their expectations and behaviour. For this reason, examining the effects of consuming experimental drinks from a branded energy drink bottle compared to a glass irrespective of drink content should trigger some form of expectancy effect.

5.2 **Aims & Hypotheses**

The purpose of Experiment 3 is to distinguish and confirm the occurrence of a significant expectancy effect by manipulating the participants' salient beliefs via drink presentation, irrespective of drink ingredients. This experiment would differ from the previous two experiments as the participants will be consuming the experimental drinks from a branded Lucozade bottle and a clear glass. This method would manipulate the participants' expectation by creating a belief that they are consuming an active drink when they drink the experimental beverages from branded bottle in comparison to when they consume it from a clear glass, irrespective of experimental drink ingredients.

In the present experiment, the extrinsic factor was to consume the experimental beverage from a branded Lucozade bottle and from a glass with no information. This would be tested

using four different conditions (active drink in a branded bottle, placebo drink in a branded bottle, active drink in a glass and placebo drink in a glass) to measure whether drink presentation, irrespective of drink content affects overall cognitive performance and mood which is triggered by expectancy response. It was hypothesised points (3a – 3.3c) that:

3a. **There will be a main effect of ingredient**, such that participants consuming active ingredient either from a glass or bottle they will have enhanced **cognitive performance** whereas consuming a placebo drink from a glass or bottle will not have an enhancing effect on overall performance for the active ingredient condition compared to the placebo ingredient, testing an expectancy effect).

3.1a. There will be a **main effect of ingredient** such that participants consuming active ingredient either from a glass or bottle they will have enhanced **mood**, whereas consuming a placebo drink from a glass or bottle will not have an enhancing effect on overall mood (i.e., the mood subscales tension and fatigue levels will decrease, and vigour activity levels will increase for the active ingredient condition compared to the placebo ingredient, testing an expectancy effect).

3b.There will be a **main effect of information** (told active / told placebo), such that participants told active will have higher **cognitive performance** for told active compared told placebo, testing an expectancy effect).

3.2b. There will be a **main effect of information** (told active / told placebo), such that participants told active will have higher **mood improvement** for told active compared told placebo, testing an expectancy effect. (i.e., the mood subscales tension and fatigue levels will decrease, and vigour activity levels will increase when told active compared to when told placebo).

3c. **There be a difference between drink consumption from a glass versus bottle** irrespective of drink ingredient on overall **cognitive performance**. The main effect of drink presentation measures expectancy effect such that participants consuming from a branded bottle would perform better compared to drinking from a glass irrespective of ingredient.

3.3c. **There be a difference between drink consumption from a glass versus bottle** irrespective of drink ingredient on overall **mood**. The main effect of drink presentation

measures expectancy effect such that participants consuming from a branded bottle would enhanced vigour experienced and decreased tension and fatigue experienced post consumption compared to drinking from a glass irrespective of ingredient.

5.3 METHOD

5.3.1 Participants

Thirty-six participants aged (18 - 40) completed a balanced placebo-controlled, counterbalanced, within-subject design approved by Aston University School of Life and Health Sciences Ethics Committee. The power analysis conducted for this study gave a sample size of 34 for the effect size of (f = 0.25) and power of (0.80). As this study recruited 36 participants the sample size was acceptable. Participants were recruited via advertisement on Aston University Sona system. The inclusion and exclusion criteria were exactly the same as Experiments 1-2.

5.3.2 Design for Experiment 3

This was a double blinded, within-subjects design, where participants were placed in each of the four conditions using a counterbalance design (see Table 3.1). As this was a repeated measures design, participants were requested to attend four consecutive sessions in the same week (e.g. Monday, Tuesday, Wednesday and Thursday) at the same time. There were four conditions and all the participants had participated in the following conditions: (active drink in a branded bottle, placebo drink in a branded bottle, active drink in glass and placebo in glass). This method was adopted to examine whether drinking an energy and placebo drink from a highly reputed branded energy drink bottle Lucozade, influence participants salient beliefs which would affect their expectancy response and outcome behaviour comparative to consuming an energy and placebo drink from a glass.

Participants also completed the Profile of Mood States (POMS) questionnaire before drink consumption and after completing the cognitive tasks (Bakan task, the Immediate verbal word free recall task, and Two-finger tapping task). The cognitive tasks took place after experimental drink had been consumed and the participants were given a twenty-minute break (sitting quietly) in the experimental room after experimental drink consumption. All four conditions and order of cognitive tasks were counterbalanced to prevent order effect of drink conditions and cognitive tasks. Please see Table 5-1 below for the information on counterbalancing drinks and cognitive tasks for each session.

Table 5-1: Representing the counterbalance order for drinks & cognitive tasks

	CONDITION.1	CONDITION.2	CONDITION.3	CONDITION.4
COGNITIVE TASKS ORDER	GIVEN ENERGY DRINK IN GLASS	GIVEN PLACEBO DRINK IN BRANDED BOTTLE	GIVEN PLACEBO DRINK IN GLASS	GIVEN ENERGY DRINK IN BRANDED BOTTLE
1ST	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	BAKAN TASK	IMMEDIATE VERBAL FREE RECALL TASK
2ND	TWO-FINGER TAPPING TASK	BAKA`;LAWKN TASK	IMMEDIATE VERBAL FREE RECALL TASK	BAKAN TASK
3RD	BAKAN TASK	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	TWO-FINGER TAPPING TASK

5.3.3 Procedure

Within this double blinded, within-subjects design, participants were placed in each of the four conditions using a counterbalance design. A quarter of the participants had each condition according to the order in the above table (i.e., some had condition 1 first and some had condition 2 etc.). After written informed consent, participants completed the POMS questionnaire followed by the experimental beverage and were given five minutes to drink the experimental beverage with a twenty minute break during which time they are asked to sit quietly in the experimental room. After the twenty-minute break, participants commenced the battery of cognitive tasks: Bakan task, Immediate verbal free recall and Two-finger tapping task. This was followed by the POMS questionnaire. Finally, the participants were debriefed.

5.4 **RESULTS**

ANOVAs were conducted to measure the comparisons set out to examine expectancy and psychoactive effects for mood and cognitive tasks. A 2x2x2 ANOVA was conducted for POMS subscales with Time (before and after) drink consumption, Drink (active / placebo) and Presentation of drink (bottle/ glass) measuring possible expectancy effect as within-subject factors. 2x2 ANOVA was conducted for all the cognitive tasks with drink (active/placebo) and Presentation (bottle/ glass) measuring expectancy effect as the within-subject factor. The analysis section will commence with assessing the effects of blood glucose levels on drink consumption, followed by assessing hypotheses 3b – 3d consecutively.

5.4.1 Measuring the effects on cognitive performance and sensorimotor movement only

A repeated measures 2x2 ANOVA was conducted for all cognitive tasks to measure the psychoactive effect of consuming placebo and active drinks how manipulative information affects overall performance. A 2x2 ANOVA within subject repeated measures with: Drink (active/ placebo) and Presentation (bottle/ glass) as factors for the Bakan task, Immediate verbal recall task and Two-finger tapping task as within subjects factors. For the mean and standard deviation for cognitive tasks for all drink conditions (see Table 5.2) and for ANOVA (see table in Appendix 6.2).

Table: 5-2: The mean & standard deviation for the cognitive tasks for all drink conditions (n 36)

	Active		**Placebo**	
	Glass	**Bottle**	**Glass**	**Bottle**
	Mean (S.D)	**Mean (S.D)**	**Mean (S.D)**	**Mean (S.D)**
Bakan Task (mean hits / block)	3.44 (1.01)	3.46(1.01)	3.77 (1.46)	3.75 (1.11)
Tapping Task (tapping speed in ms)	279 (63.50)	275 (44.08)	278 (71.25)	265 (51.37)
Word Recall Task (Total recalled/ 20)				
1 second presentation	9 (2.80)	9 (3.25)	10 (2.54)	10 (3.33)
2 second presentation	11 (3.23)	11 (3.81)	11 (2.92)	12 (3.57)

The analysis of variances indicated that there were no significant main effects the energy drink or placebo drink from a branded bottle or glass on cognition P>0.05. The interactions between ingredients and presentation for all the cognitive tasks were also non-significant and they were as follows: The Bakan task: ($F(1,35) = 0.018$, $p = 0.893$), Two-finger tapping task: ($F(1, 35) = 0.224$, $p = 0.625$) and Immediate verbal recall task 1 second presentation time: ($F(1,35) = 0.998$, $p = 0.325$) and 2 second presentation time: ($F(1, 35) = 0.194$, $p = 0.662$). Therefore hypothesis 3c was rejected. That is, there was no significant expectancy effect over and above any psychoactive effect on the cognitive tasks. Thus, none of the hypotheses were accepted for the cognitive tasks. For the overall analysis outcome please see Appendix 6.2. p>0.05 for all cognitive tasks.

5.4.2 Measuring the effects on mood subscales only

The mean and standard deviation for the six subscales for mood see (Table 5.3). A 2x2x2 repeated measures within subjects ANOVA was conducted to analyse POMS subscales individually with the within subjects factors were Time (pre and post drink) and Drink (active / placebo) and Presentation (given drink in a bottle / given drink in a glass) prior consumption were the repeated measures see (Table 5.4).

Table 5-3: The mean affective mood state scores and standard deviation for all experimental drink conditions (n 36)

MOOD	TIME	ACTIVE		PLACEBO	
		GLASS	BOTTLE	BOTTLE	GLASS
		MEAN (S.D)	MEAN (S.D)	MEAN (S.D)	MEAN (S.D)
TENSION	BEFORE	5.81 (4.19)	6.81 (3.14)	4.39 (4.18)	4.08 (4.38)
	AFTER	5.08 (4.21)	5.17 (2.78)	4.61 (4.16)	3.78 (5.15)
DEPRESSION	BEFORE	2.94 (4.22)	3.50 (4.41)	2.94 (4.01)	2.58 (5.79)
	AFTER	2.11 (3.49)	2.11 (3.26)	2.06 (3.68)	2.78 (6.19)
ANGER	BEFORE	2.42 (2.89)	5.81 (3.74)	1.50 (4.16)	1.50 (4.16)
	AFTER	1.50 (2.25)	4.17 (2.97)	2.03 (3.10)	1.94 (5.51)
VIGOUR	BEFORE	11.47 (4.53)	11.78 (4.28)	9.44 (5.71)	10.41 (5.38)
	AFTER	12.72 (5.90)	12.97 (3.93)	9.81 (5.72)	8.94 (5.25)
FATIGUE	BEFORE	5.61 (4.70)	5.25 (4.31)	5.00 (4.61)	3.47 (3.34)
	AFTER	3.72 (3.09)	3.08 (3.01)	4.89 (3.89)	3.81 (3.93)
CONFUSION	BEFORE	5.17 (3.62)	3.94 (3.95)	5.06 (3.29)	4.58 (3.63)
	AFTER	5.81 (3.58)	3.31 (2.11)	5.00 (3.11)	4.55 ((3.76)

The 2x2x2 analysis of variance conducted for POMS subscales reports only the significant findings in table (5.4) below and for the complete analysis you can find this in appendix 6.3.

Table: 5-4 Representing 2X2X2 Anova's for energy drink & placebo drink conditions for each of the POMS subscales (n 36)

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Ingredient (Active /Placebo)	7.657 (1, 35)	0.009	0.180
Presentation (Given in bottle/ Given in a glass)	5.915 (1, 35)	0.020	0.145
Ingredient * Presentation	6.376 (1, 35)	0.016	0.154
DEPRESSION			
Presentation (Given in bottle/ Given in a glass)	8.298 (1, 35)	0.007	0.192
ANGER			
Time	12.094 (1, 35)	0.001	0.257
Ingredient (Active /Placebo)	11.537 (1, 35)	0.002	0.248
Time*Ingredient	20.217 (1, 35)	0.000	0.366
Ingredient* Presentation	14.321 (1, 35)	0.001	0.623
VIGOUR			
Ingredient (Active /Placebo)	8.183 (1, 35)	0.008	0.209
FATIGUE			
Presentation (Given in bottle/ Given in a glass)	20.641 (1, 35)	0.000	0.371
Ingredient * Presentation	16.669 (1, 35)	0.000	0.323
CONFUSION			
Time	8.542 (1, 35)	0.006	0.196

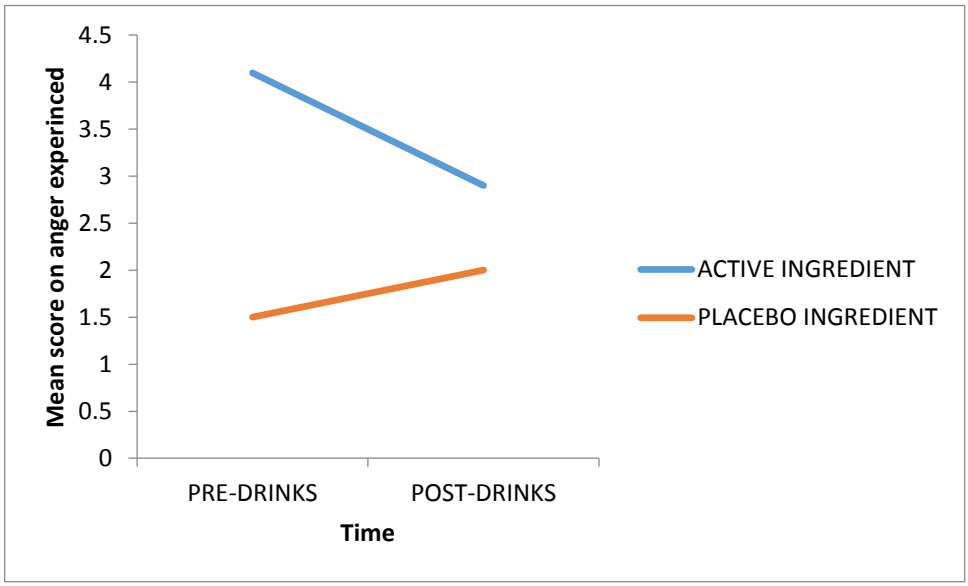

Figure 5-2 Representing the interaction between time and ingredients on anger experienced

The 2x2x2 analysis of variance conducted for POMS subscales and it was that there was one key significant interaction (see Table 5.4) and for the full analysis see Appendix (6.3). There was a significant interaction between Time and Ingredients for $F(1, 35) = 20.217$, $p<0.01$) with significant main effects for time ($F(1,350 = 12.094$, $p< 0.01$) and drink ($F(1,35) = 11.537$, $p<0.01$) for anger mood subscale indicated that anger levels decreased when active drink was consumed overall, see figure (5.2).

Thus, the hypothesis 3.1a was rejected as there was no expectancy effect found for mood subscales (tension, fatigue and vigour). Overall it was found that there was some essence of psychoactive effect and drinking from a bottle on anger experienced post consumption. There were no other significant interactions found ($p>0.05$).

5.5 DISCUSSION

The aim of this experiment was to test whether participants' outcome behaviour of cognitive performance, sensorimotor movement and mood can be influenced by drink presentation (*branded bottle* versus *clear glass*) irrespective of drink ingredients. The findings from this experiment were equivocal as majority of the hypotheses were not accepted overall.

The first hypothesis 3a suggested there would be a main effect of ingredient, such that participants consuming active ingredient either from a glass or bottle they would have enhanced cognitive performance whereas consuming a placebo drink from a glass or bottle would not have an enhancing effect on overall performance for the active ingredient condition compared to the placebo ingredient, testing an expectancy effect). And for hypothesis 3b.there would be a main effect of information (told active / told placebo), such that participants told active will have higher cognitive performance for told active compared told placebo, testing an expectancy effect). For the cognitive tasks it was found there were no significant findings suggesting an expectancy effect. Although the Bakan task, Immediate verbal free recall tasks and Two-finger tapping task did not indicate any significant findings, the mean scores over the course of the task indicated an improvement in performance overall. For instance, for the Bakan task the participants' indicated greater correct mean responses when they consumed the placebo drinks from branded bottle comparatively to the energy drink consumption. Furthermore, for the Two-finger tapping task, participants were found to tap faster when they consumed placebo drink and energy drink from a bottle compared to drinking the same drinks from a glass, indicating a drink presentation effect, although the analysis of variance found no significant main effects or interactions for any of the cognitive tasks. Perhaps participants had preconceived assumption that consuming experimental drinks from a branded bottle would enhance their performance irrespective of drink content. It is important to measure what participant's salient beliefs, attitudes, previous knowledge and expectations are towards energy drinks in order to understand expectancy response. Understanding the concept behind participant's beliefs about psychoactive ingredients will help shape and predict outcome behaviour, as this would be mediated by expectancy response.

It has been established that expectancy response has substantial scope as a psychological feature and potency. However, it is easy to document the psychological phenomenon but difficult to explain it. Though we are aware that response expectancy effects experience, behaviour and psychological function, it is more important to understand the mechanism in which these effects occur. It is possible that behavioural conditioning and expectation contribute to the specified placebo effect (Oken, 2008). Expectancy effects play an important role in understanding placebo response.

Hypothesis 3.1a. there would be a main effect of ingredient such that participants consuming active ingredient either from a glass or bottle they would have enhanced mood, whereas consuming a placebo drink from a glass or bottle would not have an enhancing effect on overall mood (i.e., the mood subscales tension and fatigue levels will decrease, and vigour activity levels would increase for the active ingredient condition compared to the placebo ingredient, testing an expectancy effect). And for hypothesis3.2b there would be a main effect of information (told active / told placebo), such that participants told active would have higher mood improvement for told active compared told placebo, testing an expectancy effect. (i.e., the mood subscales tension and fatigue levels would decrease, and vigour activity levels will increase when told active compared to when told placebo). However. This hypothesis was rejected for the mood subscales vigour, fatigue and tension. Although, the mean scores for tension and fatigue indicated that overall when participants consumed the placebo drink from a branded bottle there was a marginal increase in tension levels and fatigue levels compared to when they consumed the experimental beverages from a glass. Although it was expected that participant's tension and fatigue levels would reduce when they consumed the experimental beverage from a branded bottle, it was evidential that drink presentation had no effect on mood before and after drink due to no initial difference between time-point. Similarly, participants mean score for vigour had decreased when they consumed the placebo drink from a glass compared to when they consumed the placebo from a branded bottle suggesting random variation from before and after drink consumption. However, there was a significant interaction between time and ingredients found for anger, suggesting participants anger levels decreased largely for active drink compared to placebo drink overall.

The latter hypotheses measured there be a difference between drink consumption from a glass versus bottle irrespective of drink ingredient on overall cognitive performance and mood post consumption compared to drinking from a glass irrespective of ingredient.

The analysis found no effect of consuming the psychoactive drink from a branded bottle or glass on cognitive performance and sensorimotor movement. However, there were some significant interactions effects found for mood subscales tension, anger, fatigue and confusion, when the active drink was consumed overall in particular from the branded bottle. There was also a decrease in tension, anger and fatigue experienced post-drink consumption from a branded bottle conditions. Indicating that drink presentation influences participants' mood irrespective of drink content. Thus, there was a psychoactive effect and drink presentation effect found.

However, the analysis confirmed there was a psychoactive drink effect on mood and in particular when the active drink was consumed from a branded bottle. These findings are also consistent with previous two experiments, which have found an association with psychoactive drinks on mood.

The previous two experiments and the present experiment have all suggested possible expectancy effects but the findings have all been ambiguous perhaps due to there being some discrepancy between participants who consumed the psychoactive drinks regularly to those participants who do not consume such beverages habitually. Previous research has indicated that factors such as; habits, beliefs, attitudes, past experience and self-efficacy all contribute to shaping and modifying a participant's overall performance and behavioural outcome either in a positive or negative way (Armitage and Conner, 2001). Hence, caffeine and glucose consumption affect participants differently, which may be due to either previous exposure or awareness of the effects of psycho-stimulating effects of caffeine and glucose. Many research studies have found consumption of stimulants such as caffeine, glucose, alcohol or drugs, which have pharmacological effects upon ingestion, are associated with expectancy concerning nature of stimulant consumed upon performance (Green, Taylor, Elliman & Rhodes 2001; Poltavski & Petros, 2006). In order for consumers to associate such expectancies they must be habitual consumers to understand and experience exert effects on daily performance, behaviour and mood (Oei & Hartley, 2005). Alternatively, participants who are not aware of such stimulating effects may not associate any form of expectancy and

therefore they are unable to shape or predict outcome behaviour. Habitual consumption correlates with withdrawal affects where participants become dependent on the outcome response or behaviour and therefore when they are abstained from psychoactive drinks, their cognitive performance levels and mood will improve upon consumption. In contrast, participants who are not habitual consumers of psychoactive drinks will have the same effect on performance relative to when habitual consumers are abstained from their regular psycho-stimulating beverage.

Taking all three experiments to consideration which have not indicated significant expectancy effects but psychoactive effects on mood only, it is important to investigate participants' attitudes, beliefs, habits, past experience, knowledge, motivation and self-efficacy by conducting a study which examines participants' habitual behaviour of consuming psychoactive drinks. This could be achieved by measuring the antecedents of TPB model, which would postulate participants' intentions to perform or not to perform a particular behaviour (Azjen, 2005). Intentions are a function of three determinants, which are attitude, subjective norm, and perceived behavioural control, which predict intention. Understanding participants' attitude, subjective norms and perceived behavioural control prior experimental testing could be used to predict expectancy effect of habitual psychoactive consumers of energy drinks and caffeine on cognitive performance and mood.

5.6 **CONCLUSION**

In conclusion, the present experiment was unsuccessful in portraying significant analysis variances for expectancy effect and therefore all three hypotheses were rejected. Although, the analysis had found significant interactions between mood and energy drink consumption from a branded bottle. Overall the experiment had equivocal evidence for an improvement of performance subsequent from the consumption of experimental beverages, which intended to create expectancy effects by drinking the experimental beverages from branded bottle and glass. This indicated the presence of a psychoactive effect and the influence of drink presentation on mood. This effect may be associated with previous exposure and experience of drinking energy drinks from highly reputed branded bottles. There is cited evidence to suggest attitudes, beliefs, habits, past experience, knowledge, motivation and self-efficacy, should be taken into account to establish significant expectancy response when

psychoactive ingredients are consumed. Understanding participant's behaviour before drink consumption would play a key role in determining and predicting expectancy intentions after drinking a psychoactive beverage. Thus, the phenomena of expectations are either positive or negative which can modulate behaviour and is dependent upon previous experiences that influence our expectations accordingly. For this reason the next experiment would investigate factors such as beliefs, attitude, past experience, knowledge, motivation and whether participants are habitual consumers of psychoactive ingredients in order to predict expectancy effect.

CHAPTER 6: Experiment 4

6.1 Introduction

6.1.1 The placebo expectancy effects measured using the theory of planned behaviour

Previous experiments within this thesis have looked at the effects of caffeine and glucose independently and in combination with various forms of manipulation methods, which may indicate some form of an expectancy effect. It was important to commence this research by firstly understanding the actual effects of caffeine and glucose independently which was assessed in Experiment 1. Experiment 2 examined the extent of the effects of consuming energy drinks containing (caffeine and glucose) as a combination on cognition, sensorimotor movement and mood, and whether this was mediated by expectancy when participants consumed the placebo beverage and informed that they are consuming an active drink. A reversal effect was found for the Two-finger tapping task whereby participants tapped faster when they were given a placebo drink and informed that they are consuming a placebo drink which has not been previously found in published studies. However, the overall findings were ambiguous and did not confirm significant expectancy main effects and interactions throughout the experiment. It was concluded that further research was required to measure the difference in cognitive performance when both psychoactive and non-psychoactive drinks are consumed from a branded energy drink bottle versus from a clear glass. By comparing the effects of consuming the experimental beverages from a glass and branded bottle irrespective of drink content would indicate whether marketing and pre-exposure of branded energy drink bottle would influence and manipulate overall performance and mood which has been mediated by previous experience and expectancy. These concepts lead to Experiment 3, which measured the effects of drink presentation irrespective of drink content in order to explore possible expectancy effect of drinking from a branded bottle versus a glass. However, Experiment 3 was unsuccessful in portraying significant expectancy effect as the experiment had equivocal evidence for improvement in performance. Experiment 3 confirmed the significant psychoactive effect of consuming energy drink overall on mood

subscales tension, anger, vigour and fatigue irrespective of drink presentation. After conducting these three small experiments, it was apparent that predicting an expectancy effect purely from placing participants in experimental conditions without having knowledge and information on participant habitual drinking behaviour or knowing if participants' have any salient views or beliefs about drinking psychoactive drinks requires further research.

After examining the previous three experiments in this thesis, the present experiment intends to increase the absorption time of the experimental drink from twenty minutes too thirty minutes. Recent research by Giles et al (2012) and Specterman et al (2005) have found in their experiments that blood glucose measures should be taken after thirty minutes of drink consumption as this is considered as a significant time to measure blood glucose levels. Furthermore, it has been acknowledged that (99%) caffeine is immediately absorbed into from the gasintestinal tract into the bloodstream with peak plasma consumption reached between thirty–sixty minutes after ingestion (Arnaud, 1993; Fredholm Battig, Holmen, Nehig and Zvartau, 1999). Thus, in the present experiment, participants will commence cognitive testing after thirty minutes absorption period as this is considered as the appropriate time for participants to begin cognitive testing.

The present chapter intends to examine whether participants' beliefs, past experience, attitude, habits, subjective norms, perceived behaviour control, intentions and self-identity, play a role in predicting expectancy response when consuming a psychoactive drink. The phenomena of expectations are either positive or negative, which can modulate behaviour depending on participants' experiences and expectations of consuming psychoactive beverages. Observed effects of psychoactive ingredients on cognitive performance and mood are not entirely a result of the pharmacological effects of ingestion. As there is evidence suggesting the exert effects of consuming psychoactive ingredients which are mediated by expectancy (Lotshaw et al., 1996; Mikalesen et al., 2001; Oei & Hartley, 2005). Such expectancies are generally created by past experience, which end to shape an individual's attitudes and beliefs either positively, or negatively of outcome behaviour. Understanding participants' beliefs, attitudes, subjective norms, perceived behavioural control, habits and past experience would predict expectancy effect. This leads to the present study Experiment 4, which aims to investigate and extend on the above experiments by examining the effects of Theory of planned behaviour model (TPB) components and whether these components from TPB can be used to predict expectancy effect.

The TPB model as described by Azjen (1991) is a theoretical approach that has been used to predict behaviour and intentions (Glanz, Rimer & Lewis, 2002; Armitage & Conner, 2001; Hardeman et al., 2002; Godin & Kok, 1996). The TPB model predicts intentions by three main constructs, 1) attitude towards behaviour could either be positive or negative evaluation of performing that particular a behaviour, 2) subjective norm are the perceived social pressure to engage or not to engage in particular behaviour. Subjective norm is determined by accessible normative beliefs concerning the expectation of important referents, 3) perceived behavioural control is the feeling of self-efficacy or perceived ability of the individual to perform behaviour or control over whether they can perform it or not (Azjen, 2005). Each construct comprises of different determinants, which potentially influence an individual's overall behaviour outcome, and identifies which constructs have significant impact on behavioural outcome along with those constructs, which do not affect behaviour. TPB has been successful in predicting a wide variety of health behaviours such as smoking cessation, alcohol consumption, drug abuse, blood pressure, exercising and dieting among many others (Glanz et al., 2002; Armitage & Conner, 2001; Hardeman et al., 2002; Godin & Kok, 1996).

Social learning theory supports cognitive theory as they both highlight the situation and personal beliefs in understanding one's alcohol use (Abrams and Niaura, 1987). According to the social learning theory alcohol consumption whether it is for alcohol abuse or social consumption results from either, high positive alcohol expectancies, low negative alcohol expectancies and low drink refusal self-efficacy. These expectancies are associated to an individuals anticipated consequence from their alcohol consumption. For instance an example of a positive alcohol expectancy would be, i.e. 'alcohol makes me more fun and talkative' and an example of a negative alcohol expectancy would be, i.e., 'I become aggressive when I drink alcohol'. Conversely, refusal of alcohol drink refers to the individual's perceived ability to resist an alcoholic beverage in drinking situations such as, social events (Connor, Gudgeon, Young & Saunders, 2007). Thus, meta-analysis conducted for alcohol expectancy studies have found to predict alcohol use (Kieffer, Cronin & Fister, 2004), which has also been supported by alcohol, related self-efficacy to predict future alcohol consumption (Adamson, Sellman & Framplen, 2009; Maisto, Cliffford, Longabaugh & Beattie, 2002).

Evidence of inconsistency between individual's beliefs and their behaviour is not limited to the context of binge drinking (Johnston & White, 2006). Numerous alcohol studies have demonstrated that people's attitudes are incongruent with their behaviour, which influences their rational decision making (Fishbein & Azjen, 1975). Alcohol studies have often deployed the TPB to predict future drinking behaviour and alcohol related outcome expectancy theory, which has been associated with people's reasoned assessment of positive and negative consequences of drinking alcohol (Kuther, 2002). It has been found that the construct attitude and perceived behavioural control have consistently been found to be related to behaviour (Azjen & Fishbein, 1973; Fromme et al., 1993). Thus in such alcohol studies, Azjen-style attitude measures speculate that expectations of positive and negative measures touch on expectations about generalized outcomes of drinking consequences individually but not in combination of the two (i.e., positive and negative consequences of drinking alcohol), which have been assessed using the Comprehensive effects of alcohol questionnaire (Fromme et al., 1993).

An alcohol study by Armitage and Conner (2001) used the TPB to predict drinking behaviour and found that subjective norm had less predictive power for behavioural intentions than attitude for most behaviours, reporting intentions was predicted by attitude was 49% whereas for subjective norms was 34% of the variance, which was the weaker link in predicting outcome behaviour. There are many studies, which have successfully applied the TPB model to predict behavioural intentions. Research has identified that TPB model is a valuable tool for predicting future behaviour. Subsequently, Hoie, Moan and Rise (2009) assessed the context of participant intentions to quit smoking using the TPB model. This study had hypothesised that the predictive effectiveness using the TPB model was mediated by past experiences. Thus, it was found that the components for TPB accounted for 12.3% of the variance in the intention of participants quitting smoking with the strongest impact mediated by past behaviour component. Thus, as there are many alcohol studies which have used the TPB model to predict alcohol drinking behaviour which indicate that all the constructs from the original TPB model can be assessed to predict most addictive behaviours, such as psychoactive drinks such as energy drinks and caffeine by measuring an individual's attitude, beliefs, subjective norms, perceived behavioural control and intentions.

In order to understand and explore participants' views on psychoactive drinks, the constructs of TPB have been deployed within a questionnaire which measures participants' attitudes, subjective norms, perceived behavioural control and intentions, in order to predict behaviour and expectancy response. A questionnaire was designed for the present experiment after carefully analysing the previous three studies, which have not yet found significant expectancy effects but have indicated the possibility of an expectancy effect existing. The overall aim for the TPB model is to predict planned behaviour. The TPB posits that individual behavioural intention is a function of beliefs in the following three areas; behavioural beliefs (the individual's attitude towards behaviour), normative beliefs (subjective beliefs) and control beliefs (perceived behavioural control) (Ajzen, 1991). Meta analyses have found these three antecedents to have direct and indirect influence on behaviour (Armitage and Connor, 2001).

There are two main mechanisms considered in order for a placebo effect to occur, one is the reward expectation and the other is pre-conditioning. The reward expectation is the mechanism, which motivates the participant work harder to achieve a particular reward outcome. The pre-conditioning mechanism has been associated with regular exposure or consumption of a product, such as habitual caffeine intake. When a product is consumed on a regular basis and beneficial outcomes are achieved, the product will be conditioned to expect an improvement irrespective of actual ingredients every time the product is ingested i.e. placebo being consumed instead of actual active product. The phenomenon of expectation is dependent upon previous experiences, which influence our expectations whether an outcome is positive or negative. Experience of uncertainty can enhance expectation levels, which activate a phasic dopaminergic levels followed after a reward, and this effect is the strongest when a reward arrives as a surprise (de la Fernandez 2004). Conversely, if a participant has never consumed a caffeinated beverage before, but is informed their performance will be enhanced by caffeine intake and it would be expected that the outcome achieved would be positive surprise to the participant. Thus, if participants are pre-conditioned to certain energy drinks and or are habitual coffee consumers or do not like the taste of coffee, they automatically create an expectation of how they will feel after the consumption of a specific beverage or product. If they have a positive view about consuming energy drinks and caffeine they generally are expected to have positive changes in their mood and cognition in comparison to negative experiences and expectations.

Habitual consumers of psychoactive drinks tend to self-identify with positive effects of consuming such beverages which shapes the individuals attitudes and beliefs towards intentions and outcome behaviour (Wager & Nitschke, 2005).

Self-identity is composed of self-assessments, such as personality attributes, knowledge of one's skills and abilities, one's occupation and hobbies, and awareness of one's physical attributes. In regards to the present study, self-identity refers to someone such as (i.e., 'I am someone who consumes energy drinks to stay alert' or 'I am the kind of person who drinks energy drinks'). In order for an individual to identify himself or herself with a product they must have previous experience and knowledge of the physiological and psychological attributes of consuming psychoactive drinks. It is therefore important to analyse all the components from the original TPB model and in general participants past behaviour, habits, beliefs and what social concepts they identify with drinking energy drinks and how this information could be utilised in predicting expectancy.

6.2 **Aims & Hypotheses**

Taking previous research into consideration, which has portrayed the effectiveness of using TPB model components in the format of a questionnaire, it would be ideal to utilise the TPB questionnaire to assess whether the TPB components can be used to predict expectancy effect and response in the present study. The TPB questionnaire will examine each construct within the questionnaire prior drink consumption in the first experimental condition, which would determine which constructs significantly predict intentions and expectancy.

In order to understand the association between behaviour and psychoactive beverage consumption, the TPB model questionnaire was used to measure which constructs are strong predictors of intentions and expectancy, and which constructs have no impact on participants' cognitive performance and mood. It was therefore hypothesised that:

4a. There will be a **main effect of ingredient** (active / placebo) such that participants will exhibit faster tapping speed for the two-finger tapping task, recall more words during the immediate verbal recall task and recognise more words correctly and promptly when the active drink is consumed compared to when the placebo drink condition.

4.1a. There will be a **main effect of ingredient** (active / placebo) such that participants will experience **mood improvement** (vigour will increase were tension and fatigue levels will decrease) for the active drink is consumed compared to when the placebo drink condition.

4b. There will be a **main effect of information** (told active / told placebo) whereby participant will exhibit **enhanced cognitive performance** when they are told they are consuming an active drink irrespective of ingredient, indicating an expectancy effect.

4.2b. There will be a **main effect of information** (told active / told placebo) whereby participant **mood** will improve (vigour will increase, tension and fatigue will decrease) when they are told they are consuming an active drink irrespective of ingredient, indicating an expectancy effect.

4c. The TPB model components (attitude, subjective norms, perceived behavioural control and intentions) and the additional components included in the questionnaire (belief, habit, past behaviour and self-identity) as measured by the TPB questionnaire will predict the variance in the above expectancy effect (that is, the variance in the amount of difference between given placebo told energy drink and given placebo drink told placebo drink).

6.3 METHOD

6.3.1 Participants

Sixty participants aged (18 - 36) years completed a balanced placebo-controlled, counterbalanced, within subject design approved by Aston University School of Life and Health Sciences Ethics Committee. This experiment intends to measure eight different predictors (attitude, subjective norm, perceived behavioural control, intentions, beliefs, habit, past behaviour, self-identity) using a multiple regression analysis to predict the variance in expectancy effect. In order to ensure sufficient statistical power, a post-hoc statistical power calculator for multiple regression analysis using the calculator on the danielsoper website (http://www.danielsoper.com/statcalc3/calc.aspx?id=9) which gave the observed power for the multiple regression analysis, given the observed probability level,

the number of predictors, the observed R2, and the sample size. It was found that a power analysis was conducted which gave a sample size of 60, for the effect size of (f = 0.25) and power of (0.87). Participants were recruited via advertisement on Aston University Sona system. The inclusion and exclusion criteria were exactly the same as Experiments 1-3 except for in this study the recruitment advertisement requested habitual psychoactive consumers of energy drinks and caffeine to participate only.

6.3.2 Design for Experiment 4

This was a double blinded, within-subjects design, where participants were placed in each of the four conditions using a counterbalance design (please see **Error! Reference source not found.**). As this was a repeated measures design, participants were requested to attend four consecutive sessions in the same week (e.g. Monday, Tuesday, Wednesday and Thursday) at the same time. There were four conditions and all the participants had participated in the following conditions: (active drink in a glass and told that it is active drink, placebo drink in a glass and told this is not an active drink, active drink in glass and told this is not an active drink and placebo in glass and told this is an active drink). The methodology was similar to previous experiments in this thesis, which aimed to examine possible expectancy effects of consuming experimental beverages irrespective of drink ingredients.

Participants were requested to complete the TPB questionnaire in condition 1 only. The questions were constructed to measure participants; past behaviour, attitude, habit, belief, subjective norms, perceived behaviour control, intentions, self-identity using a 7 point Likert. Before any analysis took place for this questionnaire, a test reliability analysis was conducted where questions with low inner consistency were removed by conducting the principle components analysis. The purpose of conducting a principle components analysis was to find a small set of linear combinations of the covariates that are uncorrelated with each other. Principal components analysis is a method of data reduction. This will avoid the multicollinearity problem. Conducting principle components analysis would ensure that the linear combinations chosen have maximal variance. Thus, a good regression design chooses values of the covariates that are spread out. Therefore, the questions that were removed after conducting the principle components analysis have been listed below under the question categories (i.e., perceived behavioural control and belief) were self-identity questions were split into two individual constructs. The question numbers for these constructs can be found below. The questionnaire commenced in asking questions in the following order;

Past behaviour – the Cronbach's alpha (α) was 0.67 for the following items: (on average, how often over the last 6 months have you consumed energy drinks) and (frequency of how many times you normally consume 330ml bottle for energy drinks a day and in week) on scale ranging from (Never – 4/6 times a week).

Attitude – the Cronbach's alpha (α) was 0.82 for all the items in the questionnaire, therefore no question were removed from the analysis. The questions which measured attitude were: (*To me, drinking energy drinks frequently is..*), (*Drinking energy drinks would make me feel..*), (Energy drinks taste good), (*My attitude towards drinking energy drinks is..*), (*My attitude towards drinking energy drinks is..*), (*I believe the claims made on energy drinks in adverts by branded companies such as (e.g. Lucozade) are correct / true..*) measured on a 7 point Likert scale varying from: extremely negative-extremely positive, strongly disagree – strongly agree, definitely false-definitely true.

Habit - the Cronbach's alpha (α) was 0.87 for all the items in the questionnaire, therefore no question were removed from the analysis (*I cannot function without consuming energy drinks*), (*I cannot function cognitively and physically without consuming 1 energy drink a day..*), (*I feel fatigue without consuming my daily psychoactive (caffeine and glucose) beverage..*), (*I feel stimulated every time I consume energy drinks..*), (*I feel content when I consume my daily psychoactive (caffeine and glucose) beverage..*), (*I experience withdrawal symptoms if I do not consume caffeine..*) on a 7 point Likert scale strongly disagree-strongly agree.

Belief – the Cronbach's alpha (α) was 0.66 for the following items (Drinking energy drinks regularly will make me feel cognitively smarter (intelligent)..), (Drinking energy drinks will make me feel happy..), (Drinking energy drinks will have an effect on my performance..), on a 7 point Likert scale strongly disagree-strongly agree. Question (16) Feeling cognitively smarter (intelligent) on my course / module would be: (Bad 1 2 3 4 5 6 7 Good) was removed to increase inner consistency for belief from Cronbach's alpha (α) of 0.54 to 0.66.

Subjective Norm – the Cronbach's alpha (α) was 0.89 for all the items in the questionnaire, therefore no question were removed from the analysis. The questions which measured subjective norms were: (*Most people who are important to me think that I should drink energy drinks frequently..*), (*Generally, members of my family think that I should drink energy drinks frequently..*), (*Generally, my friends think that I should drink energy drinks frequently..*), (*I like to do what my friends think that I should..*), (*Most famous personalities I admire claim to drink energy drinks and they promote this in adverts that we should drink energy drinks..*) on a 7 point Likert scale unlikely – likely.

Perceived behavioural control – the Cronbach's alpha (α) was 0.76 for the following items: (I do not believe I can perform well without drinking energy drinks..), (I need to drink energy drinks to stay awake in my lecture..), (I am confident that I can drink energy drink at least 3 times in the next 7 days..), (*I am confident that I will perform my best in the cognitive tasks when I drink the experimental beverage*..) on a 7 point Likert scale strongly disagree – strongly agree. Question (25) *Energy drinks are easily available to me (Strongly disagree 1 2 3 4 5 6 7 Strongly agree)* was removed to increase inner consistency for perceived behavioural control from Cronbach's alpha (α) of 0.69 too 0.76.

Intentions – the Cronbach's alpha (α) was 0.80 for all the items in the questionnaire, therefore no question were removed from the analysis. The questions which measured subjective norms were: (*I intend to drink energy drinks in the next 7 days*..), (*Over the next 7 days, it is likely I will consume an energy drink*..), (*Over the next 7 days my main way of staying alert will be to consume energy drink*..), on a 7 point Likert scale definitely will – definitely will not.

Self-identity the Cronbach's alpha (α) was 0.52 for the following items: (*I am someone who consumes energy drinks to stay alert..)* and (*I am the kind of person who drinks energy drinks…)* on a 7 point Likert scale likely-unlikely. Although the Cronbach's alpha (α) was not as strong as the other constructs within the questionnaire both questions (33) *I am someone who consumes energy drinks to stay alert* (Unlikely 1 2 3 4 5 6 7 Likely) and (34) *I am the kind of person who drinks energy drinks* (Unlikely 1 2 3 4 5 6 7 Likely) were kept as removing either question would reduce the inner consistency further. Therefore, self-identity was split into two constructs as self-identity (1) and self-identity(2) for questions (33) and (34) respectively.

They also completed POMS questionnaire before drink consumption and after completed the following cognitive tasks (Immediate verbal free recall task, Recognition task and the Two-finger tapping task). The cognitive tasks took place after experimental drink had been consumed and the participants had been given a thirty minutes break (sitting quietly) in the experimental room. Participants were given a thirty minute absorption break to digest the experimental beverage as the previous three experiments had permitted only twenty minutes

to digest the experimental beverage which found non-significant expectancy effects and in some cases no effects of consuming the stimulant drinks. Thus, for this experiment additional time was added to allow absorption time of stimulant drink, which has also been recommended, in recent research (Giles et al., 2012; Specterman et al., 2005). All four conditions and order of cognitive tasks were counterbalanced to prevent order effect of drink conditions and cognitive tasks. Please see (**Error! Reference source not found.**) below for information on counterbalancing drinks and cognitive tasks for each session.

Table 6-1Representing the counterbalance order for the drinks and cognitive tasks

	CONDITION.1	CONDITION.2	CONDITION.3	CONDITION.4
COGNITIVE TASKS ORDER	GIVEN ACTIVE DRINK/ TOLD ACTIVE	GIVEN PLACEBO DRINK / TOLD ACTIVE	GIVEN PLACEBO DRINK / TOLD PLACEBO	GIVEN ACTIVE DRINK / TOLD PLACEBO
1ST	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	BAKAN TASK	RECOGNITION TASK
2ND	TWO-FINGER TAPPING TASK	BAKAN TASK	RECOGNITION TASK	IMMEDIATE VERBAL FREE RECALL TASK
3RD	BAKAN TASK	RECOGNTION TASK	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK
4TH	RECOGNTION TASK	IMMEDIATE VERBAL FREE RECALL TASK	TWO-FINGER TAPPING TASK	BAKAN TASK

6.3.3 Procedure

Within this double blinded, within-subjects design, participants were placed in each of the four conditions using a counterbalance design (please see **Error! Reference source not found.**). All the drink conditions were not counterbalanced but randomised (i.e., some participants had condition 1 first and others had condition 2 first and so forth, depending on when they commenced the experiment). After written informed consent, participants completed the TPB questionnaire in condition 1 only. The POMS questionnaire was competed in each condition followed by the experimental beverage. Participants were given five minutes to drink the experimental beverage with a thirty minutes break during which time they are asked to sit quietly in the experimental room. After the thirty minutes break participants commenced the battery of cognitive tasks listed above in Table (**Error! Reference source not found.**). This was followed by the POMS questionnaire. Finally, the participants were debriefed.

6.4 **RESULTS**

The analysis will commence by testing each hypothesis in order (4a – 4c) to confirm whether the null hypothesis should be accepted or rejected. For hypothesis 4a the cognitive task analysis commenced with measuring whether there was an expectancy effect on cognitive performance and sensorimotor movement (i.e., *given placebo drink and told they are consuming an energy drink, versus, given placebo drink and told they are consuming a placebo drink*) using 2x2 way ANOVA.

The analysis conducted for hypothesis 4b examined the expectancy effects on mood subscales. This was assessed using a repeated measures 2X2X2 way ANOVA, with Time-point (before and after) drink intake and Expectancy (*given placebo drink and told they are consuming a placebo drink versus given placebo drink told they are consuming an energy drink*) as factors on mood subscales.

Hypothesis 4c analysis consisted of conducting multiple regression analysis in order to determine which factors predict expectancy effects. The first step of regression analysis examined whether the basic TPB model variables (attitude, subjective norm, perceived behaviour control) are significant predictors for Intention. The second step regression

analysis included the additional variables (belief, habit, past behaviour, self-identity1 and self-identity2) of intentions. The variables included in the latter steps of the regression were included after conducting principle component test and anything lower than (0.5) was excluded. Finally, expectancy effect calculations for the cognitive tasks and mood subscales were used as criterion variables to examine if they predict expectancy.

6.4.1Measuring the effects on cognitive performance and sensorimotor movement only

A repeated measures 2x2 ANOVA was conducted for all cognitive tasks to measure the psychoactive effect of consuming placebo and active drinks how manipulative information affects overall performance. A 2x2 ANOVA within subject repeated measures with: Drink (active/ placebo) and Presentation (bottle/ glass) as factors for the Recognition task, Immediate verbal recall task and Two-finger tapping task as within subjects factors. For the mean and standard deviation for cognitive tasks for all drink conditions (see Table 6.2) and for ANOVA (see Table 6.3).

Table 6-2 The mean & standard deviation for all drink conditions (n 60)

	ACTIVE		**PLACEBO**	
	TOLD ACTIVE	**TOLD PLACEBO**	**TOLD ACTIVE**	**TOLD PLACEBO**
	MEAN (S.D)	**MEAN (S.D)**	**MEAN (S.D)**	**MEAN (S.D)**
RECOGNIION MEMORY (RT in MS)	809 (86.72)	785 (83.87)	807 (92.22)	791 (83.87)
RECOGNITION MEMORY (SCORE OUT OF 40)	30.62 (4.22)	30.83 (3.26)	30.05 (3.41)	29.35 (3.68)
BAKAN TASK (MEAN HITS / BLOCK)	3.44 (1.01)	3.46 (1.01)	3.75 (1.11)	3.77 (1.46)
TAPPING TASK (TAPPING SPEED IN MS)	279 (63.50)	275 (44.08)	265 (51.37)	278 (71.25)
WORD RECALL TASK (TOTAL RECALLED/ 20)				
1 SECOND PRESENTATION	9 (2.80)	9 (3.25)	10 (3.33)	10 (2.54)
2 SECOND PRESENTATION	11 (3.23)	11 (3.81)	12 (3.57)	11 (2.92)

Table 6-3 2x2 Anova's for the cognitive tasks when energy drinks and placbeo drink conditions (n 60)

	F (Degrees of freedom)	P	Partial Eta Square
Recognition Memory (RT in ms)			
Ingredients (Active /Placebo)	11.498 (1, 59)	0.001	0.163
Information (Told Active/ Told Placebo)	0.120 (1, 59)	0.730	0.002
Ingredients * Information	0.253 (1, 59)	0.617	0.004
Recognition Memory (Score out of 40)			
Ingredients (Active /Placebo)	0.386 (1, 59)	0.537	0.006
Information (Told Active/ Told Placebo)	5.702 (1, 59)	0.020	0.088
Ingredients * Information	1.290 (1, 59)	0.261	0.021
Immediate verbal recall task (mean words recalled from a list of 20 words)			
1 second word presentation			
Ingredients (Active /Placebo)	4.824 (1, 59)	0.032	0.076
Information (Told Active/ Told Placebo)	14.157 (1, 59)	0.000	0.194
Ingredients * Information	1.357 (1,59)	0.249	0.022
2 second word presentation			
Ingredients (Active /Placebo)	9.253 (1, 59)	0.004	0.136
Information (Told Active/ Told Placebo)	7.892 (1, 59)	0.007	0.118
Ingredients * Information	5.652 (1, 59)	0.021	0.087

Key: * = interaction

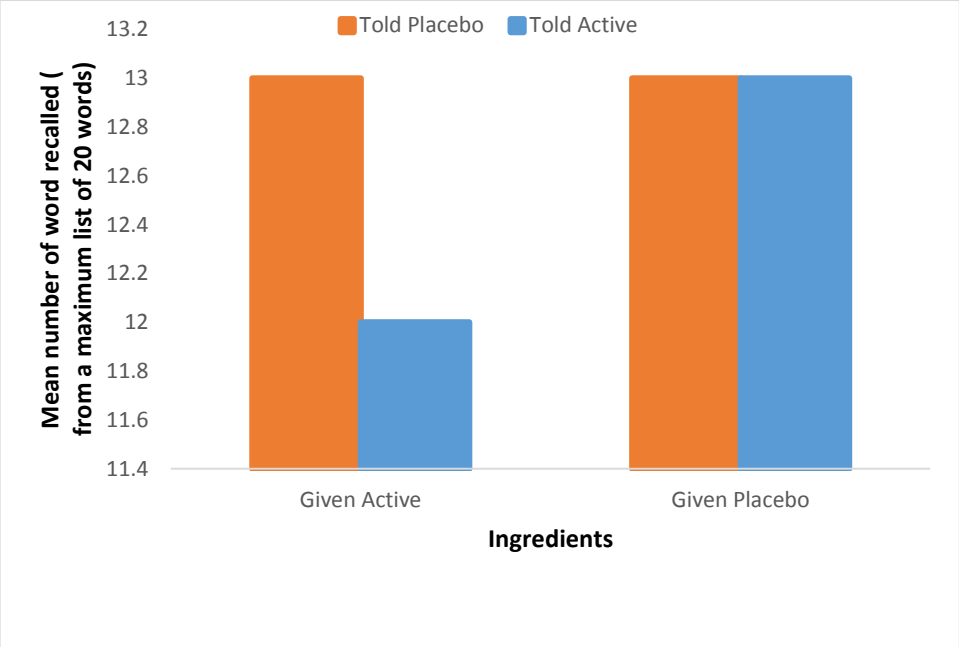

Figure 6-1 Representing the interaction between ingredients and information on the immediate verbal recall task for 2 second word presentation

The analysis of variance found there was a significant interaction for Immediate verbal recall task for the two second word presentation between drink (active / placebo) and information given prior ingestion (told active / told placebo) ($F(1,59) = 5.652$, $p < 0.05$) with significant main effects of drink and information, indicating participants recalling more words for placebo drink conditions overall indicating an expectancy effect and a reverse effect for the drink condition given placebo and told placebo see figure (6.1). There were no other significant interactions found for the cognitive tasks $p > 0.05$).

6.4.2 Measuring the effects on mood subscales only

The mean and standard deviation for the six subscales for mood see (Table 6.4). A 2x2x2 repeated measures within subjects ANOVA was conducted to analyse POMS subscales individually with the within subjects factors were Time (pre and post drink) and Drink (active / placebo) and Information (told active / told placebo) prior consumption were the repeated measures see (Table 6.5).

Table 6-4 The mean affective mood state scores and standard deviation for all experimental drink conditions (n 60)

MOOD	TIME	ACTIVE		PLACEBO	
		TOLD ACTIVE MEAN (S.D)	TOLD PLACEBO MEAN (S.D)	TOLD ACTIVE MEAN (S.D)	TOLD PLACEBO MEAN (S.D)
TENSION	BEFORE	4.33 (2.89)	3.50 (2.38)	3.03 (2.32)	3.63 (2.24)
	AFTER	3.25 (2.49)	2.63 (1.73)	2.35 (1.80)	3.31 (2.10)
DEPRESSION	BEFORE	2.25 (2.20)	2.98 (3.02)	2.51 (2.52)	2.52 (2.19)
	AFTER	1.73 (1.99)	1.63 (1.80)	2.25 (3.06)	2.13 (2.72)
ANGER	BEFORE	2.75 (2.72)	2.07 (2.07)	2.37 (2.50)	2.28 (2.37)
	AFTER	1.87 (2.04)	1.33 (1.42)	1.68 (2.15)	1.72 (1.74)
VIGOUR	BEFORE	11.50 (3.88)	10.75 (3.81)	11.90 (4.25)	11.02 (4.30)
	AFTER	15.62 (4.09)	13.45 (4.59)	16.02 (4.16)	13.72 (4.48)
FATIGUE	BEFORE	4.58 (3.22)	3.42 (2.02)	3.43 (2.31)	4.72 (3.94)
	AFTER	3.57 (2.90)	3.60 (3.19)	3.28 (4.67)	4.15 (4.95)
CONFUSION	BEFORE	4.15 (2.77)	3.57 (2.40)	4.17 (2.43)	3.57 (2.07)
	AFTER	3.75 (2.67)	3.05 (1.70)	3.15 (2.23)	3.08 (1.90)

Table 6-5: 2x2x2 Anova's for energy drink & placebo drink conditions for POMS subscales (n 60)

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Information (told active/ told placebo)	23.010 (1, 59)	0.000	0.281
Time*Ingredient	13.964 (1, 59)	0.000	0.191
DEPRESSION			
Information (told active/ told placebo)	17.613 (1, 59)	0.000	0.230
Time*Information	4.324 (1, 59)	0.042	0.068
Ingredient * Information	4.267 (1, 59)	0.043	0.067
ANGER			
Information (told active/ told placebo)	24.802 (1, 59)	0.000	0.296
VIGOUR			
Information (told active/ told placebo)	14.174 (1, 59)	0.000	0.717
Time*Information	8.706 (1, 59)	0.005	0.129
FATIGUE			
Time*ingredient	8.185 (1, 59)	0.006	0.122
Time*Ingredient*Information	4.372 (1, 59)	0.041	0.069
CONFUSION			
Time	5.871 (1, 59)	0.018	0.090
Information (told active/ told placebo)	14.412 (1, 59)	0.000	0.196

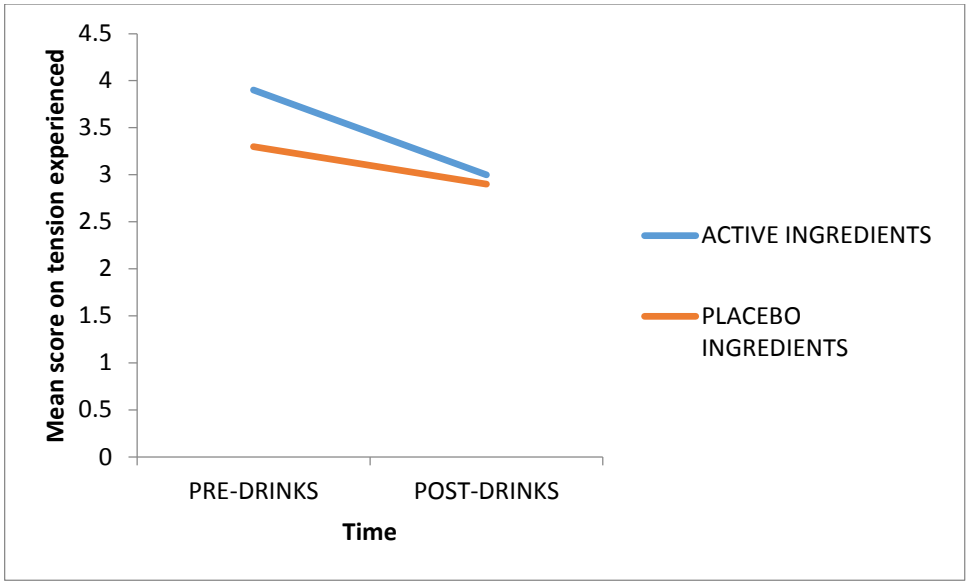

Figure 6-2 The interaction between time and ingredients on tension experienced

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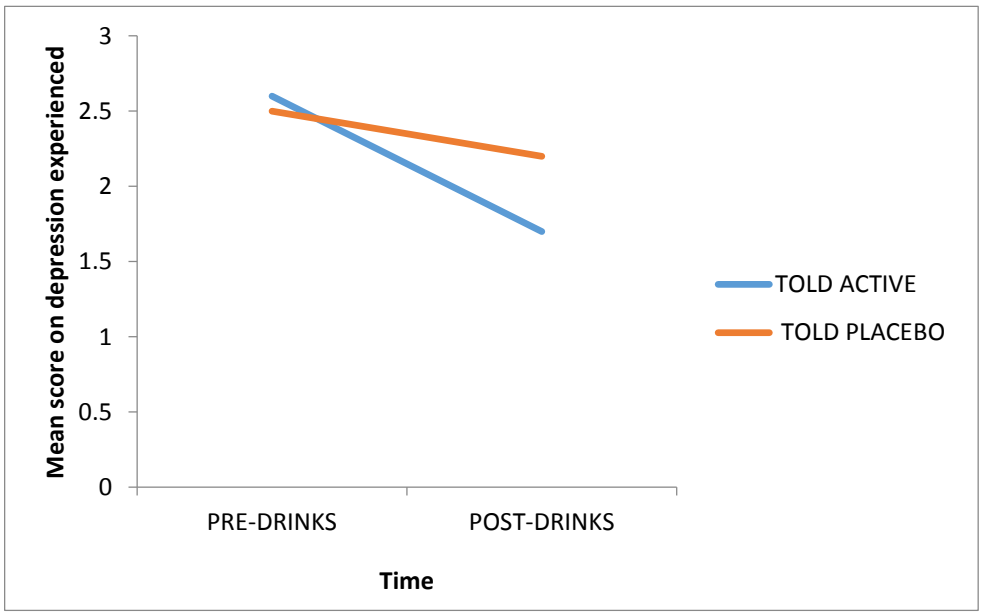

Figure 6-3 The interaction between time and information on depression experienced

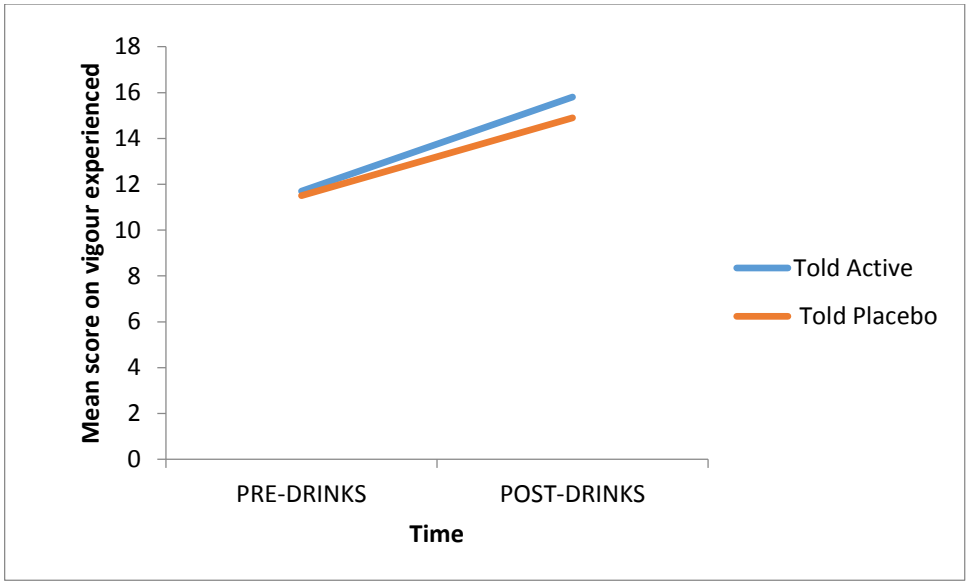

Figure 6-4 The interaction between time and condition on vigour experienced

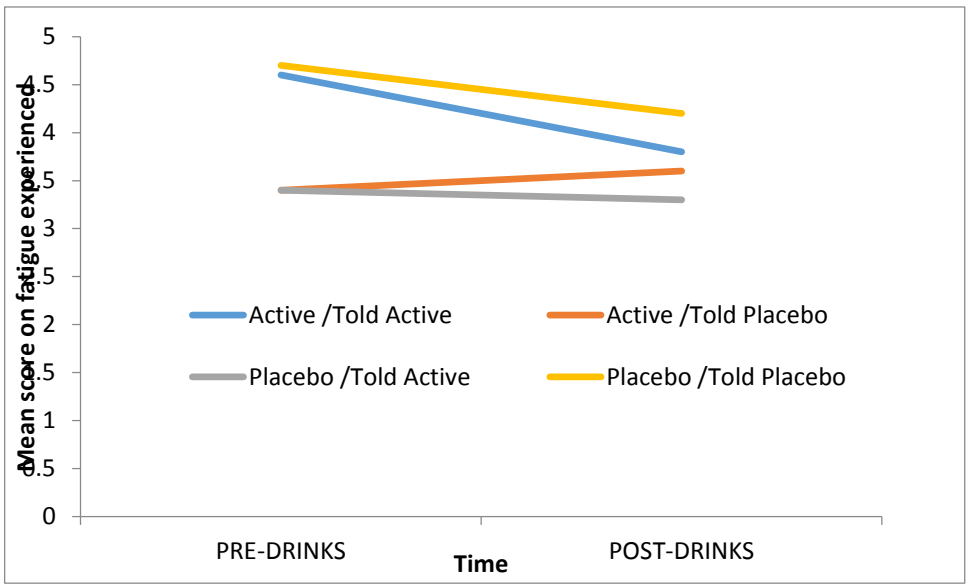

Figure 6-5 The interactions between time, ingredients and information given to the participants on fatigue experienced

For the complete analysis variance for all mood subscales please see Appendix (7.4). The significant outcomes for POMS questionnaire are represented in Table (6.5). The 2x2x2 analysis of variance conducted for POMS subscales and it was found there were four

significant interactions. There was a significant interaction for tension experienced between time and ingredients ($F(1, 59) = 23.01$, $p < 0.01$) with significant main effect found for time ($p<0.05$) indicating there was greater decrease in tension experienced when participants were given active the drink and told they are consuming the active drink overall, see Figure (6.2).

There was a significant interaction found for depression between time and information given ($F(1, 59) = 4.324$, $p < 0.05$) which has been indicated by figure (6.3). This suggests that a greater decrease in depression post active drink consumption compared to placebo drink regardless of information given, indicating a psychoactive effect rather than an expectancy effect.

There was a significant interaction for vigour experienced between time and information ($F(1, 59) = 8.706$, $p < 0.01$). Figure (6.4) indicated a greater increase in vigour under the 'told active' conditions compared to the told placebo, which was independent of the physiological effects on mood.

Analysis of the fatigue data revealed a significant time x ingredients interaction ($F(1, 59) = 8.185$, $p <0.01$) and a significant time x ingredients x information interaction ($F(1, 59) = 4.372$, $p < 0.05$), however, no main effects found for fatigue ($p>0.05$). Figure (6.5) indicates that there was a greater decrease in fatigue when participants were given active and told active compared to given active told placebo suggesting a reverse effect, suggesting the information effected participants overall fatigue levels irrespective of drink ingredient. For the placebo condition given placebo told active there was smaller decrease in fatigue experienced post drink consumption. However, for the condition given placebo told placebo, participants fatigue levels decreased, suggesting another possible reverse effect. Thus, the reverse effect indicated that information given to participants had somewhat significant effect on beliefs irrespective of drink ingredient. This interaction suggests there was a significant effect of information for the active drink conditions overall.

Looking at the significant interactions found for the mood subscales, hypothesis 4.2b was only accepted for vigour experienced, which indicated an expectancy effect. Whereas, tension drink consumption and fatigue had a significant effect of information for the active drink condition, but no expectancy effect found for these mood subscales. There were no other significant interactions found ($p>0.05$).

6.5 Multiple Regressions

4c. The TPB model components (attitude, subjective norms, perceived behavioural control and intentions) will predict the variance in the above expectancy effect as measured in the TPB questionnaire for cognitive tasks and mood subscales. Stepwise analysis was conducted to measure if the original TPB variables can predict intention as the criterion variable which are the dependent variables (attitude, subjective norm and perceived behavioural control) this was step 1 as these items are from the original TPB model, and then the following items were placed in consecutive steps for (belief, habit, past behaviour, slef-identity1 and self-identity2. The predictor variables were placed in the order of what variables were considered to have good predictive ability of the criterion variable based on partial F-tests (that is the t-tests). Thus the first predictors (attitude subjective norms and PBC) in the stepwise model are justifiable as they all have ($p < 0.05$). All the important predictor variables for predicting the criterion have been included and any predictor variable that had ($p > 0.05$) was eliminated. Furthermore, Cronbach's alpha analysis for all the constructs within the TPB questionnaire was conducted to test reliability of TPB questionnaire. To view the TPB questionnaire (please see Table 6-6).

In order to assess hypothesis 4c, initial examination of the relationships between the TPB components (attitude, subjective norms, perceived behavioural control and intentions) and the additional variables included in the TPB questionnaire (belief, habit, past behaviour, self-identity1 and self-identity2) were analysed using correlations (see Table 8-1 in Appendix 7.5). The correlation analysis indicated significant relationship between attitude and self-identity2 with intention variable (i.e., more likely the participant would consume a psycho-stimulant drink to enhance their performance). The variable attitude correlated significantly with all the variables (intention, subjective norm, PBC, belief, habit, and self-idenityt2) which all were significant at ($p < 0.01$), self-identity1 was significant at ($p < 0.05$) and variable measuring past behaviour did not significantly correlate with attitude ($p > 0.05$). Thus, the constructs included in the TPB questionnaire found attitude and self-identity2 were strongly related to intention to consume psychoactive drinks such as energy drinks and caffeine.

Overall it was found that self-identity2 significantly correlated with all the constructs in within the TPB questionnaire.

6.5.1 Predicting intentions using TPB questionnaire variables

It was acknowledged from the correlation analysis that attitude and self-identity2 correlated significantly with intention variable. However, conducting the stepwise regression found that the only significant variable to predict intention was for Step 6 which measured self-idenity2 ($F(6, 59) = 2.784$, $p = 0.012$), with the adjusted R square of 55.1% of the variance, suggesting participants identify with drinking energy drinks regularly. The following ANOVAs results were unsuccessful in predicting intention for Step 1 which measured (attitude, subjective norms and perceived behavioural control) was ($F(1, 59) = 0.860$, $p = 0.467$), Step 2 measured participants beliefs ($F(2, 59) = 0.924$, $p = 0.457$), Step 3 measured habit ($F(3, 59) = 0.984$, $p = 0.436$), Step 4 measured past behaviour ($F(4, 59) = 1.593$, $p = 0.168$), Step 5 measured self-identity1 ($F(5, 59) = 0.234$). The standardized Beta coefficient measures indicated only one predictor variable that was significant to have an effect on the criterion variable intensions which was Step 6, indicating the model improves by adding variables (see Table 6-6).

Table 6-6 Representing the Regression output for prediction on intention

	R^2	B	Significant level	p value
Step.1				
Attitude	0.210	-0.22	0.14	P > 0.05
Subjective Norm		-0.04	0.79	P > 0.05
Perceived Behaviour Control		0.38	0.07	P > 0.05
Step.2				
Belief	0.251	-0.41	0.07	P > 0.05
Step.3				
Habit	0.289	0.26	0.17	P > 0.05
Step.4				
Past Behaviour	0.391	-0.35	0.01	P >0.05
Step.5				
Self-Identity 1	0.396	-0.16	0.25	P > 0.05
Step.6				
Self-Identity 2	0.551	0.47	0.00	P < 0.01

6.5.2 Predicting expectancy effect for cognitive tasks using regression analysis

In order to determine whether the social-cognitive TPB variables can predict the level of expectancy effect in proposed variables (Recognition speed, Immediate verbal recall task (mean words correctly recalled from a presentation list of 20 words) for 1s and 2s presentation speed and Two-finger taping task) correlations between cognitive tasks and TPB variables were conducted for each task. For the correlation for Recognition word (see Table 8.2 in Appendix 7.5), Recognition speed (see Table 8-3 in Appendix 7.5), Immediate verbal recall for 1 second word presentation (see Table 8-4 in Appendix 7.5) Immediate verbal recall for 2 seconds word presentation (see Table 8-5 in Appendix 7.5), and for Two-finger tapping task (see **Error! Reference source not found.** 8-6 in Appendix 7.5). The

egression analysis was conducted for each task to assess whether TPB variables can predict expectancy effect (see **Error! Reference source not found.**). The mean difference was omputed in SPSS for each cognitive task for the drink conditions (‘*given placebo drink and told they are consuming a placebo drink*’ versus ‘*given a placebo drink and told they are consuming an energy drink’*), which were labelled as the expectancy mean difference and used as the criterion variable.

For the Immediate verbal recall task (mean words correctly recalled from a presentation list of 20 words) for 1 second word presentation correlated with attitude and subjective norms ($p<0.05$) and for 2 second word presentation there was highly significant correlation with attitude and habit ($p< 0.01$). Furthermore, there were no significant correlations found for the Two-finger tapping task and words recognised for the Recognition task ($p>0.05$) see (Tables 6.12 – 6.16 in Appendix 7.5).

In order to address the question of predicting expectancy for cognitive tasks, the initial examination of the relationship between TPB questionnaire variables and each cognitive task were made using correlations. TPB variables in the questionnaire found that self-identity1 correlated with recognition speed ($p = 0.05$) which accounted for 11.4% of the variance in the cognitive task (see Table 6.17). The multiple regression analysis found that the constructs from the TPB questionnaire were unable to predict expectancy for Recognition word was ($F(9, 59) = 1.406$, $p = 0.211$), Recognition speed ($F (1, 59) = 0.717$, $p = 0.691$), Immediate verbal recall task (mean words correctly recalled from a presentation list of 20 words) for 1 second word presentation ($F (9, 59) = 1.646$, $p = 0.128$), Immediate verbal recall task (mean words correctly recalled from a presentation list of 20 words) for 2 second word presentation ($F (9, 59) = 2.000$, $p = 0.059$) and for Two-finger tapping task ($F (9, 59) = 0.973$, $p = 0.473$). Therefore, hypothesis 4a was rejected in the present study which examined whether there is an expectancy effect on cognitive performance which could be predicted using the regression analysis ($p > 0.05$).

Table 6-7 Representing the summarised results of the multiple regression analysis for expectancy effect on cognitive tasks (n 60)

VARIABLES	*RECOGNITION TASK RECOGNISED WORDS*		*RECOGNITION TASK RECOGNITION SPEED*		*IMMEDIATE VERBAL RECALL TASK 1 SECOND WORD PRESENTATION*		*IMMEDIATE VERBAL RECALL TASK 2 SECOND WORD PRESENTATION*		*TWO FINGER TAPPING TASK*	
	B	R^2	B	R^2	B	R^2	B	R^2	B	R^2
ATTITUDE	0.84	0.05	20.76	0.03	-1.63	0.17	-1.67	0.17	0.91	0.05
SUBJECTIVE NORM	-0.44		-8.83		-0.37		-0.21		1.21	
PERCEIVED BEHAVIOUR CONTROL	0.51		6.05		-0.06		-0.12		-4.01	
BELIEF	0.78		8.33		0.47		0.53		4.28	
INTENTIONS	-0.54		-4.26		-0.57		-0.46		-1.17	
HABIT	-0.73	0.10	-1.96	0.04	-0.27	0.17	-0.78	0.20	-4.88	0.09
PAST BEHAVIOUR	-0.41	0.15	2.36	0.04	-0.16	0.17	-0.24	0.20	1.46	0.11
SELF-IDENTITY 1	-0.70	0.20	-17.32*	0.11	0.50	0.22	0.49	0.25	-1.48	0.11
SELF-IDENTITY 2	-0.08	0.20	0.32	0.11	-0.45	0.23	0.35	0.27	3.37	0.15

*p< 0.05, **p<0.01 correlations matrices which significantly correlate

6.5.3 Predicting expectancy effect for mood subscales using regression analysis.

In order to determine whether proposed mood variables can predict the level of expectancy effect a regression analysis was conducted. First the expectancy mean differences were computed for the proposed mood subscales (tension, anger, vigour, fatigue and confusion) for the after drink conditions (‘*given placebo drink and told they are consuming a placebo drink’* versus *‘given placebo drink and told they are given an energy drink’*) which were selected after conducting expectancy ANOVA for POMS. The mean expectancy differences were computed using the transform function in SPSS which were used in the regression analysis. The table of correlations between the mood subscales can be seen as follows; tension (Table 8-7 in Appendix 7.5), anger (Table 8-8 in Appendix 7.5), vigour (Table 8-9 in Appendix 7.5), fatigue (Table 8-10 in Appendix 7.5) and confusion (Table 8-11 in Appendix 7.5) for expectancy effect. Followed by a regression analysis was conducted by placing the listed mood subscales as the criterion variable.

The correlation analysis found subjective norms and perceived behavioural control correlated with tension ($p<0.05$) and with belief ($p<0.01$). There was also a significant correlation found for vigour for belief and habit ($p<0.01$). Finally there was a significant correlation with confusion and subjective norm ($p<0.05$). These correlations suggest that there is some relationship between TPB variables with mood scales in predicting expectancy. There were no other significant correlations found ($p>0.05$) (see Tables 8.7 -8-11)

Looking at the multiple regressions for the mood subscales (tension, anger, vigour, fatigue and confusion) there were only two significant models which emerged which were for vigour activity and confusion. The Adjusted R square for vigour activity was 18.7% of the variance ($F(9, 50) = 2.505$, $p = 0.019$) indicating participants habits and self-identity were significant predictor variables for expectancy effect in vigour experienced by participants, although the whole model was significant only for habit and self-idenitity2 which were significant individual predictors. The Adjusted R square for expectancy in confusion was 9% of the variance although the Anova was non-significant ($F(9, 50) = 1.648$, $p = 0.127$). Similarly, the adjusted R square for expectancy in fatigue was 3% of the variance indicating that subjective norm and belief had significant predictor variables expectancy effects in fatigue,

however Anova was found to be non-significant (F(9, 50) = 1.212, p = 0.309). Tension and anger were not significant predictors for expectancy effect (p>0.05) (see Table 6.24).

The multiple regression analysis indicated that the TPB questionnaire identified two variables past-behaviour and self-identity2 that account for 19.5% of the variance in predicting intentions. Furthermore, there were two variables identified habit and self-identity2 which accounted for 18.7% of the variance in predicting vigour activity participants may experience when they consume the experimental drink conditions '*given placebo drink and informed they are consuming an energy drink*' indicating an expectancy effect.

Table 6-8 Representing the output for expectancy effect of mood

Variables	Tension		Anger		Vigour		Fatigue		Confusion	
	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2
Attitude	-0.16	0.14	-0.32	0.08	-0.10	0.15	0.08	0.10	-0.45	0.19*
Subjective Norm	0.20		-0.03		-0.04		-0.37*		0.05	
Perceived Behaviour Control	0.06		-0.05		0.01		0.01		0.14	
Belief	0.18		0.18		0.19		0.51*		-0.27	
Intentions	0.04		-0.08		0.19		0.16		0.02	
Habit	-0.06	0.15	0.10	0.08	0.40	0.23*	-0.30	0.13	0.13	0.21
Past Behaviour	0.25	0.19	-0.24	0.10	-0.08	0.25	-0.23	0.16	0.04	0.21
Self-identity 1	-0.20	0.22	-0.01	0.10	0.18	0.26	0.18	0.18	0.15	0.22
Self-identity 2	0.10	0.22	0.21	0.13	0.32	0.31*	0.01	0.18	-0.15	0.23

*p<0.05 significant impact of predictor variable on criterion variable

Looking at the overall analysis for predicting expectancy effect, it was evidential that 18.7% of the variance predicted expectancy effect in vigour. Although confusion accounted for 9% and fatigue accounted for 3% of the variance in predicting expectancy effect for these mood subscales, the analysis of variance was non-significant, therefore based on these results predicting expectancy effects in confusion and fatigue appear to offer little additional predictive power beyond that contributed by the predicted expectancy effects in vigour. Furthermore, 11.4% of the variance accounted for self-identity1 predicting expectancy effect in the Recognition task for speed recognition only, indicating participant's energy drink behaviour correlates with recognition memory. Furthermore, it was found that self-identity2 correlated with all the constructs from the TPB model with 55.1% of the variance accounting for participant's intentions to drink energy drinks regularly. There were no other significant expectancy effects predicted for mood and cognitive tasks ($p>0.05$). Thus, the constructs self-identity1 and self-identity2 significantly correlate with TPB variables to predict intentions or expectancy effect overall.

6.6 Discussion

The overall findings for the present experiment indicated that there was an expectancy effect found for mood. In particular vigour activity, as participants portrayed enhancement in vigour activity when they were informed they were consuming a psychoactive drink irrespective of drink ingredients. It was also acknowledged that participants' performance was better when they consumed the psychoactive drinks irrespective of information given prior to consumption about the drinks, suggesting caffeine and glucose have cognitive enhancing properties. There was a significant expectancy effect and reverse effect found for the immediate verbal recall task for the two second word presentation, indicating the information given prior ingestion had a positive effect on performance. However, there were no other significant expectancy effects found for remaining cognitive tasks. The multiple regression analysis for the cognitive tasks indicated that expectancy response could not be predicted using the variables from the TPB questionnaire. The multiple regression conducted with intention as the criterion found that past behaviour and self-identity significantly predict a participant's intentions. Furthermore, the multiple regression analysis conducted for mood subscale vigour activity found habit and self-identity2 to significantly predict expectancy effect.

Expectancy effects on cognitive tasks and mood subscales:

The analysis of variance testing the first hypothesis in this chapter 4a. indicated there will be an interaction between ingredient and information, such that participants performance levels for (Two-finger tapping task, Immediate verbal recall and the Recognition task) will be enhanced for given a placebo drink and told they are consuming an active ingredient drink, compared to when they consume a placebo drink and told they are consuming a placebo, where participants performance will not indicate significant improvement (This hypothesis is testing for expectancy effect). This study assessed whether there is any difference on cognitive performance and sensorimotor movements when participants were '*given a placebo drink and told they are consuming a placebo drink' versus 'given a placebo drink and told they are consuming an energy drink*'. Thus there were no significant main effects found on drink consumed and information given about the drink prior ingestion on overall performance. The findings from the present study are consistent with the previous three experiments where there was significant expectancy effect found for Immediate verbal recall. However, no expectancy effects found on cognitive performance and sensorimotor movement irrespective of having thirty minutes for absorption time compared to the previous three experiments in this thesis where participants were given twenty minutes only. As additional ten minutes was given for absorption this had no effect on overall performance and mood (Giles et al., 2012).

Conversely, the second hypothesis 4b. suggested there will be an interaction between ingredient and information, such that participants mood subscales (vigour increasing, tension and fatigue decreasing) a placebo drink and told they are consuming an active ingredient drink, compared to when they consume a placebo drink and told they are consuming a placebo drink (This hypothesis is testing for expectancy effect). Experiment 4 had measured whether there would be an expectancy effect on mood subscales when participants were '*given a placebo drink and told they are consuming a placebo drink' versus 'given a placebo drink and told they are consuming an energy drink*', found overall participants felt less tense and confused after consuming the experimental beverage irrespective of drink information given prior ingestion. Whereas, there were significant interaction found for vigour activity experienced suggesting participants felt less anger and more vigorous for the drink condition 'given placebo drink and told they are consuming an energy drink', indicating an expectancy

effect. Although, the second hypothesis had hypothesised that the mood subscales tension and fatigue levels would decrease and vigour levels would increase as there would be a difference between the two placebo drink conditions was rejected for tension and fatigue, but accepted for vigour activity.

The findings for possible expectancy effects for both cognitive and mood for the present study have been consistent with the previous two experiments in this thesis, which assessed expectancy effects. Although, participants were given additional thirty minutes to digest the drink compared to the previous three experiments were participants were given only twenty minutes had no effect on overall cognitive performance but had somewhat effect on general mood.

Psychoactive effect versus placebo effect on overall cognitive performance and mood subscales:

The analysis of variance conducted for mood subscales found that there were three significant interactions indicating psychoactive effect of drink and information for vigour and fatigue, whereas, participants felt less depressed when they were under the impression they have consumed a placebo drink compared to an energy drink suggesting a reverse placebo effect.

The analysis of variance conducted for cognitive tasks and sensorimotor movement found there was a significant psychoactive effect 'given an energy drink and told they are consuming an energy drink' on the Recognition task speed. It was found that overall participants recalled more words from the 2 seconds word presentation list compared to the 1 second word presentation list for the immediate verbal recall task. However, there was a reverse placebo effect found for Immediate verbal recall task as participants recalled more words from the drink condition '*given an energy drink and told they are consuming a placebo drink*'. This may have been due to the fact participants felt they are required to put more effort towards a task as they are under the assumption they are consuming a non-active drink compared to when they were informed they are consuming an active drink.

The previous experiments in this thesis have not found significant psychoactive effects, but there was a significant reverse placebo effect found for the Two-finger tapping task in Experiment 2. Thus, there have been two occasions were there has been a reverse placebo

effect were participants have performed better on tasks when they are under the impression they are consuming a placebo beverage, suggesting the successful manipulation of information given prior drink ingestion which influences performance. The reverse placebo effect may have risen due to participants being aware of achieving undesirable effects after receiving inactive drink creating pessimistic beliefs of potential performance. Having such beliefs may have motivated the participants to perform better to achieve a desirable outcome behaviour (Colloca & Miller., 2011).

TPB variables predicting intention and expectancy effect:

The current experiment investigated and extended on the previous three experiments in this thesis by examining the effects of TPB model components and whether they can be used to predict expectancy effect. The phenomena of expectations are either positive or negative, which can modulate behaviour depending on participants' experiences and expectations of consuming psychoactive beverages. Assessing the constructs in the TPB model would confirm the strong predictors of intentions and expectancy effects in cognition and mood, and which constructs have no impact on these expectancy effects. Thus the third hypothesis 4c in the present study examined the TPB model components (attitude, subjective norms, perceived behavioural control and intentions) and the additional components included in the questionnaire (belief, habit, past behaviour and self-identity) will predict the variance in the above expectancy effect (that is, the variance in the amount of difference between given placebo told energy drink and given placebo drink told placebo drink) as measured by the TPB questionnaire. This hypothesis assessed whether the TPB model components (attitude, subjective norms, perceived behavioural control and intentions) will predict the variance in the above expectancy effect as measured in the TPB questionnaire for the cognitive tasks and mood subscales. This was analysed using multiple regression analysis. Throughout this thesis there has been some indication that manipulative information influences participants' perception of experimental drink consumption on mood irrespective of drink ingredients. The constructs from the TPB model were placed as the criterion variables to measure expectancy effects in cognitive tasks and mood subscales.

The correlations between cognitive tasks and TPB variables were significant for the immediate verbal recall task only with attitude, subjective norms and habit. There were no significant correlations found for the other cognitive tasks and TPB variables and the

regression analysis was unsuccessful in predicting expectancy effect. Similarly, for the mood subscales the correlation analysis found significant relationship between tension and subjective norms, perceived behavioural control and belief. There was significant relationship between vigour, belief, and habit. Lastly there was a significant correlation between confusion and subjective norms.

The findings from the current experiment have not indicated significant relationship between participants' attitude, subjective norms, and perceived behavioural control in predicting intentions. However, the additional variables included in the TPB model (belief, habit, past-behaviour, self-identity1 and self-identity2) found that past behaviour and self-identity2 predicts intentions. The relationship between past behaviour and intentions suggests that past behaviour can predict future intentions when psychoactive beverage consumption has taken place. It also points to the idea that past experience of consuming energy drinks may have had some degree of negative or positive effect on performance and overall experience, which mediates future intentions of consuming such beverages. Self-identity2 refers to participants who claim '*they are the type of person who just drinks energy drinks*', which also could mediate future intentions depending on how strong or weak the participant's self-perception towards psychoactive ingredients may be. Furthermore, the findings from the regression analysis identified the variables habit and self-identity2 account significantly for the model variance in predicting expectancy in participants vigour activity experienced, suggesting a possible expectancy response. Habit refers to how often participants consume psychoactive drinks and how participants associate the consumption to outcome behaviour and expectancy response. Suggesting, habitual consumers are likely to experience positive mood changes after consuming psycho-stimulating beverages in comparison to non-habitual consumers. Lastly, for confusion the Adjusted R square was 9% of the variance indicating participants attitudes were significant predictors for expectancy in confusion. This indicates that participants attitude towards experimental drinks significantly influences the expectancy effect in confusion experienced. The other variables within the TPB model and questionnaire did not indicate any form of variance on intentions.

A study was conducted by Norman (2011) to assess the constructs in TPB that predict binge drinking intentions and behaviour among undergraduate students. This study measured whether habit strength explained additional variance in binge drinking behaviour. The TPB model found attitude predicted 75% of the variance in binge drinking intentions with self-

efficacy predicting 35% of variance for intentions. Habit was found to make up additional variance of 6% with intentions being the significant predictor. It was concluded in this study that binge drinking was under the control of both intentions and habitual processes. In order to reduce binge drinking among undergraduate students it was suggested that interventions should be designed which focus on the motivational determinants (i.e. positive or negative) consequences of binge drinking as well as environmental factors (i.e. contextual cues) that promote binge drinking. Thus, in the present study indicated habit and self-idendity2 to be individual significant predictor variables for vigour with 18.7% of the variance predicting expectancy. Habitual consumers of psychoactive stimulants are likely to portray significant correlation and variance psychoactive consumption behaviour in predicting possible expectancy effect using the TPB model. However, there is a possibility that the participants who took part in the experiment may not have been habitual consumers and therefore may be confounding variables.

There have been numerous studies which have successfully applied the TPB model to predict behavioural intentions. For instance, Stone et al (2010) employed the TPB model to predict academic misconduct intentions and behaviour. Although the present study was successful in identifying a significant model with variables such as past behaviour and self-identity predicting intentions, there is somewhat an association to previous knowledge and experience, which can modify future behaviour. For instance, if an individual is familiar with the effects of consuming energy drinks or in general psychoactive beverages, they are more prone to experience a positive or negative expectancy effect from consumption in comparison to someone who has no previous exposure to psychoactive drinks.

Previous research has suggested that TPB model can be deployed in a questionnaire to predict intentions and behaviour outcome. In the present study this concept was used to predict expectancy response. However, the analysis outcome for cognitive task did not portray significant expectancy effects for placebo drink conditions, whereas, the TPB model was able to predict expectancy effect in vigour activity by examining participants habits and self-identity2. Although the multiple regression analysis indicated intention can be predicted by examining participants past behaviour and the purpose of drinking energy drinks, however, this does not support the prediction of expectancy effect.

While, the present study recruited a significant sample size, it may be that the participants who signed up to the study were not habitual psychoactive consumers, even though this was a key requirement for recruitment. It is highly possible that participants signed up to the study for module credits disregarding the study's inclusion criteria for their own benefit. Conversely, participants who signed up may have been habitual consumers of psychoactive drinks but perhaps not caffeine or energy drinks but habitual tea drinkers. It is very difficult in such research to ensure all participants adhere to the inclusion criteria. Perhaps it would be ideal to run a diary study of participants drinking habits two weeks prior to experimental testing to have a meaningful understanding of participants drinking behaviour and mood.

6.7 **Conclusion**

In conclusion, the present findings concur with previous experiments within this thesis that have explored expectancy effects in relation to psychoactive consumption. All four studies have not found significant expectancy effects on sensorimotor movement in general cognitive performance and mood when psycho-stimulating beverages containing caffeine and glucose were consumed. Although, there have been some findings which suggest possible expectancy effects, nevertheless these findings are ambiguous and are not conclusive to support all given hypotheses. The TPB model identified that intention can be predicted by two of the constructs within this model; past behaviour and self-identity and the analyses also identified that expectancy effect in vigour activity can be predicted by habit and self-identity. However, the TPB model with the additional constructs included was unable to predict expectancy response significantly for cognitive performance. Thus, the present study findings suggest that consumption of psychoactive beverages such as caffeine and glucose have enhancing effects on mood and cognition, irrespective of what information is given to participant's prior consumption. Furthermore, having a better understanding of participants' past experience, salient beliefs and habitual processes, may help predict future expectancy response. Thus, proposed revisions to TPB model and questionnaire are required keeping in line with rational expectation that TPB model contributes to several constructs which could be utilised in predicting expectancy effect. This model can be refined for habitual psychoactive consumers who have knowledge, past experience, salient beliefs, attitudes associated with regular consumption of psychoactive drinks containing caffeine and glucose on daily performance and mood. Further work is needed to confirm such predictions and findings, to determine and identify casual mechanism by which consumers set expectancy effects of consuming energy drinks, or any other psycho-stimulating beverages.

Chapter 7: OVERALL DISCUSSION

This thesis explored four small series of studies which aimed to systematically investigate the various psychological factors that can affect cognitive performance and mood upon consumption of psychoactive beverages such as energy drinks. The first objective was to examine the effects of psychoactive ingredients, caffeine and glucose independently and then in combination as an energy drink in order to rule out any differences between caffeine and glucose upon cognition, sensorimotor movements and mood. Secondly, this thesis also aimed to investigate whether expectancy effects enhanced cognitive performance and mood or whether this was due to previous exposure, familiarity, salient beliefs or positive manipulative information during the experiment in regards to the drink and branding of products. Lastly, this thesis utilised and evaluated The Theory of Planned Behaviour Model, to measure whether this model could be modified to predict expectancy responses. These research themes were tested and measured across four experimental studies, and findings are summarised as follows (see **Error! Reference source not found.**).

Table 7-1 Representing the summary of all effects found in all four experiments within this thesis

	Experiment 1: Examining the independent effects of caffeine and glucose and their placebo drinks on cognitive performance and mood	Experiment 2: Examining the effects of caffeine and glucose as a combination and their placebo drinks on cognitive performance and mood	Experiment 3: Examining the effects of energy drinks and their placebo drinks on drink presentation, 'branded bottle versus glass' on cognitive performance and mood	Experiment 4: Predicting expectancy effect using TPB model when energy drinks and their placebo drinks are consumed
Psychoactive effects	Active caffeine drink consumption indicated significant number of correct hits on Bakan task. Caffeine consumption had decreased tension and anger levels post drink and increased vigour experienced. However, active glucose consumption had increased anger and reduced vigour experienced post drink.	Blood glucose levels increased when energy drinks were consumed. Tension levels decreased for the drink condition given active and told active, but increased when given active but told placebo. Suggesting possible psychoactive and expectancy effect. Similarly, confusion levels decreased when given active and told they are consuming active, indicating a psychoactive effect overall. Participants' mood before drink was relative low therefore there was not much change post drink. No psychoactive effect found on cognitive performance.	No psychoactive effect found for cognitive tasks when energy drink was given in glass or branded bottle. Significant interactions found for tension, anger, vigour and fatigue indicating psychoactive effects for energy drinks consumed from a glass and bottle.	Significant interaction found for mood subscales tension, depression, vigour and fatigue indicating psychoactive effects as overall information given (told active/ told placebo) had no effect on drink consumed.
Expectancy effects	This experiment was designed to assess psychoactive effects of caffeine and glucose independently only.	There was significant interaction between drink (active/placebo) and information given (told active/ told placebo), indicating an expectancy effect when participants were given placebo drink and told they are consuming an active drink on the task, immediate verbal recall task for 1 second presentation list. There was an noticeable effect found of information given prior ingestion on the Two-finger tapping task for the drink condition 'given *placebo drink and informed they are consuming a placebo drink'*. Participants tapped faster for this drink condition compared to '*given placebo drink and informed they are consuming an energy drink*'.	No expectancy effects found for drink and drink presentation on cognitive performance and mood.	Expectancy effect and reverse effect found for the task Immediate verbal recall for 2 second presentation list. Participants recalled more words when given active/told placebo and also for given placebo/told placebo drink. No other significant interactions found for cognitive tasks. There was significant effect of information given on the mood subscale vigour, when given placebo/told active indicating a expectancy effect.
Reverse placebo effect	No	There was a reverse placebo effect for Two-finger tapping task as participants tapped faster when they were under the impression they are consuming a placebo drink.	No	Participants recalled more words in the Immediate verbal recall task when they were given active/told placebo and for the drink condition given placebo/told placebo suggesting a reverse placebo effect.
Random variation effect	No	No	No	
Any other effect found	-	-	-	TPB questionnaire identified two variables past-behaviour and self-identity2, which accounts for 55.1% of the variance in predicting intentions. Habit and self-identity2 accounted for 18.7% of the variance in predicting expectancy effects in vigour for the drink conditions '*given placebo drink and informed they are consuming an energy drink*' indicating an expectancy effect.

According to Glade (2010), caffeine is a stimulant, which arouses consumers emotionally and physically, whereas glucose has been considered as a primary source of energy and fuel for the brain. Before any expectancy effect could be investigated, it was important to understand the actual effects of these psychoactive ingredients independently. Experiment 1, examined the ingredients caffeine and glucose independently using within subjects placebo design without any form of manipulation. It was expected that inhibiting manipulation would indicate the actual effects of the psychoactive ingredients of caffeine and glucose on cognitive performance and mood. Experiment 1 had found that caffeine consumption had reduced the mean scores for tension, anger and increased vigour experienced overall. However, there were no significant effects found that indicated glucose drink had affected mood. Glucose consumption had indicated an increase in tension levels and anger levels which is not in line with previous studies by Donohoe et al., (2000) and Green et al., (2001).Furthermore, the cognitive task findings for Experiment 1 indicated glucose had no effect on cognitive performance. Caffeine consumption indicated significant effect on the Bakan task as participants made correct hits over the course of task, which is in line with Elliman et al., (2010); Koppelstaetter et al., (2007); Hewlett et al., (2001), who all reported caffeine consumption enhancement on the Bakan task as alertness, concentration, vigilance and reaction time when caffeine drinks were consumed. Thus, reflecting on all four experiments within this thesis, there has been a consistent trend of psychoactive effects relative to expectancy effect on cognitive performance. Although the psychoactive effect confirms the stimulating properties of consuming psychoactive drinks containing glucose and caffeine, there is no significant indication of placebo expectancy effects in cognitive performance or predicting expectancy in cognitive tasks. This may have been due to various limiting factors such as participants having lower expectations of consuming the experimental drinks, first time consumers of energy drink and therefore may not have enjoyed the taste of experimental drink or the sample size for the first three experiments should have been larger overall.

Malinauskas et al., (2007) found that over half of the student population rely on energy drinks as stimulating drink to consume throughout education, in order to stay alert, reduce symptoms of hangover, fatigue and increase energy (Attila & Cakir, 2011). Experiment 2 was designed to examine the extent of the effects of consuming an energy drink containing (caffeine and glucose) as a combination on cognition, sensorimotor movement and mood,

and whether this was mediated by expectancy when participants consume the placebo beverage. Experiment 2 found that blood glucose levels increased from baseline after experimental drink consumption, with greater increase in blood glucose levels when the energy drink was consumed, which is in line with Donohoe & Benton (2000) study. Tension levels decreased when energy drink was consumed and when participants were informed they are drinking energy drink in comparison to when they were given the energy drink and informed they are consuming a placebo drink, which indicated a possible expectancy effect. Tension increased when participants consumed the placebo drinks irrespective of what they were informed indicating there was a psychoactive effect on tension levels irrespective of manipulative information. However, the analysis of variance did find a significant interaction between drink (active/placebo) and information given (told active/ told placebo) on Immediate verbal recall task for 1 second word presentation, indicating an expectancy effect, as participants recalled more words when they consumed a placebo drink and informed they are consuming an active drink. Similarly, for the Two-finger tapping task, the mean speed for tapping was fastest for given placebo and told placebo compared to given active and told active indicating a reverse effect, although there were no significant findings. Experiment 2 findings were ambiguous due to the small sample size and therefore did not confirm expectancy effects of consuming the experimental drinks, which manipulate participants' beliefs to enhance cognition and mood.

Consumption of psychoactive drinks has been associated with specific expectations, which trigger different response outcomes, which are independent of the psychoactive consumed (Kirsch, 2004). Thus creating unambiguous expectancies, which are dependent on the manipulative information provided to the participants. Although, participants were given manipulative information (i.e., given placebo drink and informed they are consuming an energy drink) would induce expectancy effects, however, this was not the case. Perhaps participants could taste the difference between the active drink and placebo drink. In contrast previous research by Scholey and Kennedy (2004), found consuming energy drinks in combination of other ingredients such as ginseng and ginkgo biloba along with caffeine and glucose are considered to create enhancing effects in cognition. Perhaps measuring caffeine and glucose in combination was not effective enough to enhance participants' performance.

Kirsch (2004) found there is a growing acceptance of expectation as the basic concept for placebo effects, which has led to the understanding that beliefs influence placebo effects,

which mediate expectancy response. For instance, each individual holds salient beliefs, which are either extrinsic or intrinsic towards a particular product or substance. These salient beliefs activate response expectancies, which shape behavioural outcome. If a participant's belief towards a Lucozade drink were positive, this would mediate positive expectancy response and favourable behavioural outcome in comparison to a non-familiar branded drink where they may hold a negative belief.

Experiment 3 aimed to examine the extrinsic factors influencing expectancy effect and in this case the extrinsic factor was drink presentation. The experimental drinks were presented to the participants in a branded Lucozade bottle and from a glass with no additional information. This was tested using four different conditions (active drink in a branded bottle, placebo drink in a branded bottle, active drink in glass and placebo in glass) to measure whether drink presentation, irrespective of drink content affects overall cognitive performance and mood which is triggered by expectancy response. However, Experiment 3 was unsuccessful in representing significant expectancy effects of drink presentation on cognition and mood. It was found that overall energy drink improved mood such as anger, levels decreased post active drink consumption, indicating psychoactive effect of drink overall. In contrast, it was found that when participants consumed the placebo drink from the branded bottle, tension levels increased in comparison to when they consumed the energy drink from the branded bottle were tension levels decreased suggesting drink presentation triggers salient beliefs of positive effects of consuming beverages from highly reputed branded bottled drinks. Overall, tension levels reduced for three of the conditions, which included both the glass presentation conditions and only increased for given placebo in a branded bottle.

Experiment 3 found participants performed better when they consumed a placebo drink in bottle compared to consuming the placebo drink from glass, indicating salient beliefs influence performance and expectations. Though drink presentation indicated better performance overall for cognitive tasks and mood irrespective of drink content, there was no difference between active and placebo drink distinguished. Furthermore, the analysis conducted to assess the psychoactive effects found no effect on cognition but there was a significant effects found for mood subscales tension, anger, fatigue and confusion, which has been consistent in the previous two experiments, indicating that caffeine and glucose have stimulating effects on mood.

As the previous three experiments were ineffective in facilitating expectancy effect, Experiment 4 was designed to observe whether participants' beliefs, past experience, attitude, habits, subjective norms, perceived behaviour control, intentions and self-identity, play a role in predicting expectancy response when consuming a psychoactive drink. It was found in Experiment 4, mood improved positively when participants consumed energy drinks and when participants were informed they are consuming an active drink, indicating psychoactive effect. For instance, tension levels, depression, fatigue and confusion experienced all decreased when participants consumed energy drinks. There was a significant expectancy effect found for enhancement in vigour activity, as participants' portrayed greater increase in vigour activity when they consumed placebo drink and informed they are consuming an energy drink indicated an expectancy effect. The cognitive task, immediate verbal recall for the 2 second word presentation indicated an expectancy effect and a reverse effect. It was found that participants recalled more words when they were given the active drink and told they are consuming a placebo drink, and for the drink condition given placebo and told they are consuming a placebo drink respective. Possible expectancy effect for immediate verbal recall task is consistent to Experiment 2, as participants also recalled more words when given placebo but told they are consuming an active drink. These findings may be due to either participants focusing more on the cognitive tasks or there may be other limiting factors such as detectable taste difference, or simply because caffeine and glucose had enhancing properties which improved participants performance. Conversely, participants are conscious they are consuming a placebo drink and are trying their best to perform better in the given cognitive tasks.

A person's attitude towards performing a particular behaviour is likely to be positive if that person perceives that there are positive outcomes resulting from the behaviour (i.e., consuming an energy drink will enhance my performance). Thus, favourable attitude is likely to increase a person's intention to participate in a given behaviour. Many studies have found attitude has been consistently correlated with intention an is a good predictor of intention (e.g., Norman, Conner & Bell., 2000; Rhodes, Jones & Courneya, 2002; Brickell, Chatzisarantis & Pretty, 2006; Rhodes, Macdonald & McKay, 2006; Everson, Daley & Usher, 2007). Attitude has been considered as significant predictor compared to subjective norms and perceived behavioural control of various behaviour intentions such as exercise, dieting, smoking and binge drinking (Hagger, Anderson, Kyriakaki & Darkings, 2007).

Thus, the more favourable one's attitude (be it instrumental or affective) towards drinking energy drinks, the greater likelihood of that individual to engage in psychoactive drinking behaviour.

The multiple regression analysis was conducted to measure whether the TPB questionnaire could be utilised to predict intentions. It was found that there were two constructs which could predict participants intentions of consuming psychoactive beverages which were, past behaviour (*e.g., how often do you consume coffee, tea, energy drinks, water in a day / week)* and self-identity (*e.g., I am someone who consumed energy drinks, I am someone who consumes energy drinks to stay alert*). These constructs were significant predictors of intentions if participants were habitual psychoactive consumers, as the final experiment intended to recruit habitual psychoactive consumers only as this was made apparent in the inclusion criteria of the experiment. The multiple regression analysis was used to examine whether the TPB questionnaire could be used to predict expectancy response on cognitive tasks. However, there were no significant expectancy findings for any of the cognitive tasks and therefore it was implausible for the TPB model to predict expectancy response.

Conversely, there was a significant expectancy effect found for the mood subscale vigour. It was found that habit and self-identity2 accounted for 18.7% of the variance in predicting expectancy in vigour. It was also acknowledged that attitude accounted for 9% of the variance for predicting expectancy in confusion and furthermore, subjective norm and beliefs accounted for 3% of the variance in predicting expectancy effect in fatigue. However, the mood subscales confusion and fatigue had a lower statistical power in predicting expectancy in these mood subscales respectively. Findings for Experiment 4 had indicated a trend with the previous three experiments, as there were no significant expectancy effects derived for cognition. However, the TPB model had significantly indicated that habit and self-ideneity2 were significant predictors of expectancy effects in the mood subscale vigour. It was found that TPB model could predict intentions using two constructs, past behaviour and self-identity2. Hoie et al (2009) used the TPB model to predict smoker's intentions and it was found that intentions could be predicted by past experience and behaviour, which accounted for 12.3% of the variance in the intention of participants quitting smoking. Conversely, the present experiment also found past behaviour and self-identity2 accounted for 19.5% of variance in predicting intentions for habitual consumers of psychoactive beverages. Moreover, the variance for habits and self-identity2 predicts

expectancy effects vigour activity, which accounted for 18.7% of variance, suggesting that familiarity of energy drinks creating either positive expectation of outcome response of consuming energy drinks.

Self-identity is generated by the participant's personality traits, which are associated with positive or negative expectations of consuming psychoactive drinks (Jaksic et al., 2013). Personality traits have been found to interact with the mechanism of expectancy, were participants are either pessimistic or optimistic which affects participants behaviour in terms of either avoiding harm, novelty seeking, reward dependence or confidence enhancing when they consume certain pharmacological or psychoactive substances (Stein, 2008; Jaksic et al., 2013; Aukst-Margeti & Jakovljevic, 2013). Whereas, for past experience perspective, placebo or nocebo effects may be associated to three signs: icons (observations), indices (conditioning) and symbols (communication), which transform perceptions of signs into placebo or nocebo responses (Collac & Miller, 2011b). This occurs when information portrayed by the signs acknowledged triggers responses which are translated by the human brain neural network by generating specific experience, expectancy and behaviour Collac et al., 2011b). Experiment 4, indicated that past behaviour was a significant predictor of intentions, which suggests that participants past experience of consuming psychoactive drinks signs were all triggered either by positive or negative expectations of energy drinks. Although participants were informed they are consuming an energy drink and were presented the experimental drink in a clear glass, participants would have either believed or not believed the experimenter as there was no bottle branding to trigger previous knowledge and experience. Furthermore, if participants drank a particular brand of energy drinks, they may have tasted other energy drinks in order to find the drink, which offers them the best cognitive enhancement. Therefore, if the experimental drink triggered negative expectations due to taste, this would modify the participant's attitude and belief, which would affect overall outcome behaviour.

Previous studies have found attitudes to be consistent predictors of intention to binge drinking (Murgraffe et al., 2001; Johnston & White, 2003; Norman & Conner, 2006). A study by Cooke et al (2006) examined whether extending the TPB model could be used in predicting binge-drinking behaviour by examining the impact of attitude and anticipated regret. This study found ($\beta = 0.30$) for attitude and ($\beta = 0.47$) for anticipated regret were significant predictors of intentions accounting for 58% of the variance. It was concluded

that modifying attitudes and inducing regret may be effective strategies for reducing binge-drinking intentions among students. Taking previous studies into account, which have found participants intentions to significantly correlate with attitude, provides an understanding, which can be used to design interventions, which encourage students to drink without binge drinking. Similarly, Experiment 4 found past behaviour and self-identity2 were significant predictors of intentions, whereas, habit and self-identity2 were significant predictors of expectancy for vigour. Although attitude accounted for 9% of the variance in predicting expectancy effects in confusion but the analysis of variance was non-significant which was unfortunate, as manipulating attitude in order to predict expectancy effects in energy drinking behaviour on a larger scale. This could be assessed if participants' were followed up one-month later to evaluate whether expectancy effects can be predicted using TPB model with extended additional variables as it has been done in Experiment 4. Energy drinking behaviour is very popular among student population and understanding their attitude and beliefs towards energy drinks. Energy drinks, such as Lucozade, are often marketed to improve brain function as well as athletic performance. It would be important to investigate whether branded energy drinks actually improve performance due to the psychoactive ingredients caffeine and glucose or can expectancy effects among habitual consumers create such effects. Expectancy effects can only be measured on habitual consumers as participants associate product branding, past experience, and learnt knowledge of consuming energy drinks with either positive or negative experience. Thus, the TPB model constructs are suitable measures in predicting expectancy effect in energy drinking behaviour.

The phenomenon of positive or negative expectations modulates behaviour, which is dependent upon previous experiences. Pervious experiences therefore influence our expectations, whether an outcome would be positive or negative. For instance, having expectations of a beverage from a reputed branding (i.e., Lucozade) would modulate the consumer's previous experience of consuming this drink and recall whether this energy drink had a positive or negative outcome. This concept therefore creates expectation in the participants to the appropriate behaviour to ensure they receive reward (i.e., have the focus to recall more words when they complete the Immediate verbal recall task (mean words correctly recalled from a presentation list of 20 words)). In order to ensure future reward acquisition, this is mediated by the neuronal circuits linking to cognitive, emotional and motor responses (Kalivas et al., 1999; Mogenson and Yang, 1991; Tom et al., 2007).

Nevertheless, expectancies modify experiences and perceptions of events therefore it is not just motivated behaviour. There has also been evidence of a biological change in when an individual expects a reward, which causes changes in the dopamine levels and in the present thesis it was consistently found participants' mood had positively improved after psychoactive drink consumption irrespective of information given (De La Fuente-Fernandez, 2004).

Though, there have been some findings throughout this research, which suggest possible expectancy effects, these findings were ambiguous and therefore not conclusive to support all given hypotheses. Thus, the present thesis has a number of limitations that should be noted. First, the sample sizes for Experiments 1 – 3 may not have been statistically significant to portray significant expectancy effects, but there were some significant effects found for mood subscales tension, vigour and fatigue when psychoactive drinks were consumed and also for Bakan task, and immediate verbal recall task. However, for Experiment 4 the power of statistical analysis was calculated indicating minimum of sixty participants were required to detect any difference within experiment. However, having recruited sixty participants, there was no indication of expectancy effect in Experiment 4 for cognition, but there was for mood. This may have been due to the fact that the psychoactive effect was more influential than the expectancy effects overall, which enhanced performance due to the psychoactive properties (caffeine and glucose) within the energy drink. Although expectancy effects were found for mood subscales, this may have been created by the manipulative information given prior drink consumption where participants created either positive or negative expectations prior consumption, of how the experimental drink would make them feel. If participants create positive attitude and beliefs towards the energy drink by associating with previous experience, they will encounter positive mood changes. Whereas, participating in cognitive tasks, which they are not familiar with, may create negative expectations or the participants may have low self-efficacy, which creates negative expectations towards performance. By the third or fourth attempt of participating in the cognitive tasks, participants become familiar with what to expect which may increase their self-efficacy to perform better. As this was not examined, it would be a good idea to measure participants expectation's using the TPB models constructs in each experimental condition, to assess changes in self-efficacy towards completing and performing well in all cognitive tasks.

7.1.1 Implications & Limitations of all four experiments

Conversely, the TPB model was unable to predict expectancy response for cognitive tasks. However, it is important to consider participants may not have been habitual psychoactive consumers, as it if often the case participants are dis-honest about their behaviour in order to participate in a study for personal incentives. Therefore the findings were not representative for habitual energy drink consumers as the TPB model was unable to predict expectancy. It was made apparent by the TPB questionnaire that participants were predominantly caffeine consumers than energy drink consumers. Often in experimental research participants sign up to studies for rewards which offer them either credits for a course or incentive such as payment for taking part, without genuine interest in the research which results in major implications to examine causal effect. It was acknowledged that past behaviour and self- identity predict intention as well as habit and self-identity, which predicted expectancy effects in vigour activity. There is clear indication that if all the participants taking part in the study were habitual psychoactive drink consumers, there would be higher reliability of other constructs within the TPB model. However, as there were very few participants who were habitual consumers of energy drinks this may have attenuated the strength of correlations with intentions and predicting expectancy (Armitage & Conner, 2001; Conner & Sparks, 2005). Thus, Pavlovian conditioning (Pavlov, 1927), suggests if the same product is consumed regularly (i.e., energy drinks) and if there is an improvement in health, behaviour or other, this product will be conditioned to expect an improvement irrespective of actual ingredients (i.e. placebo being consumed instead of actual active product). Perhaps if participants were conditioned to energy drinks for a month verse placebo drink prior testing, there may be significant evidence of Pavlovian conditioning predicting expectancy effects on cognition and mood levels.

Confounding factors which may have prevented possible significant expectancy effects portraying would be associated to the absorption time and measures of caffeine and glucose within the psychoactive drink which vary in different studies. For instance, a study by Dawkins (2011) gave participants fifty-five minutes to digest the experimental drink. Whereas, Donohoe & Benton (2000) allowed participants thirty minutes digestion time for drink and before blood glucose measures could be taken, which was not the case for the present experiments as participants were given twenty minutes in the first three experiments

and thirty minutes digestion time for the fourth experiment. Perhaps permitting longer digestion time between forty-five minutes too one hour may have been suitable in order for effective cognitive and mood to be evidential throughout the experiments.

Furthermore, factors such as thirst and appetite were not controlled for and measured for each participant before consuming the experimental beverages as this may have impeded on glucose enhancement effect (Rogers et al., 2001). When participants are thirstier, they perform significantly better on cognitive tasks and alertness enhances once participants initial thirst has been be satisfied irrespective of experimental drink ingredients (Neave et al., 2001). This effect has also been found when participants appetitive state (i.e., feeling hungry) as they are refrained from eating or drinking several hours before experiment. Participants' encounter positive placebo effects by reversing the negative effects as they feel more thirsty and hungry at the time of the experiment (Scholey et al., 2009). Feeling thirsty prior ingesting psychoactive drink could have either positive or negative expectancy effects on cognitive performance and mood irrespective of drink content.

Lastly, although participants are required to abstain from psychoactive ingredients such as caffeine and glucose two hours prior to experiment, this often is not the case, as participant may not have adhered to the instructions which were given prior testing and therefore difficult to notice and acknowledge the true effects of consuming psychoactive experimental drinks. Further, if some participants were habitual consumers, they may not have refrained from drinking energy drinks, caffeine or other psychoactive beverages prior experiment to prevent withdrawal effects, which creates equivocal results.

On a whole, though there were no significant expectancy effects found from consuming non-active drinks on cognitive tasks, except for Experiment 2 and Experiment 4 for the Immediate verbal recall task and also for vigour activity for Experiment 4. Furthermore, the Two-finger tapping task indicated some elements suggesting expectancy effect for Experiment 2, as participants tapped faster for the placebo drink condition and informed they are consuming an active drink and also for the drink condition given placebo and told placebo. This suggested a reversal effect as participants tapped faster to compensate for drinking a placebo drink. Some of the findings are consistent with previous research suggesting glucose in particular can enhance memory and caffeine reduces tension and fatigue experienced overall. However, the aim of this thesis was to investigate possible

placebo expectancy effects of consuming psychoactive drinks, but the present studies found psychoactive effects when stimulants such as caffeine and glucose are consumed which are in line with previous studies. The studies comprised a convenience sample of predominantly female students and as a result the generalizability of the results can be questioned. Although, the underlying aim was to test whether TPB model could be utilised to predict expectancy response, it was not possible to identify the relationship between habitual consumers and the constructs from TPB model to predict expectancy response and outcome. Thus, future research would include measuring participants' initial appetitive and thirst states prior experiment, which would determine whether consuming any beverage to manage initial thirst, enhances cognitive performance and mood irrespective of drink content would define the difference between actual effects and expectancy effects. Further, it would be vital to run diary study one-week prior experiment to identify which participants are habitual consumers of psychoactive drinks in order to rule out non-habitual consumers. This would therefore control for the confounding variable which would affect prediction of expectancy response using the TPB model.

7.2 CONCLUSION

This thesis systematically investigated the various psychological factors that can affect performance and mood enhancing effects of energy drinks other than the actual psychoactive nature of ingredients present in the drink. There have been many studies which have explored addictive behaviour (i.e., alcohol drinking, smoking or taking drugs) and expectancy effects created prior participation of listed addictive behaviour. However, there is extensive research examining the effects of psychoactive ingredients caffeine and glucose independently and in combination as an energy drink but no research has examined expectancy effects of consuming these drinks in depth. Many consumers drink psychoactive drinks habitually to enhance their performance and mood which can therefore be considered as addictive behaviour. Taking this into account, it would be important to understand why consumers drink psychoactive drinks and whether there is any association between the actual psychoactive ingredients on cognition and mood, or are these changes in overall performance and mood due to expectancy effects. The concept of expectancy effects can be unambiguous especially when the information provided to the participants prior to the experimental study is specific to a possible outcome response.

Conducting a series of balanced placebo studies within this thesis were designed to distinguish and confirm whether the enhancement in cognitive performance and mood are correlated with the actual psychoactive effects or they have been created by preconditioning, previous knowledge, and attitude towards energy drinks. In order to have investigate this concept behind how expectancy effects are derived from external cues, such as habits, preconditioning, knowledge, and attitudes etc the TPB model was adapted to predict expectancy outcome behaviour and responses. This thesis used the TPB model to explain and understand what antecedents predict expectancy effects when participants think they are consuming psychoactive beverages. Although, the findings from the series of experiments conducted in this thesis found that there were psychoactive effects of consuming caffeine and glucose on mood and in some studies on cognitive performance, there were ambiguous findings indicating any effects on cognitive performance. However, there were significant findings indicating that the TPB model can be used to predict intentions of consuming energy drinks in the future and expectancy effect for the mood subscale vigour and confusion. This thesis can therefore confirm that caffeine and glucose have psychoactive effects on cognitive

performance and mood, but in order to find to significant expectancy effects on cognitive performance perhaps longitudinal study may be required were habitual energy drink consumers behaviour, performance is monitored and then followed up a month later to assess whether expectancy can be predicted using the TPB model.

To conclude, the present thesis has found caffeine and glucose ingestion effects cognitive performance and mood, but there were no significant findings which were conclusive of expectancy effects using the TPB model for cognition, although the model can be used to predict intention of future energy drink drinking and expectancy in vigour and confusion experienced by participants'. Unlike other research (Elliman et al., 2010; Oei & Hartley, 2005), these findings do not support a synergistic effect of psychoactive stimulants and expectancy, although the latter experiment clearly indicates the positive psychoactive effects of caffeine and glucose on mood and cognition. Thus, the present studies suggest there are elements of expectancy effects on mood overall and perhaps this is associated with positive attitudes and beliefs towards drinking psychoactive beverages, which may have been created by branding, marketing of energy drinks and social environment, triggering positive mood enhancement. Therefore, future research should focus and highlight the motivational and environmental factors that promote psychoactive drink consumption and what beliefs, subjective norms, perceived behavioural control and intentions are associated with such drinking behaviour, which could be used to predict expectancy response using the constructs within TPB model along with additional factors such as past behaviour to predict energy drinking behaviour.

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APPENDIX

APPENDIX 1. THE PROFILE OF MOOD STATES QUESTIONNIARE (POMS)

Participant number: Session: Study:

POM's Standard Form

Below is a list of words that describe feelings that people have. Please read each word carefully then circle the number that best describes how you feel at RIGHT NOW.

		Not at all	A little	Moderately	Quite a bit	Frequently

1	Friendly	0	1	2	3	4
2	Tense	0	1	2	3	4
3	Angry	0	1	2	3	4
4	Worn out	0	1	2	3	4
5	Unhappy	0	1	2	3	4
6	Clear- headed	0	1	2	3	4
7	Lively	0	1	2	3	4
8	Confused	0	1	2	3	4
9	Sorry for things done	0	1	2	3	4
10	Shaky	0	1	2	3	4
11	Listless	0	1	2	3	4
12	Peeved	0	1	2	3	4
13	Considerate	0	1	2	3	4
14	Sad	0	1	2	3	4
15	Active	0	1	2	3	4

16	On edge	0	1	2	3	4
17	Grouchy	0	1	2	3	4
18	Blue	0	1	2	3	4
19	Energetic	0	1	2	3	4
20	Panicky	0	1	2	3	4
21	Hopeless	0	1	2	3	4
22	Relaxed	0	1	2	3	4
23	Unworthy	0	1	2	3	4
24	Spiteful	0	1	2	3	4
25	Sympathetic	0	1	2	3	4
26	Uneasy	0	1	2	3	4
27	Restless	0	1	2	3	4
28	Unable to concentrate	0	1	2	3	4
29	Fatigued	0	1	2	3	4
30	Helpful	0	1	2	3	4

31	Annoyed	0	1	2	3	4
32	Discouraged	0	1	2	3	4
33	Resentful	0	1	2	3	4
34	Nervous	0	1	2	3	4
35	Lonely	0	1	2	3	4
36	Miserable	0	1	2	3	4
37	Muddled	0	1	2	3	4
38	Cheerful	0	1	2	3	4
39	Bitter	0	1	2	3	4
40	Exhausted	0	1	2	3	4
41	Anxious	0	1	2	3	4
42	Ready to fight	0	1	2	3	4
43	Good natured	0	1	2	3	4
44	Gloomy	0	1	2	3	4
45	Desperate	0	1	2	3	4

46	Sluggish	0	1	2	3	4
47	Rebellious	0	1	2	3	4
48	Helpless	0	1	2	3	4
49	Weary	0	1	2	3	4
50	Bewildered	0	1	2	3	4
51	Alert	0	1	2	3	4
52	Deceived	0	1	2	3	4
53	Furious	0	1	2	3	4
54	Efficient	0	1	2	3	4
55	Trusting	0	1	2	3	4
56	Full of pep	0	1	2	3	4
57	Bad - tempered	0	1	2	3	4
58	Worthless	0	1	2	3	4
59	Forgetful	0	1	2	3	4

60	Carefree	0	1	2	3	4
61	Terrified	0	1	2	3	4
62	Guilty	0	1	2	3	4
63	Vigorous	0	1	2	3	4
64	Uncertain about things	0	1	2	3	4
65	Bushed	0	1	2	3	4

APPENDIX 2. THEORY OF PLANNED BEHAVIOUR QUESTIONNAIRE (TPB)

How to fill in this questionnaire

Please circle the number on the following scales nearest your response to each question.

For example, if you felt strongly that drinking coffee is nutritious, you would respond like this:

Nutritious 1 2 3 4 5 6 7 non-nutritious

Alternatively, if you did not feel strongly about either way about how nutritious drinking coffee is, you would respond like this:

Nutritious 1 2 3 5 6 7 non-nutritious

Past Behaviour:

1. Please circle the most appropriate box to indicate, on average, how often over the last 6 months have you consumed energy drinks
    a. Never
    b. Occasionally
    c. Once per month
    d. Once per fortnight
    e. Once per week
    f. 2-3 times per week
    g. 4-6 times per week
    h. Once a day
    i. More than once per day

Please circle the place on the following scales that best represent your response to each

Please assume the term 'frequently' to mean 3 or more times a week

Attitude questions:

2. To me, drinking energy drinks frequently is:

a.	Harmful	1	2	3	4	5	6	7 Beneficial
b.	Convenient	1	2	3	4	5	6	7 Inconvenient
c.	Unpleasant	1	2	3	4	5	6	7 Pleasant
d.	Stimulating	1	2	3	4	5	6	7 Relaxing

3. Drinking energy drinks would make me feel:

a.	Happy	1	2	3	4	5	6	7 Unhappy
b.	Self-conscious	1	2	3	4	5	6	7 Self-assured
c.	Inadequate	1	2	3	4	5	6	7 Capable
d.	Enticed	1	2	3	4	5	6	7 Disgusted
e.	Guilty	1	2	3	4	5	6	7 Carefree
f.	Lethargic	1	2	3	4	5	6	7 Energetic
g.	Inactive	1	2	3	4	5	6	7 Active
h.	Unfocused	1	2	3	4	5	6	7 Focused
i.	Well	1	2	3	4	5	6	7 Unwell
j.	Content	1	2	3	4	5	6	7 Discontent
k.	Worried	1	2	3	4	5	6	7 Calm
l.	Unenthusiastic	1	2	3	4	5	6	7 Enthusiastic

4. Energy drinks taste good

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

5. My attitude towards drinking energy drinks is:

Extremely Extremely Unfavourable

1 2 3 4 5 6 7 Favourable

6. My attitude towards drinking energy drinks is:

Extremely								Extremely
Negative	1	2	3	4	5	6	7	Positive

7. I believe the claims made on energy drinks in adverts by branded companies such as (e.g. Lucozade) are correct / true

Definitely false	1	2	3	4	5	6	7	Definitely True

8. I cannot function cognitively without my daily dose of caffeine:

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

9. I cannot function cognitively and physically without consuming 1 energy drink a day:

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

10. I feel fatigue without consuming my daily psychoactive (caffeine and glucose) beverage:

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

11. I feel stimulated every time I consume energy drinks

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

12. I feel content when I consume my daily psychoactive (caffeine and glucose) beverage

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

13. I experience withdrawal symptoms if I do not consume caffeine

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

14. Drinking energy drinks frequently is good for my cognitive performance

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

15. Drinking energy drinks regularly will make me feel cognitively smarter (intelligent)

Unlikely 1 2 3 4 5 6 7 Likely

16. Feeling cognitively smarter (intelligent) on my course / module would be:

Bad 1 2 3 4 5 6 7 Good

17. Drinking energy drinks will make me feel happy:

Unlikely 1 2 3 4 5 6 7 Likely

18. drinking energy drinks will have an effect on my performance:

Unlikely 1 2 3 4 5 6 7 Likely

19. Most people who are important to me think that I should drink energy drinks frequently

Definitely false 1 2 3 4 5 6 7 Definitely True

20. Generally, members of my family think that I should drink energy drinks frequently

Definitely false 1 2 3 4 5 6 7 Definitely True

21. Generally, my friends think that I should drink energy drinks frequently

Definitely false 1 2 3 4 5 6 7 Definitely True

22. I like to do what my friends think that I should

Definitely false 1 2 3 4 5 6 7 Definitely True

23. Most famous personalities I admire claim to drink energy drinks and they promote this in adverts that we should drink energy drinks frequently

Unlikely 1 2 3 4 5 6 7 Likely

24. Given my lifestyle / taste preferences, it is likely that I will drink energy drinks frequently over the next 4 weeks.

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

25. Energy drinks are easily available to me

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

26. I do not believe I can perform well without drinking energy drinks

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

27. I need to drink energy drinks to stay awake in my lecture

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

28. I am confident that I can drink energy drink at least 3 times in the next 7 days

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

29. I am confident that I will perform my best in the cognitive tasks when I drink the experimental beverage.

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

30. I intend to drink energy drinks in the next 7 days:

Definitely will 1 2 3 4 5 6 7 Definitely will not

31. Over the next 7 days, it is likely I will consume an energy drink:

Definitely will 1 2 3 4 5 6 7 Definitely will not

32. Over the next 7 days my main way of staying alert will be to consume energy drink

Definitely will 1 2 3 4 5 6 7 Definitely will not

33. I am someone who consumes energy drinks to stay alert

Unlikely 1 2 3 4 5 6 7 Likely

34. I am the kind of person who drinks energy drinks

Unlikely 1 2 3 4 5 6 7 Likely

35. Please indicate the frequency of how many times you normally consume the following drinks in the table below (this is measured as per cup for coffee, tea and water, and 330ml bottle for energy drinks):

	In a day	In a week
Coffee		
Tea		
Energy drinks		
Water		

APPENDIX 3. Published Abstract in the Journal: Appetite, Volume 57, Issue 2, October 2011, Pages 566

566 K.M. Appleton, S. Higgs / Appetite 57 (2011) 553–569

Placebo expectancy effects in the relationship between acaí berry, caffeine and glucose on cognition and sensory motor movements

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E-mail address: sandhuj3@aston.ac.uk (J. Sandhu).

Present studies investigated the extent of expectancy in the effect of acaí berry, caffeine, glucose and water on cognition. In Study 1, participants (N= 46) attended four test sessions where participants were given an acaí berry and placebo drink in a pre-packaged bottle with additional information about acaí berries and for the other two they were given the same drinks in a glass with no additional information. In Study 2, participants (N= 45) consumed three different psychoactive beverages (acaí berry, caffeine and glucose) with water as the control drink. Information was provided to the participants with each psychoactive beverage. The task battery comprised of immediate verbal free-recall task, an immediate verbal recognition memory task, measure of motor speed (two-finger tapping) and the Pegboard dexterity test. Both studies used a within-subjects design. All conditions were administered in a counterbalanced order during which participants were given 330ml drink 20 min prior to completing a cognitive assessment battery, in addition to a Profile of Mood States questionnaire before drink consumption and after completing all four cognitive battery assessments. Study 1 found a significant effect of presentation modality on two-finger tapping and pegboard task performance. Immediate verbal memory was better when the beverages were presented in a glass. Study 2 found that caffeine and glucose improved sensory motor performance. Caffeine, glucose and water consumption led to better recall

when words were presented for 1s compared to 2s presentation. The results are interpreted in terms of there being some contribution of expectancy effects of the psychoactive drinks. doi:10.1016/j.appet.2011.05.094 **Attention**

APPENDIX 4. Experiment 1 Information sheet given before the experiment commenced.

The experiment you are signing up to participate in aims to examine the independent effects of psychoactive ingredients caffeine and glucose on cognitive performance, sensorimotor movements and general mood.

In order to assess the independent effects of caffeine and glucose stimulants, this experiment has adopted a balanced placebo design where participants will participate in four experimental conditions:

1. Given active glucose drink
2. Given active caffeine drink
3. Given placebo glucose drink
4. Given placebo caffeine drink

These four drink conditions will be randomly assigned to each participant and counterbalanced. The order of drinks consumed during the experiment will not be the same as listed above. All drinks will be administered randomly and double blinded.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire.

If you are happy to participate please complete the consent form. If you have any further questions please do not hesitate to ask.

Researcher:

Jaspreet Sandhu Email: sandhuj3@aston.ac.uk

Supervisor:

Dr. Mike Green Email: m.w.green@aston.ac.uk

APPENDIX 4.1. Experiment 1 Consent form

CONSENT FORM

Aston University Researcher: Jaspreet Sandhu PhD Student

Does caffeine and glucose affect cognitive performance and mood.

This study will last approximately 1 hour and it will consist of completing four cognitive battery tests, which will last five minutes each. You will also be completing POM's questionnaire. Furthermore, you will be consuming caffeine and glucose drinks along with their placebos followed by 20-minute break before completing cognitive tests. You will have to attend four consecutive sessions in order to receive your 50 credits.

In order to participate in this study, it is necessary to give your consent. By signing this informed consent you are indicating that you understand the nature of the research study and your role in that the research you agree to participate in. Please consider the following points before signing:

I understand that my participation will be and that all information I provide will remain confidential. I understand that participation in research is voluntary and that after or during anytime of the research project has begun, I may refuse to participate further without penalty. Hence I can withdraw from this research anytime without explanation. I have been given briefing of the study and I fully understand what is required as a participant in this study. If I require any further information regarding this study I can contact the researcher via email.

By signing this form I am stating that I understand the above information and consent to participate in this study being conduction at Aston University.

Consent Form: Gender:

Age: Signature:

APPENDIX 4.2 EXPERIMENT 1- THE COGNITIVE TASKS

Representing 2X2X2 ANOVA'S for active caffeine and glucose drinks and their placebo drink conditions for each of the POMS subscales (n 36)

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Time (Before/After)	0.463 (1, 35)	0.500	0.013
Caffeine Drinks (Active /Placebo)	13.630 (1, 35)	0.001	0.280
Glucose Drinks (Active/ Placebo)	0.643 (1, 35)	0.428	0.018
Time*Caffeine drinks	9.579 (1, 35)	0.004	0.215
Time*Glucose drinks	1.995 (1, 35)	0.067	0.054
Caffeine Drinks * Glucose drinks	0.237 (1, 35)	0.630	0.007
Time*Caffeine Drinks*Glucose Drinks	0.810 (1, 35)	0.374	0.023
DEPRESSION			
Time (Before/After)	0.186 (1, 35)	0.669	0.005
Caffeine Drinks (Active /Placebo)	0.016 (1, 35)	0.898	0.000
Glucose Drinks (Active/ Placebo)	0.335(1, 35)	0.566	0.009
Time*Caffeine drinks	0.009 (1, 35)	0.926	0.000
Time*Glucose drinks	0.006 (1, 35)	0.940	0.000
Caffeine Drinks * Glucose drinks	1.418 (1, 35)	0.242	0.039
Time*Caffeine Drinks*Glucose Drinks	2.340 (1, 35)	0.135	0.063
ANGER			

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Time (Before/After)	0.412 (1, 35)	0.525	0.012
Caffeine Drinks (Active /Placebo)	0.012 (1, 35)	0.914	0.000
Glucose Drinks (Active/ Placebo)	1.454 (1, 35)	0.236	0.040
Time*Caffeine drinks	0.237 (1, 35)	0.630	0.007
Time*Glucose drinks	2.495 (1, 35)	0.123	0.067
Caffeine Drinks * Glucose drinks	2.453 (1, 35)	0.126	0.066
Time*Caffeine Drinks*Glucose Drinks	13.743 (1, 35)	0.001	0.282
VIGOUR			
Time (Before/After)	0.096 (1, 35)	0.785	0.003
Caffeine Drinks (Active /Placebo)	0.838 (1, 35)	0.366	0.023
Glucose Drinks (Active/ Placebo)	0.670 (1, 35)	0.419	0.019
Time*Caffeine drinks	15.047 (1, 22)	0.000	0.301
Time*Glucose drinks	1.757(1, 35)	0.194	0.048
Caffeine Drinks * Glucose drinks	8.588 (1, 35)	0.000	0.197
Time*Caffeine Drinks*Glucose Drinks	11.773 (1, 35)	0.002	0.252
FATIGUE			
Time (Before/After)	0.003 (1, 35)	0.958	0.000
Caffeine Drinks (Active /Placebo)	1.637 (1, 35)	0.209	0.045
Glucose Drinks (Active/ Placebo)	48.146 (1, 35)	0.000	0.579
Time*Caffeine drinks	0.046 (1, 35)	0.832	0.001
Time*Glucose drinks	0.091 (1, 35)	0.765	0.003

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Caffeine Drinks * Glucose drinks	1.314 (1, 35)	0.260	0.036
Time*Caffeine Drinks*Glucose Drinks	2.240 (1, 35)	0.143	0.060
CONFUSION			
Time (Before/After)	8.098 (1, 35)	0.007	0.188
Caffeine Drinks (Active /Placebo)	10.012 (1, 35)	0.003	0.222
Glucose Drinks (Active/ Placebo)	26.252 (1, 35)	0.000	0.429
Time*Caffeine drinks	0.006 (1, 35)	0.940	0.000
Time*Glucose drinks	3.855 (1, 35)	0.058	0.099
Caffeine Drinks * Glucose drinks	3.237 (1, 35)	0.081	0.085
Time*Caffeine Drinks*Glucose Drinks	1.973 (1, 35)	0.169	0.053

Key: * = interaction

APPENDIX 5. Experiment 2 Information sheet prior to drink ingestion.

Expectancy effects of energy drinks on cognitive performance and mood

You are being invited to take part in a research study. Before you decide whether you wish to take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask the investigator any questions you may have about the study. Take time to decide whether or not you wish to take part.

You are being asked to take part in a research study for a PhD thesis. This PhD thesis consists of series of small studies, which explores the relationship between energy drinks on cognition and mood. Jaspreet Sandhu, as part of her PhD research, is carrying out the research, her supervisors are: Dr. Carol Holland and Dr. Mike Green, Senior Lecturers.

WHAT WILL HAPPEN

In this study, you will be asked to complete one questionnaires measuring your mood a. You will be requested to consume an energy drink within five minutes, followed by twenty-minute absorption time of beverage. Following this, you will complete the mood questionnaire for the second time and will commence the four cognitive tasks (Immediate verbal free recall, two finger tapping task, recognition task and Bakan task). This study involves some deception, as in two of the sessions you will receive a placebo beverage and in the other two you will receive the active energy drink. The risk of consuming the energy drink is no higher than the normal use of energy drinks.

ELIGBILTY

The exclusion criterion has been place because of the high glucose and caffeine content of the experimental beverages, and thus participants who are excluded are those with: diabetes or other glucose regulatory problems, Phenylketonuria, Glucose Intolerance, and Pregnant.

PREPARTAION FOR STUDY

Participants will be requested to abstain from food and drink which is high in glucose and caffeine 2 hours prior testing in order to maintain consistency at baseline but to ensure that they are not in obvious state of withdrawal (for habitual caffeine participants).

TIME COMMITMENT

The study typically takes 60 minutes (per session) across 4 sessions. This is a repeated measures design, therefore participants will be requested to attend ALL four consecutive sessions in the same week (e.g. Monday, Tuesday, Wednesday and Thursday) at the same time.

PARTICIPANTS' RIGHTS

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

BENEFITS AND RISKS

There are no known benefits or risks for you in this study.

COST, REIMBURSEMENT AND COMPENSATION

Your participation in this study is voluntary. You will receive 50 CREDITS in return for your participation.

CONFIDENTIALITY/ANONYMITY

The data we collect do not contain any personal information about you. No one will link the data you provided to the identifying information you supplied as each participant will be

given a participation number. Data may be used at conferences, or publication, but no personal information will be provided.

FOR FURTHER INFORMATION

Jas Sandhu will be glad to answer your questions about this study at any time. You may contact her at sandhuj3@aston.ac.uk or Supervisor: mike.green@aston.ac.uk

Appendix 5.1. Experiment 2 Consent form

CONSENT FORM

Aston University Researcher: Jaspreet Sandhu PhD Student

Do Energy drinks affect cognitive performance and mood.

This study will last approximately 1 hour and it will consist of completing four cognitive battery tests, which will last five minutes each. You will also be completing POM's questionnaire. Furthermore, you will be consuming energy drinks containing caffeine and glucose along with their placebos. For two of the experimental conditions you will be informed correctly and the other two conditions incorrectly about the drink you are consuming. This will be followed by 20-minute break before completing cognitive tests. You will have to attend four consecutive sessions in order to receive your 50 credits.

In order to participate in this study, it is necessary to give your consent. By signing this informed consent you are indicating that you understand the nature of the research study and your role in that the research you agree to participate in. Please consider the following points before signing:

I understand that my participation will be and that all information I provide will remain confidential. I understand that participation in research is voluntary and that after or during anytime of the research project has begun, I may refuse to participate further without penalty. Hence I can withdraw from this research anytime without explanation. I have been given briefing of the study and I fully understand what is required as a participant in this study.

If I require any further information regarding this study I can contact the researcher via email. By signing this form I am stating that I understand the above information and consent to participate in this study being conduction at Aston University.

Consent Form:

Gender:

Age:

Signature:

APPENDIX 5.2. Information given prior to drink consumption.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed active energy drink and told they are consuming an energy drink:

The drink you are about to consume is **an active energy drink** consisting of caffeine and glucose. This drink **will enhance** you cognitive performance and improve your overall mood upon ingestion.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed active energy drink and told they are consuming a placebo drink:

The drink you are about to consume is **not an active energy drink** consisting of caffeine and glucose. This drink will **not** enhance you cognitive performance or improve your overall mood upon ingestion.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed placebo drink and told they are consuming a placebo drink:

The drink you are about to consume is **not an active energy drink** consisting of caffeine and glucose. This drink will **not** enhance you cognitive performance or improve your overall mood upon ingestion.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed placebo drink and told they are consuming an energy drink:

The drink you are about to consume is **an active energy drink** consisting of caffeine and glucose. This drink **will enhance** you cognitive performance and improve your overall mood upon ingestion.

Appendix 5.2. Representing 2x2 ANOVAs for the cognitive tasks when energy drinks & placebo drinks were consumed for drink conditions (n 23)

	F (Degrees of freedom)	P	Partial Eta Square
Bakan task (mean correct hits / 6 Blocks)			
Drink (Active /Placebo)	0.308 (1, 22)	0.584	0.014
Information (Told Active/ Told Placebo)	0.214 (1, 22)	0.648	0.010
Drink * Information	0.126 (1, 22)	0.726	0.006
Tapping task (ms)			
Drink (Active /Placebo)	4.242 (1, 22)	0.051	0.162
Information (Told Active/ Told Placebo)	0.407 (1, 22)	0.530	0.018
Drink * Information	0.208 (1, 22)	0.653	0.009
Recognition Task			
Recognition Speed (ms)			
Drink (Active /Placebo)	0.412 (1, 22)	0.528	0.018
Information (Told Active/ Told Placebo)	0.672 (1, 22)	0.421	0.030
Drink * Information	0.163 (1, 22)	0.690	0.007
Recognition Task			
Correct Recognition (N)			
Drink (Active /Placebo)	1.292 (1, 22)	0.268	0.055
Information (Told Active/ Told Placebo)	0.094 (1, 22)	0.762	0.004
Drink * Information	0.157 (1, 22)	0.695	0.007

	F (Degrees of freedom)	P	Partial Eta Square
Immediate verbal recall task (mean words recalled from a presentation list with maximum of 20 words)			
1 second word presentation			
Drink (Active /Placebo)	0.189 (1, 22)	0.668	0.009
Information (Told Active/ Told Placebo)	0.449 (1, 22)	0.510	0.020
Drink * Information	7.243 (1,22)	0.013	0.248
2 second word presentation			
Drink (Active /Placebo)	0.001 (1, 22)	0.973	0.010
Information (Told Active/ Told Placebo)	2.814 (1, 22)	0.108	0.113
Drink * Information	0.619 (1, 22)	0.440	0.027

Key: * = interaction

APPENDIX 5.3. 2X2X2 ANOVA'S for mood subscales Experiment 2

Representing ANOVA for energy drink & placebo drink conditions for each of the POMS subscales (n 23)

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Time (Before/After)	0.079 (1, 22)	0.781	0.004
Ingredient (Active /Placebo)	6.475 (1, 22)	0.018	0.227
Information (Told Active/ Told Placebo)	0.111 (1, 22)	0.742	0.005
Time*Ingredient	0.093 (1, 22)	0.742	0.004
Time*Information	0.004 (1, 22)	0.949	0.000
Ingredient * Information	0.831 (1, 22)	0.372	0.036
Time*Ingredient *Information	4.963 (1, 22)	0.036	0.184
DEPRESSION			
Time (Before/After)	1.069 (1, 22)	0.312	0.046
Ingredient (Active /Placebo)	0.002 (1, 22)	0.967	0.000
Information (Told Active/ Told Placebo)	2.773(1, 22)	0.110	0.112
Time*Ingredient	2.060 (1, 22)	0.165	0.086
Time*Information	0.408 (1, 22)	0.530	0.018
Ingredient * Information	3.942 (1, 22)	0.060	0.152
Time*Ingredient*Information	0.954 (1, 22)	0.339	0.042
ANGER			
Time	0.064 (1, 22)	0.803	0.003
Ingredient (Active /Placebo)	0.347 (1, 22)	0.562	0.016

	F (Degrees of freedom)	P	Partial Eta Square
Information (Told Active/ Told Placebo)	2.134 (1, 22)	0.158	0.088
Time*Ingredient	1.848 (1, 22)	0.188	0.078
Time*Information	0.001 (1, 22)	0.987	0.001
Ingredient * Information	0.503 (1, 22)	0.486	0.022
Time*Ingredient*Information	1.004 (1, 22)	0.327	0.004
VIGOUR			
Time	1.006 (1, 22)	0.327	0.004
Ingredient(Active /Placebo)	1.084 (1, 22)	0.309	0.047
Information (Told Active/ Told Placebo)	0.668 (1, 22)	0.423	0.029
Time*Ingredient	1.077 (1, 22)	0.311	0.047
Time*Information	1.085(1, 22)	0.309	0.047
Ingredient * Information	1.655 (1, 22)	0.212	0.070
Time*Ingredient*Information	0.789 (1, 22)	0.384	0.035
FATIGUE			
Time	0.999 (1, 22)	0.328	0.044
Ingredient (Active /Placebo)	1.013 (1, 22)	0.325	0.044
Information (Told Active/ Told Placebo)	9.103 (1, 22)	0.006	0.293
Time*Ingredient	1.051 (1, 22)	0.316	0.046
Time*Information	0.079 (1, 22)	0.781	0.004
Ingredient * Information	2.097 (1, 22)	0.162	0.087
Time*Ingredient*Information	1.219 (1, 22)	0.282	0.052
CONFUSION			
Time	8.879 (1, 22)	0.007	0.288
Ingredient (Active /Placebo)	6.071 (1, 22)	0.022	0.216
Information (Told Active/ Told Placebo)	1.800 (1, 22)	0.193	0.076

	F (Degrees of freedom)	P	Partial Eta Square
Time*Ingredient	3.581 (1, 22)	0.072	0.140
Time*Information	2.533 (1, 22)	0.126	0.103
Ingredient * Information	0.231 (1, 22)	0.636	0.010
Time*Ingredient*Information	0.628 (1, 22)	0.437	0.028

Key =* Interactions

APPENDIX 6. Experiment 3 Information sheet given at the beginning of the experiment.

Expectancy effects of energy drinks on cognitive performance and mood; branded bottle versus glass.

You are being invited to take part in a research study. Before you decide whether you wish to take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask the investigator any questions you may have about the study. Take time to decide whether or not you wish to take part. You are being asked to take part in a research study for a PhD thesis. This PhD thesis consists of series of small studies, which explores the relationship between energy drinks on cognition and mood. Jaspreet Sandhu, as part of her PhD research, is carrying out the research, her supervisors are: Dr. Carol Holland and Dr. Mike Green, Senior Lecturers.

WHAT WILL HAPPEN

In this study, you will be asked to complete one questionnaire measuring your mood. You will be requested to consume an energy drink within five minutes, followed by twenty-minute absorption time of beverage. Following this, you will complete the mood questionnaire for the second time and will commence the three cognitive tasks (Immediate verbal free recall, two finger and Bakan task). This study involves some deception, as in two of the sessions you will receive a placebo beverage and in the other two you will receive the active energy drink in branded bottle and glass. The risk of consuming the energy drink is no higher than the normal use of energy drinks.

ELIGBILTY

The exclusion criterion has been place because of the high glucose and caffeine content of the experimental beverages, and thus participants who are excluded are those with: diabetes or other glucose regulatory problems, Phenylketonuria, Glucose Intolerance, and Pregnant.

PREPARTAION FOR STUDY

Participants will be requested to abstain from food and drink which is high in glucose and caffeine 2 hours prior testing in order to maintain consistency at baseline but to ensure that they are not in obvious state of withdrawal (for habitual caffeine participants).

TIME COMMITMENT

The study typically takes 60 minutes (per session) across 4 sessions. This is a repeated measures design, therefore participants will be requested to attend ALL four consecutive sessions in the same week (e.g. Monday, Tuesday, Wednesday and Thursday) at the same time.

PARTICIPANTS' RIGHTS

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

BENEFITS AND RISKS

There are no known benefits or risks for you in this study.

COST, REIMBURSEMENT AND COMPENSATION

Your participation in this study is voluntary. You will receive 50 CREDITS in return for your participation.

CONFIDENTIALITY/ANONYMITY

The data we collect do not contain any personal information about you. No one will link the data you provided to the identifying information you supplied as each participant will be given a participation number. Data may be used at conferences, or publication, but no personal information will be provided.

FOR FURTHER INFORMATION

Jas Sandhu will be glad to answer your questions about this study at any time. You may contact her at sandhuj3@aston.ac.uk or Supervisor: mike.green@aston.ac.uk

APPENDIX 6.1. Experiment 3 Consent form

CONSENT FORM

Aston University Researcher: Jas Sandhu PhD Student

Do Energy drinks affect cognitive performance and mood: branded bottle versus glass.

This study will last approximately 1 hour and it will consist of completing three cognitive battery tests, which will last five minutes each. You will also be completing POM's questionnaire. Furthermore, you will be consuming energy drinks containing caffeine and glucose along with their placebos from a branded Lucozade bottle and from a glass. This will be followed by 20-minute break before completing cognitive tests. You will have to attend four consecutive sessions in order to receive your 50 credits.

In order to participate in this study, it is necessary to give your consent. By signing this informed consent, you are indicating that you understand the nature of the research study and your role in that the research you agree to participate in. Please consider the following points before signing:

I understand that my participation will be and that all information I provide will remain confidential. I understand that participation in research is voluntary and that after or during anytime of the research project has begun, I may refuse to participate further without penalty. Hence, I can withdraw from this research anytime without explanation. I have been given briefing of the study and I fully understand what is required as a participant in this study.

If I require any further information regarding this study, I can contact the researcher via email. By signing this form, I am stating that I understand the above information and consent to participate in this study being conduction at Aston University.

----------Consent Form:

Gender:

Age:

Signature:

APPENDIX 6.2. 2x2 ANOVAs for the cognitive tasks when energy drinks & placebo drinks were consumed for drink conditions (n 36)

	F (Degrees of freedom)	P	Partial Eta Square
Bakan task (mean correct hits / 6 Blocks)			
Ingredient (Active /Placebo)	0.231 (1, 35)	0.561	0.001
Presentation (Given in bottle/ Given in a glass)	3.370 (1, 35)	0.075	0.080
Ingredient * Presentation	0.018 (1, 35)	0.893	0.001
Tapping task (ms)			
Ingredient (Active /Placebo)	0.792 (1, 35)	0.380	0.023
Presentation (Given in bottle/ Given in a glass)	0.556 (1, 35)	0.465	0.016
Ingredient * Presentation	0.244 (1, 35)	0.625	0.007
Immediate verbal recall task (mean words recalled from a presentation list with maximum of 20 words)			
1 second word presentation			
Ingredient (Active /Placebo)	1.912 (1, 35)	0.176	0.052
Presentation (Given in bottle/ Given in a glass)	0.079 (1, 35)	0.781	0.002
Ingredient *Presentation	0.998 (1,35)	0.325	0.028
2 second word presentation			
Ingredient (Active /Placebo)	1.470 (1, 35)	0.234	0.040

	F (Degrees of freedom)	P	Partial Eta Square
Presentation (Given in bottle/ Given in a glass)	0.029 (1, 35)	0.867	0.001
Ingredient * Presentation	0.194 (1, 35)	0.662	0.006

Key: * = interaction

APPENDIX 6.3. 2X2X2 ANOVA'S for mood subscales Experiment 3

Representing ANOVA for energy drink & placebo drink conditions for each of the POMS subscales (n 36)

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Time (Before/After)	1.329 (1, 35)	0.257	0.037
Ingredient (Active /Placebo)	7.657 (1, 35)	0.009	0.180
Presentation (Given in bottle/ Given in a glass)	5.915 (1, 35)	0.020	0.145
Time*Ingredients	0.002 (1, 35)	0.974	0.000
Time*Presentation	0.132 (1, 35)	0.718	0.004
Ingredients* Presentation	6.376 (1, 35)	0.016	0.154
Time*Ingredients*Presentation	1.531 (1, 35)	0.224	0.042
DEPRESSION			
Time (Before/After)	0.019 (1, 35)	0.890	0.001
ingredients (Active /Placebo)	0.170 (1, 35)	0.170	0.005
Presentation (Given in bottle/ Given in a glass)	8.298 (1, 35)	0.007	0.192
Time*ingredients	0.527 (1, 35)	0.473	0.015
Time*Presentation	2.432 (1, 35)	0.128	0.065
Ingredients * Presentation	3.637 (1, 35)	0.065	0.094
Time*Ingredients*Presentation	0.001 (1, 35)	0.987	0.001
ANGER			
Time	12.094 (1, 35)	0.001	0.257
Ingredients (Active /Placebo)	11.537 (1, 35)	0.002	0.248
Presentation (Given in bottle/ Given in a glass)	2.356 (1, 35)	0.134	0.063

	F (Degrees of freedom)	P	Partial Eta Square
Time*ingredients	20.217 (1, 35)	0.000	0.366
Time*Presentation	0.246 (1, 35)	0.623	0.007
Ingredients * Presentation	14.321 (1, 35)	0.001	0.623
Time*Ingredients*Presentation	0.484 (1, 35)	0.491	0.014
VIGOUR			
Time	0.042 (1, 35)	0.838	0.001
Ingredients (Active /Placebo)	8.183 (1, 35)	0.008	0.209
Presentation (Given in bottle/ Given in a glass)	0.669 (1, 35)	0.420	0.021
Time*ingredients	0.074 (1, 35)	0.788	0.002
Time*Presentation	1.588 (1, 35)	0.217	0.049
Ingredients * Presentation	3.804 (1, 35)	0.060	0.109
Time*ingredients*Presentation	1.939 (1, 35)	0.174	0.059
FATIGUE			
Time	0.622 (1, 35)	0.436	0.017
Ingredients (Active /Placebo)	0.049 (1, 35)	0.827	0.001
Presentation (Given in bottle/ Given in a glass)	20.641 (1, 35)	0.000	0.371
Ingredients*Drink	3.553 (1, 35)	0.068	0.098
Time*Presentation	0.589 (1, 35)	0.448	0.017
Ingredients* Presentation	16.669 (1, 35)	0.000	0.323
Time*Ingredients*Presentation	0.026 (1, 35)	0.876	0.001
CONFUSION			
Time	8.542 (1, 35)	0.006	0.198
Ingredients (Active /Placebo)	0.268 (1, 35)	0.608	0.008
Presentation (Given in bottle/ Given in a glass)	0.010 (1, 35)	0.922	0.001
Time*Ingredients	0.268 (1, 35)	0.608	0.008
Time*Presentation	1.514 (1, 35)	0.227	0.041
ingredients * Presentation	3.018 (1, 35)	0.091	0.079

	F (Degrees of freedom)	P	Partial Eta Square
Time*Ingredients*Presentation	0.010 (1, 35)	0.921	0.000

Key = * interactions

APPENDIX 7. Experiment 4 Information sheet given prior sign up and prior ingestion.

PARTICIPANT INFORMATION SHEET

Predicting expectancy effects of energy drinks using the Theory of Planned Behaviour Model Questionnaire

You are being invited to take part in a research study. Before you decide whether you wish to take part, it is important for you to understand why the research is being done and what taking part will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask the investigator any questions you may have about the study. Take time to decide whether or not you wish to take part.

You are being asked to take part in a research study for a PhD thesis. This PhD thesis consists of series of small studies, which explores the relationship between energy drinks on cognition and mood. Jaspreet Sandhu, as part of her PhD research, is carrying out the research, her supervisors are: Dr. Carol Holland and Dr. Mike Green, Senior Lecturers.

WHAT WILL HAPPEN

In this study, you will be asked to complete two questionnaires one measuring your mood and self-report on your beliefs about energy drinks. You will be requested to consume an energy drink within five minutes, followed by thirty-minute absorption time of beverage. Following this, you will complete the mood questionnaire for the second time and will commence the three cognitive tasks (Immediate verbal free recall, two finger tapping task and recognition task). This study involves some deception, as in two of the sessions you will receive a placebo beverage and in the other two you will receive the active energy drink. The risk of consuming the energy drink is no higher than the normal use of energy drinks.

ELIGBILTY

The exclusion criterion has been place because of the high glucose and caffeine content of the experimental beverages, and thus participants who are excluded are those with: diabetes

or other glucose regulatory problems, Phenylketonuria, Glucose Intolerance, and Pregnant. Furthermore, participants also must be regular coffee / energy drink consumer in order to participate in order to ensure participants are familiar with effects of consuming caffeine.

PREPARTAION FOR STUDY

Participants will be requested to abstain from food and drink which is high in glucose and caffeine 2 hours prior testing in order to maintain consistency at baseline but to ensure that they are not in obvious state of withdrawal (for habitual caffeine participants).

TIME COMMITMENT

The study typically takes 60 minutes (per session) across 4 sessions. This is a repeated measures design, therefore participants will be requested to attend ALL four consecutive sessions in the same week (e.g. Monday, Tuesday, Wednesday and Thursday) at the same time.

PARTICIPANTS' RIGHTS

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

BENEFITS AND RISKS

There are no known benefits or risks for you in this study.

COST, REIMBURSEMENT AND COMPENSATION

Your participation in this study is voluntary. You will receive **20 CREDITS** in return for your participation.

CONFIDENTIALITY/ANONYMITY

The data we collect do not contain any personal information about you. No one will link the data you provided to the identifying information you supplied as each participant will be given a participation number. Data may be used at conferences, or publication, but no personal information will be provided.

FOR FURTHER INFORMATION

Jas Sandhu will be glad to answer your questions about this study at any time. You may contact her at sandhuj3@aston.ac.uk or Supervisor: carol.holland@aston.ac.uk

APPENDIX 7.1. Experiment 4 Consent form

Aston University Researcher's name: Jaspreet Sandhu

Predicting expectancy effects of energy drinks using the Theory of Planned Behaviour Model Questionnaire

The study will last approximately one hour and this will consist of three cognitive tasks, which will be assessed over four sessions. The cognitive tasks are as follows: Immediate memory recall, Tapping Task, and Recognition memory task. Each task will take approximately five minutes, thus the testing for cognitive performance will take fifteen minutes in total. Furthermore two simple questionnaires will be required to be completed. In this study you will be requested to consume energy drinks made up of caffeine and glucose and placebo energy drinks, within five minutes and then given further thirty minutes to digest the experimental drink.

In order to participate in this research study, it is necessary that you give your informed consent. By signing this informed consent form you are indicating that you understand the nature of the research study and your role in that research and that you agree to participate in the research. Please consider the following points before signing:

- I understand that my participation will be and that all information I provide will remain confidential.

- I understand that participation in research is voluntary, and that, after or during anytime the research project has begun; I may refuse to participate further without penalty. Hence I can withdraw from this research at any time without any explanation.

- I have been given a briefing of the study and I fully understand what is required as a participant in this study.

- If I require any further information regarding this study I can contact the researcher via email at sandhuj3@aston.ac.uk anytime.

By signing this form I am stating that I understand the above information and consent to participate in this study being conducted at Aston University.

_____

CONSENT FORM:

Gender:----------

Age:----------

Signature of participant: ----------

APPENDIX 7.2. Experiment 4 Information given prior drink consumption

Information given prior drink consumption was a follows:

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed active energy drink and told they are consuming an energy drink:

The drink you are about to consume is **an active energy drink** consisting of caffeine and glucose. This drink **will enhance** you cognitive performance and improve your overall mood upon ingestion.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed active energy drink and told they are consuming a placebo drink:
- The drink you are about to consume is **not an active energy drink** consisting of caffeine and glucose. This drink will **not** enhance you cognitive performance or improve your overall mood upon ingestion.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed placebo drink and told they are consuming a placebo drink:

The drink you are about to consume is **not an active energy drink** consisting of caffeine and glucose. This drink will **not** enhance you cognitive performance or improve your overall mood upon ingestion.

You will be given five minutes to consume the 330ml experimental drink and further twenty minutes to digest the drink before completing any cognitive tasks and mood questionnaire. Please read the information below carefully regarding the drink you are about to consume.

- Information given when participants consumed placebo drink and told they are consuming an energy drink:

The drink you are about to consume is **an active energy drink** consisting of caffeine and glucose. This drink **will enhance** you cognitive performance and improve your overall mood upon ingestion.

APPENDIX 7.3. 2x2 ANOVAs for the cognitive tasks when energy drinks & placebo drinks were consumed for drink conditions (n 60) Experiment 4

	F (Degrees of freedom)	P	Partial Eta Square
Tapping task (ms)			
INGREDIENTS (Active /Placebo)	1.482 (1, 59)	0.228	0.025
Information (Told Active/ Told Placebo)	0.005 (1, 59)	0.944	0.001
INGREDIENTS * Information	1.396 (1, 59)	0.242	0.023
Recognition Task			
Recognition Speed (ms)			
INGREDIENTS (Active /Placebo)	11.498 (1, 59)	0.001	0.163
Information (Told Active/ Told Placebo)	0.120 (1, 59)	0.730	0.002
INGREDIENTS * Information	0.253 (1, 59)	0.617	0.004
Recognition Task			
Correct Recognition (N)			
INGREDIENTS (Active /Placebo)	0.386 (1, 59)	0.537	0.006
Information (Told Active/ Told Placebo)	5.702 (1, 59)	0.020	0.088
INGREDIENTS * Information	1.290 (1, 59)	0.261	0.021
Immediate verbal recall task (mean words recalled from a presentation list			

	F (Degrees of freedom)	P	Partial Eta Square
with maximum of 20 words)			
1 second word presentation			
INGREDIENTS (Active /Placebo)	4.824 (1, 59)	0.032	0.076
Information (Told Active/ Told Placebo)	14.157 (1, 59)	0.000	0.194
INGREDIENTS * Information	1.357 (1,59)	0.249	0.022
2 second word presentation			
INGREDIENTS(Active /Placebo)	9.253 (1, 59)	0.004	0.136
Information (Told Active/ Told Placebo)	7.892 (1, 59)	0.007	0.118
INGREDIENTS* Information	5.652 (1, 59)	0.021	0.087

Key: * =interaction

APPENDIX 7.4. 2X2 ANOVA'S for mood subscales for each condition (n 60) Experiment 4

	F (Degrees of freedom)	P	Partial Eta Square
TENSION			
Time (Before/After)	0.015 (1, 59)	0.904	0.001
INGREDIENTS(Active /Placebo)	3.343 (1, 59)	0.073	0.054
Information (told active/ told placebo)	23.010 (1, 59)	0.000	0.281
Time*INGREDIENTS	13.964 (1, 59)	0.000	0.191
Time*Information	1.813 (1, 59)	0.183	0.031
INGREDIENTS* Information	3.508 (1, 59)	0.066	0.056
Time*INGREDIENTS*Information	0.117 (1, 59)	0.734	0.004
DEPRESSION			
Time (Before/After)	0.259 (1, 59)	0.613	0.004
INGREDIENT (Active /Placebo)	1.261 (1, 59)	0.266	0.021
Information (told active/ told placebo)	17.613 (1, 59)	0.000	0.230
Time*INGREDIENT	0.843 (1, 59)	0.362	0.014
Time*Information	4.324 (1, 59)	0.042	0.068
INGREDIENT* Information	4.267 (1, 59)	0.043	0.067
Time*INGREDIENT*Information	1.564 (1, 59)	0.216	0.026
ANGER			
Time	2.413 (1, 59)	0.126	0.039
INGREDIENT (Active /Placebo)	0.002 (1, 59)	0.960	0.001
Information (told active/ told placebo)	24.802 (1, 59)	0.000	0.296

	F (Degrees of freedom)	P	Partial Eta Square
Time*INGREDIENT	3.672 (1, 59)	0.060	0.059
Time*Information	0.338 (1, 59)	0.563	0.006
INGREDIENT* Information	0.812 (1, 59)	0.371	0.014
Time*INGREDIENT*Information	0.007 (1, 59)	0.934	0.001
VIGOUR			
Time	9.972 (1, 59)	0.003	0.145
INGREDIENT(Active /Placebo)	0.585 (1, 59)	0.447	0.010
Information (told active/ told placebo)	14.174 (1, 59)	0.000	0.717
Time*INGREIDENT	0.023 (1, 59)	0.880	0.002
Time*Information	8.706 (1, 59)	0.005	0.129
INGREDIENT* Information	0.001 (1, 59)	0.989	0.001
Time*INGREDIENT*Information	0.001 (1, 59)	0.989	0.001
FATIGUE			
Time	0.965 (1, 59)	0.330	0.016
INGREDIENT (Active /Placebo)	0.104 (1, 59)	0.748	0.002
Information (told active/ told placebo)	2.301 (1, 59)	0.135	0.038
Time*INGREDIENT	8.185 (1, 59)	0.006	0.122
Time*Information	0.910 (1, 59)	0.344	0.015
INGREDIENT* Information	0.018(1, 59)	0.895	0.000
Time*INGREDENT*Information	4.372 (1, 59)	0.041	0.069
CONFUSION			
Time	5.871 (1, 59)	0.018	0.090
INGREDIENT (Active /Placebo)	0.508 (1, 59)	0.479	0.009
Information (told active/ told placebo)	14.412 (1, 59)	0.000	0.196
Time* INGREDIENT	0.549 (1, 59)	0.462	0.009
Time*Information	0.416 (1, 59)	0.522	0.007
INGREDIENT* Information	0.971 (1, 59)	0.328	0.016

	F (Degrees of freedom)	P	Partial Eta Square
Time*INGREDIENT*Information	0.880 (1, 59)	0.352	0.015

Key = * Interactions

APPENDIX 7.5. Correlation tables for Experiment 4

Table 8-1 The correlations between intentions to drink psycho-stimulant drinks (n 60)

	Intention Average	Attitude Average	Subjective Norm Average	Perceived Behavioural Control Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Intention Average	1.000	.040**	.102	.204	.080	.187	-.194	-.061	.309**
Attitude Average	.040	1.000	.426**	.403**	.326**	.506**	.021	.276*	.385**
Subjective Norm Average	.102	.426**	1.000	.519**	.620**	.422**	-.033	.042	.389**
Perceived Behavioural Control Average	.204	.403**	.519**	1.000	.772**	.686**	.218	.199	.393**
Belief Average	.080	.326**	.620**	.772**	1.000	.676**	.108	.101	.370**
Habit Average	.187	.506**	.422**	.686**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	-.194	.021	-.033	.218*	.108	.157	1.000	.329**	.291*
Self-Identity Average1	-.061	.276*	.042	.199	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	.309**	.385**	.389**	.393**	.370**	.382**	.291*	.340**	1.000

*p< 0.05, ** p < 0.01. The higher the score on intention variable, the more likely the participant would consume a psychoactive drink (i.e. considered to enhance performance)

Table 8-2 The correlations between Recognised words calculated expectancy effect and TPB questionnaire variables (n 60)

	Recognised Words	Intentions Average	Attitude Average	Perceived Behavioural Control Average	Subjective Norm Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Recognised Words	1.000	-.179	-.032	-.001	-.036	.060	-.148	-.183	-.295*	-.193
Intentions Average	-.179	1.000	.040	.204	.102	.080	.187	-.194	-.061	.309**
Attitude Average	-.032	.040	1.000	.403**	.426**	.326**	.506**	.021	.276*	.385**
Perceived Behavioural Control Average	-.001	.204	.403**	1.000	.519**	.772**	.686**	.218*	.199*	.393**
Subjective Norm Average	-.036	.102	.426**	.519**	1.000	.620**	.422**	-.033	.042	.389**
Belief Average	.060	.080	.326**	.772**	.620**	1.000	.676**	.108	.101	.370**
Habit Average	-.148	.187	.506**	.686**	.422**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	-.183	-.194	.021	.218*	-.033	.108	.157	1.000	.329**	.291*
Self-Identity Average1	-.295*	-.061	.276*	.199	.042	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	-.193	.309**	.385**	.393**	.389**	.370**	.382**	.291*	.340**	1.000

*p<0.05, **p<0.01. The higher the score for recognised words, the more likely expectancy effect could be predicted.

Table 8-3 The correlations between Recognition speed expectancy and TPB questionnaire variables (n 60)

	Recognised Speed Expectancy Variable	Intentions Average	Attitude Average	Perceived Behavioural Control Average	Subjective Norm Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Recognised Speed Expectancy Variable	1.000	.059	-.033	.273*	.260*	.305**	.126	.219	-.111	.198
Intentions Average	.059	1.000	.040	.102	.204	.080	.187	-.194	-.061	.309**
Attitude Average	-.033	.040	1.000	.426**	.403**	.326**	.506**	.021	.276*	.385**
Perceived Behavioural Control Average	.273*	.102	.426**	1.000	.519**	.620**	.422**	-.033	.042	.389**
Subjective Norm Average	.260*	.204	.403**	.519**	1.000	.772**	.686**	.218*	.199	.393**
Belief Average	.305**	.080	.326**	.620**	.772**	1.000	.676**	.108	.101	.370**
Habit Average	.126	.187	.506**	.422**	.686**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	.219*	-.194	.021	-.033	.218*	.108	.157	1.000	.329**	.291*
Self-Identity Average1	-.111	-.061	.276*	.042	.199	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	.198	.309**	.385**	.389**	.393**	.370**	.382**	.291*	.340**	1.000

Table 8-4 The correlations between Immediate verbal recall 1 second word presentation expectancy and TPB questionnaire variables (n 60)

	Immediate verbal recall 1s word presentation	Intentions Average	Attitude Average	Perceived Behavioural Control Average	Subjective Norm Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-identity Average2
Immediate verbal recall 1s word presentation	1.000	-.280*	-.285*	-.157	-.227*	-.085	-.183	.079	.141	-.078
Intentions Average	-.280*	1.000	.040	.204	.102	.080	.187	-.194	-.061	.309**
Attitude Average	-.285*	.040	1.000	.403**	.426**	.326**	.506**	.021	.276*	.385**
Perceived Behavioural Control Average	-.157	.204	.403**	1.000	.519**	.772**	.686**	.218*	.199	.393**
Subjective Norm Average	-.227	.102	.426**	.519**	1.000	.620**	.422**	-.033	.042	.389**
Belief Average	-.085	.080	.326**	.772**	.620**	1.000	.676**	.108	.101	.370**
Habit Average	-.183	.187	.506**	.686**	.422**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	.079	-.194	.021	.218	-.033	.108	.157	1.000	.329**	.291*
Self-Identity Average1	.141	-.061	.276*	.199	.042	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	-.078	.309**	.385**	.393**	.389**	.370**	.382**	.291*	.340**	1.000

Table 8-5 The correlations between Immediate verbal recall 2 second word presentation expectancy and TPB questionnaire variables (n 60)

	Immediate verbal recall 2s word presentation	Intentions Average	Attitude Average	Perceived Behavioural Control Average	Subjective Norm Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1
Immediate verbal recall 2s word presentation	1.000	-.227*	-.338**	-.249*	-.203	-.160	-.347**	.000	.060
Intentions Average	-.227*	1.000	.040	.204	.102	.080	.187	-.194	-.061
Attitude Average	-.338**	.040	1.000	.403**	.426**	.326**	.506**	.021	.276**
Perceived Behavioural Control Average	-.249*	.204	.403**	1.000*	.519**	.772**	.686**	.218*	.199
Subjective Norm Average	-.203	.102	.426**	.519**	1.000	.620**	.422**	-.033	.042
Belief Average	-.160	.080	.326**	.772**	.620**	1.000	.676**	.108	.101
Habit Average	-.347**	.187	.506**	.686**	.422**	.676**	1.000	.157	.321**
Past Behaviour Average	.000	-.194	.021	.218*	-.033	.108	.157	1.000	.329**
Self-Identity Average1	.060	-.061	.276*	.199	.042	.101	.321**	.329**	1.000
Self-Identity Average2	-.068	.309**	.385**	.393**	.389**	.370**	.382**	.291*	.340**

Table 8 6 The correlations between Two-finger tapping task expectancy and TPB questionnaire variables (n 60)

	Two-finger tapping task	Intentions Average	Attitude Average	Perceived Behavioural Control Average	Subjective Norm Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Two-finger tapping task	1.000	-.088	-.039	-.117	.076	.001	-.186	.085	-.073	.151
Intentions Average	-.088	1.000	.040	.204	.102	.080	.187	-.194	-.061	.309**
Attitude Average	-.039	.040	1.000	.403**	.426**	.326**	.506**	.021	.276*	.385**
Perceived Behavioural Control Average	-.117	.204	.403**	1.000	.519**	.772**	.686**	.218*	.199	.393**
Subjective Norm Average	.076	.102	.426**	.519**	1.000	.620**	.422**	-.033	.042	.389**
Belief Average	.001	.080	.326**	.772**	.620**	1.000	.676**	.108	.101	.370**
Habit Average	-.186	.187	.506**	.686**	.422**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	.085	-.194	.021	.218	-.033	.108	.157	1.000	.329**	.291*
Self-Identity Average1	-.073	-.061	.276*	.199	.042	.101	.321**	.329	1.000	.340**
Self-Identity Average2	.151	.309**	.385**	.393**	.389**	.370**	.382**	.291*	.340**	1.000

*p<0.05, **p<0.01. The higher the score for the Two-finger tapping task, the more likely expectancy effect could be predict

Table 8-6 The correlations between tension expectancy and TPB questionnaire variables (n 60)

	Tension	Intentions Average	Attitude Average	Subjective Norm Average	Perceived Behavioural Control Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Tension	1.000	.059	-.033	.273*	.260*	.305**	.126	.219	-.111	.198
Intentions Average	.059	1.000	.040	.102	.204	.080	.187	-.194	-.061	.309**
Attitude Average	-.033	.040	1.000	.426**	.403**	.326**	.506**	.021	.276*	.385**
Subjective Norm Average	.273*	.102	.426**	1.000	.519**	.620**	.422**	-.033	.042	.389**
Perceived Behavioural Control Average	.260*	.204	.403**	.519**	1.000	.772**	.686**	.218*	.199	.393**
Belief Average	.305**	.080	.326**	.620**	.772**	1.000	.676**	.108	.101	.370**
Habit Average	.126	.187	.506**	.422**	.686**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	.219*	-.194	.021	-.033	.218*	.108	.157	1.000	.329**	.291*
Self-Identity Average1	-.111	-.061	.276*	.042	.199	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	.198	.309**	.385**	.389**	.393**	.370**	.382**	.291*	.340**	1.000

Table 8-7 The correlations between anger expectancy and TPB questionnaire variables (n 60)

	Anger	Intentions Average	Attitude Average	Subjective Norm Average	Perceived Behavioural Control Average	Belief Average	Habit Average	Past Behaviour Average	Self- Identity Average1	Self-Identity Average2
Anger	1.000	.044	-.162	.052	.038	.142	.051	-.141	-.052	.074
Intentions Average	.044	1.000	.040	.102	.204	.080	.187	-.194	-.061	.309**
Attitude Average	-.162	.040	1.000	.426**	.403**	.326**	.506**	.021	.276*	.385**
Subjective Norm Average	.052	.102	.426**	1.000	.519**	.620**	.422**	-.033	.042	.389**
Perceived Behavioural Control Average	.038	.204	.403**	.519	1.000	.772**	.686**	.218	.199	.393**
Belief Average	.142	.080	.326**	.620**	.772**	1.000	.676**	.108	.101	.370**
Habit Average	.051	.187	.506**	.422**	.686**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	-.141	-.194	.021	-.033	.218	.108	.157	1.000	.329**	.291*
Self-Identity Average1	-.052	-.061	.276*	.042	.199	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	.074	.309**	.385**	.389**	.393**	.370**	.382**	.291*	.340**	1.000

Table 8-8 The correlations between vigour expectancy and TPB questionnaire variables (n 60)

	Vigour	Intentions Average	Attitude Average	Subjective Norm Average	Perceived Behavioural Control Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Vigour	1.000	.180	.098	.148	.318	.336**	.440**	-.067	.155	-.038
Intentions Average	.180	1.000	.040	.102	.204	.080	.187	-.194	-.061	.309**
Attitude Average	.098	.040	1.000	.426**	.403**	.326**	.506**	.021	.276*	.385**
Subjective Norm Average	.148	.102	.426**	1.000	.519**	.620**	.422**	-.033	.042	.389**
Perceived Behavioural Control Average	.318**	.204	.403**	.519**	1.000	.772**	.686**	.218	.199	.393**
Belief Average	.336**	.080	.326**	.620**	.772**	1.000	.676**	.108	.101	.370**
Habit Average	.440**	.187	.506**	.422**	.686**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	-.067	-.194	.021	-.033	.218	.108	.157	1.000	.329**	.291*
Self-Identity Average1	.155	-.061	.276*	.042	.199	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	-.038	.309**	.385**	.389**	.393**	.370**	.382**	.291*	.340**	1.000

Table 8-9 The correlations between fatigue expectancy and TPB questionnaire variables (n 60)

	Fatigue	Intentions Average	Attitude Average	Subjective Norm Average	Perceived Behavioural Control Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Fatigue	1.000	.147	-.007	-.108	.061	.122	-.008	-.174	.059	.014
Intentions Average	.147	1.000	.040	.102	.204	.080	.187	-.194	-.061	.309**
Attitude Average	-.007	.040	1.000	.426**	.403**	.326**	.506**	.021	.276*	.385**
Subjective Norm Average	-.108	.102	.426**	1.000	.519**	.620**	.422**	-.033	.042	.389**
Perceived Behavioural Control Average	.061	.204	.403**	.519**	1.000	.772**	.686**	.218	.199	.393**
Belief Average	.122	.080	.326**	.620**	.772**	1.000	.676**	.108	.101	.370**
Habit Average	-.008	.187	.506**	.422**	.686**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	-.174	-.194	.021	-.033	.218	.108	.157	1.000	.329**	.291*
Self-Identity Average1	.059	-.061	.276*	.042	.199	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	.014	.309**	.385**	.389**	.393**	.370**	.382**	.291*	.340**	1.000

*p<0.05, **p<0.01. The higher the score for fatigue, the more likely expectancy effect could be predicted.

Table 8-10 The correlations between confusion expectancy and TPB questionnaire variables (n 60)

	Confusion	Intentions Average	Attitude Average	Subjective Norm Average	Perceived Behavioural Control Average	Belief Average	Habit Average	Past Behaviour Average	Self-Identity Average1	Self-Identity Average2
Confusion	1.000	-.027	-.406	-.235*	-.149	-.223	-.159	.056	.033	-.226
Intentions Average	-.027	1.000	.040	.102	.204	.080	.187	-.194	-.061	.309**
Attitude Average	-.406**	.040	1.000	.426**	.403**	.326**	.506**	.021	.276*	.385**
Subjective Norm Average	-.235*	.102	.426**	1.000	.519**	.620**	.422**	-.033	.042	.389**
Perceived Behavioural Control Average	-.149	.204	.403**	.519**	1.000	.772**	.686**	.218	.199	.393**
Belief Average	-.223*	.080	.326**	.620**	.772**	1.000	.676**	.108	.101	.370**
Habit Average	-.159	.187	.506**	.422	.686**	.676**	1.000	.157	.321**	.382**
Past Behaviour Average	.056	-.194	.021	-.033	.218	.108	.157	1.000	.329**	.291*
Self-Identity Average1	.033	-.061	.276**	.042	.199	.101	.321**	.329**	1.000	.340**
Self-Identity Average2	-.226*	.309**	.385**	.389**	.393**	.370**	.382**	.291*	.340**	1.000

*p<0.05, **p<0.01. The higher the score for confusion, the more likely expectancy effect could be predicted