The Role of Impulsivity in Obesity and Weight-Loss Maintenance

by

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Submitted in fulfilment of the requirements for the degree of

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I am the author of the thesis entitled

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submitted for the degree of Doctor of Psychology (Health)

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Abstract of Dissertation

Approximately 18% of individuals who participate in a behavioural weight management program are successful at maintaining 10% or more of their weight loss long-term (i.e., after three years). Previous research has found that impulsivity may be a contributing factor that underlies the development and maintenance of obesity. Most studies focus on a unidimensional framework of impulsivity, whereas the two-factor model proposes two independent but related dimensions: rash impulsivity, and reward sensitivity. Furthermore, it is important to use a comprehensive measurement approach i.e., using both self-report and behavioural. A large cross-sectional study was conducted using self-report and behavioural measures of rash impulsivity and reward sensitivity. Participants were grouped into a number of categories according to BMI and weight loss history (i.e., healthy weight, overweight, obese, and weight-loss maintainers and weight-loss regainers). The overall sample consisted of 153 adults (mean age = 48.76 years, 88% female). The present dissertation consists of three primary aims. (1) Do overweight/obese adults have higher levels of impulsivity compared to healthy weight controls? (2) Are higher levels of impulsivity positively associated with weight-loss regain? (3) Is there a relationship between physical activity, impulsivity and successful weight-loss maintenance? Healthy weight individuals reported significantly lower levels of self-reported rash impulsivity than obese adults. Overweight/obese adults were more likely to regain their weight loss if they displayed heightened reward sensitivity (as measured by the Iowa Gambling Task). There was no association between physical activity and impulsivity and whether an individual was successful at weight-loss maintenance. The implications of these findings are discussed in relation to the development of interventions for individuals who are obese.
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Overview

Obesity

Obesity rates around the world are reaching pandemic proportions. Reducing obesity through weight loss is one of the most important health care interventions within Australian society and in many other Western countries. Even modest weight loss (>5% body weight) produces significant health benefits such as improvements in well-being, blood-glucose levels and triglycerides (Danielsen, Svendsen, Mæhlum, & Sundgot-Borgen, 2013; Goldstein, 1992; Shaw, O'Rourke, Del Mar, & Kenardy, 2005). However, obesity has proven difficult to treat (Spruijt-Metz, 2011). Approximately 18% of individuals who participate in a behavioural weight management program are successful at maintaining 10% or more of their weight loss long-term (i.e., after three years; Santos, Mata, Silva, Sardinha, & Teixeira, 2015). In order to reduce the physical, psychological, social and economic consequences associated with obesity, it is necessary to better understand some of the underlying mechanisms and maintaining factors associated with this complex disease.

Obesity and Impulsivity

Previous research has found that high levels of impulsivity may be a contributing factor that underlies obesity development (Bartholdy, Dalton, O’Daly, Campbell, & Schmidt, 2016; Fields, Sabet, & Reynolds, 2013; Jasinska et al., 2012; Lavagnino, Arnone, Cao, Soares, & Selvaraj, 2016; Lawyer, Boomhower, & Rasmussen, 2015). Impulsivity is a complex multi-dimensional personality trait made up of a number of factors. It can be characterised by the weakened ability to inhibit thoughts and behaviours, and a diminished regard for future consequences (Meda et al., 2009). Surprisingly, research in the obesity area
does not appear to have adopted a consistent theoretical framework to understand and measure impulsivity. The two-factor model of impulsivity, proposed by Dawe and colleagues (Dawe, Gullo, & Loxton, 2004; Dawe & Loxton, 2004), is a theoretically driven model made up of two independent but related dimensions – rash impulsivity, and reward sensitivity. Yet, some previous research has only focused on measuring rash impulsivity (Houben, 2011; Houben, Nederkoorn, & Jansen, 2014; Jasinska et al., 2012; Loeber et al., 2012; Mobbs, Iglesias, Golay, & Van der Linden, 2011; Reyes, Peirano, Peigneux, Lozoff, & Algarin, 2015), while others focus on reward-seeking traits. This could limit the overall understanding of the relationship between impulsivity and obesity. To address limitations within the current literature, this dissertation will utilise the two-factor model of impulsivity.

Impulsivity can be measured via self-report questionnaires, at the ‘trait’ level, or with behavioural measures of impulsivity, at the ‘state’ level (Sharma, Markon, & Clark, 2014). Yet, some previous research has only used self-report measures to investigate the differences between obesity and impulsivity (Annagur, Orhan, Yalcin, Ozer, & Tamam, 2015; Davis & Fox, 2008; Meule, Hofmann, Weghuber, & Blechert, 2016; Meule & Platte, 2015; Mobbs, Crépin, Thiéry, Golay, & Van der Linden, 2010) and others focus purely on behavioural measures. Very few studies have utilised the two-factor model, to look at the relationship between obesity and impulsivity, and less have examined both self-report and behavioural in the one study. This dissertation will report the findings of three primary aims which focus on examining the complex interplay between impulsivity, obesity and weight loss.

One large cross-sectional study was conducted which consisted of 153 (19 males and 134 females, 88% female) overweight and obese individuals, a group
of health weight controls, as well as successful weight-loss maintainers (WLMs) and weight-loss regainers (WLRs). The three primary aims of this dissertation are explored in three separate empirical chapters. The sample for these three chapters draw upon this larger sample collected as part of the dissertation. A brief summary of the aims and rationale for each empirical chapter is presented below.

First Empirical Chapter: Overweight and obese individuals often report higher levels of impulsivity (i.e., less inhibitory control) around palatable foods, resulting in a greater intake of calories, compared to healthy weight controls (Appelhans et al., 2011; Bartholdy et al., 2016; Brogan, Hevey, O'Callaghan, Yoder, & O'Shea, 2011). A recent systematic review and meta-analysis, investigating inhibitory control in obesity, found that inhibitory control was significantly compromised in obese adults and children, compared to healthy weight controls (Lavagnino et al., 2016). The aim of the first empirical chapter is to examine whether rash impulsivity and/or reward sensitivity are significantly associated with BMI status (healthy weight, overweight and obese) in an adult population.

Second Empirical Chapter: Reported on the relationship between impulsivity and weight-loss maintenance in a group of obese individuals. It is argued in this dissertation that impulsivity may distinguish successful weight-loss maintenance from regain (Byrne, Cooper, & Fairburn, 2003; Houben, Nederkoorn, & Jansen, 2012; Kitsantas, 2000; McKee, Ntoumanis, & Smith, 2013; Teixeira et al., 2015). Hence, this dissertation will explore whether higher levels of impulsivity may be positively associated with weight-loss regain. This may assist with developing therapeutic interventions around weight loss and weight management, which target impulsivity.
Obesity, Impulsivity and Physical Activity

Third Empirical Chapter: The relationship between obesity and impulsivity is continuing to grow and be explored in greater detail (Bartholdy et al., 2016; Fields et al., 2013; Lavagnino et al., 2016). One factor which may influence this relationship is physical activity. Recent neuroimaging research has suggested that increased levels of regular physical activity may enhance an individuals executive functioning, thereby influencing the relationship between impulsivity and obesity (Joseph, Alonso-Alonso, Bond, Pascual-Leone, & Blackburn, 2011). Conversely, previous research has found that lower levels of physical activity are thought to be associated with deficits in inhibitory control (i.e., higher levels of impulsivity; Lipnicki, Gunga, Belavý, & Felsenberg, 2009). Joseph et al. (2011) have proposed a model looking at the relationship between physical activity, eating behaviour and executive functioning. Based on these associations, the final aim of this dissertation is to investigate the association between physical activity, impulsivity and weight-loss maintenance, drawing upon the model proposed by Joseph and colleagues (Joseph et al., 2011).

The Current Dissertation

Chapter One of this dissertation will provide a comprehensive review of obesity and weight-loss maintenance. This chapter will highlight significant gaps in the literature and provide a theoretical framework for the current empirical chapters within this dissertation. Chapter Two will then initially provide a brief summary of the overarching concept of executive function. This chapter will then review the concept of impulsivity, with consideration of the two-factor model of impulsivity, how impulsivity can be measured, and its relationship with obesity and weight-loss maintenance. Chapter Three will examine the model proposed by
Joseph et al. (2011), and the relationship between physical activity, impulsivity and obesity/weight-loss maintenance. An overview of the methodological procedures and measures used in the three empirical chapters within the present dissertation will be provided in Chapter Four.

Chapter Five (first empirical chapter) will investigate whether overweight and obese adults display higher levels of impulsivity (measured via both self-report and behavioural measures), compared to a strictly defined healthy weight control group. A significant contribution of this dissertation will be the use of a “pure” healthy weight control group. Unlike some previous research, this dissertation will ensure that the healthy weight control group is strictly defined as having a lifetime history of healthy weight. Additionally, Chapter Five will investigate the relationship between self-report and behavioural measures of: rash impulsivity; and reward sensitivity. The primary aim of this chapter is to examine whether rash impulsivity and reward sensitivity are significantly associated with BMI status (healthy weight, overweight and obese) in an adult population.

Chapter Six (second empirical chapter) reports on whether those higher in impulsivity are more likely to regain their weight loss compared to those who successfully maintain their weight loss. This empirical chapter investigates a group of overweight and obese adults who lost weight more than a year ago, and are now attempting to maintain this weight loss. Specifically, Chapter Six investigates which component(s) of impulsivity (i.e., rash impulsivity or reward sensitivity, measured at both the self-report and behavioural level) differentiates successful weight-loss maintainers from weight-loss regainers.

Chapter Seven (final empirical chapter) will draw on principles from the model proposed by Joseph et al. (2011). The aim of this chapter is to examine whether there is a relationship between physical activity, impulsivity and weight-
loss maintenance. Chapter Seven also reports on whether those who maintain weight loss are more likely to: meet the physical activity guidelines (i.e., moderate physical activity or vigorous physical activity); and/or have lower levels of impulsivity (i.e., have an Iowa Gambling Task net score $\geq 0$), compared to those who regain weight.

The general discussion (Chapter Eight) will provide a critical analysis of the findings of three empirical chapters in the context of the current literature. Limitations, directions for future research and clinical implications will also be discussed.
Chapter One: Obesity

This chapter introduces the illness of obesity and briefly outlines the prevalence, factors contributing to the development of it, consequences of obesity and maintaining factors, as well as different types of weight-loss methods. The factors associated with successful weight-loss maintenance are also detailed.

1.1 Prevalence

From 1975 to 2014 the worldwide prevalence rate of obesity has more than doubled (NCD Risk Factor Collaboration (NCD-RisC), 2016). In 2014, 10.8% of men and 14.9% of women were obese, in contrast to 3.2% of men and 6.4% of women in 1975. The NCD Risk Factor Collaboration estimated that in 2014, 266 million men, and 375 million women were obese, and highlighted that the world’s population on average has become 1.5 kg heavier each decade since 1975 (NCD Risk Factor Collaboration (NCD-RisC), 2016). It is well recognised that the prevalence of obesity in children and adults is increasing at an alarming rate (Australian Bureau of Statistics, 2015; Australian Institute of Health and Welfare, 2016; NCD Risk Factor Collaboration (NCD-RisC), 2016; Wang & Lobstein, 2006). Nearly a fifth of the world’s obese adults (18.4%, 118 million), are from economically developed English-speaking countries, including the USA, UK, Ireland, Australia, New Zealand and Canada (NCD Risk Factor Collaboration (NCD-RisC), 2016; Ng et al., 2014; Schneider, Dietrich, & Venetz, 2010).

Similar to other developed countries, the prevalence of obesity has increased in Australia over the past few decades (Haby, Markwick, Peeters, Shaw, & Vos, 2012; Swinburn et al., 2011; Wang & Lobstein, 2006). In 2014–
2015, 63.4% of Australian adults (11.2 million) were overweight or obese, which consisted of 35.5% being overweight (6.3 million), and 27.9% being obese (4.9 million; Australian Bureau of Statistics, 2015). The proportion of overweight and obesity was larger among men (70.8%), compared to women (56.3%). This rate increased as people aged, with 39% for those aged 18–24 years old, to 74% for those aged 65–74 years old. In Australia, between 1995 and 2011–2012, the prevalence of overweight and obesity in adults increased from 56.3% to 62.8%, however there was no significant increase between 2011–2012 and 2014–2015 (Australian Bureau of Statistics, 2015). One in four Australian children (27.4%, 1 million) aged 5–17 years old were also overweight or obese in 2014–2015, which consisted of 20.2% overweight, and 7.4% obese. Similar to the adult statistics, there was no significant change in the proportion of children who were overweight or obese between 2011–2012 and 2014–2015 (Australian Bureau of Statistics, 2015).

Recent projections at a whole Australian population level suggest that the proportion of individuals who are healthy weight will decrease, overweight will remain stable, and obesity (including severe obesity) prevalence rates will continue to rise (Hayes, Lung, Bauman, & Howard, 2016). The rate of severe obesity (i.e., a Body Mass Index; BMI ≥ 35), which was approximately 5% in 1995, has now been projected to reach 13% by 2025, which is two to three times higher than the 1995 level (Hayes et al., 2016).

Obesity places a great economic burden on our society, and it has major implication on health (and is associated with multiple co-morbidities) and healthcare outcomes (van Smeerdijk, Jovic, Hutchins, Petre, & Lee, 2015; World Health Organization, 2014). Therefore it is imperative that more strategies are
developed to try and tackle this global problem (Australian Institute of Health and Welfare, 2016; NCD Risk Factor Collaboration (NCD-RisC), 2016). In order to do this, it is important to first better understand how to treat obesity, and what we can do to prevent it in the first place. The following few sections will explore this in greater detail.

1.2 Measurement and Classification of Obesity

The most commonly used measurement of obesity is BMI, defined as weight (kg)/ height (m²) (World Health Organization, 2000). The WHO classifications of BMI were created on evidence-based correlations between specific BMI ratings and the risk of chronic disease, mortality and morbidity risks (Shaw, Gennat, O’Rourke, & Del Mar, 2006). The classification of adult BMI’s, including overweight and obesity are shown in Table 1.1.

Table 1.1

Classification of Adults According to BMI

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.50</td>
</tr>
<tr>
<td>Healthy Weight</td>
<td>18.50–24.99</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.00–29.99</td>
</tr>
<tr>
<td>Obese</td>
<td>≥ 30.00</td>
</tr>
<tr>
<td>Class I</td>
<td>30.00–34.99</td>
</tr>
<tr>
<td>Class II</td>
<td>35.00–39.99</td>
</tr>
<tr>
<td>Class III</td>
<td>≥ 40.00</td>
</tr>
</tbody>
</table>
1.3 Contributing Factors and Consequences of Obesity

Obesity is fundamentally the result of an imbalance between energy intake and energy expenditure. It is a multifactorial disorder that is caused by a complex interaction of several factors including, biochemical, psychological, social, environmental, genetic, and economic (Roqué i Figuls et al., 2013). Health psychologists typically examine illnesses and conditions like obesity using the bio-psychosocial model, which is made up of biological (genetic, biochemical), psychological (behavioural, mood, personality) and social factors (socio-economic, familial, cultural; Caltabiano & Ricciardelli, 2012; Sarafino & Smith, 2010). They investigate how these factors interplay together to have an influence on health and illness. A bidirectional and perpetuating relationship has been proposed between obesity and the biological, psychological and social factors associated with the disease (Australian Institute of Health and Welfare, 2006; Wadden, Womble, Stunkard, & Anderson, 2002b). Furthermore, The National Institute of Health has called for greater collaboration between behavioural and psychological researchers to better understand obesity and to develop enhanced weight-loss maintenance strategies (MacLean et al., 2015). The following section will go into further detail about the physical, genetic, psychological, social and environmental health consequences associated with obesity, as well as the large economic costs.

1.3.1 Physical.

Obesity has been linked to many physical comorbidities including but not limited to: hypertension; dyslipidaemia; osteoarthritis; gallbladder disease; musculoskeletal difficulties; sleep apnoea and respiratory problems (e.g., asthma); Type 2 diabetes mellitus (T2DM); cardiovascular disease (CVD); coronary heart
disease (CHD); depression; reproductive problems for women; and even premature death (Australian Institute of Health and Welfare, 2016; Jensen et al., 2013; NCD Risk Factor Collaboration (NCD-RisC), 2016; World Health Organization, 2000). An obese individual has a 30% greater risk of premature death from diseases such as CVD, T2DM, and many cancers (e.g., breast, colon, kidney), and the risk increases by 100% when an individual has a BMI in excess of 40 (Wadden, Brownell, & Foster, 2002a). Each increase of 5 kg/m$^2$ in BMI is on average associated with approximately 30% higher overall rate of mortality (Prospective Studies Collaboration, 2009). Median survival is reduced by 2–4 years, for individuals with a BMI between 30–35 kg/m$^2$, and 8–10 years, for those with a BMI between 40–45 kg/m$^2$.

Specifically, obesity has been linked to a range of health complications due to individuals having an increased mechanical load (i.e., more pressure on joints and muscles, due to greater weight), and elevated amounts of body fat, which cause related disturbances to the metabolic and/or endocrine functioning of the body (Wirth, Wabitsch, & Hauner, 2014). Fatty tissue stores energy within the body, and is also a functioning endocrine organ, which is directly linked to the intermediary metabolism. The physical costs of obesity can also significantly reduce an individual’s quality of life and lessen their sense of well-being (Renzaho, Wooden, & Houng, 2010).

1.3.2 Genetics.

It has been well established that genetics may predispose some individuals to developing obesity (Hinney, Vogel, & Hebebrand, 2010; Wadden et al., 2002a). Obesity develops from the interaction of multiple genes, behaviours and environmental factors (Yang, Kelly, & He, 2007). Twin, adoption and family
studies have indicated that an individual’s risk of obesity is increased by 16–85% when an individual has a relative that is also obese (Allison et al., 1996; Hinney et al., 2010; Platte et al., 2003; Stunkard, Foch, & Hrubec, 1986a; Stunkard et al., 1986b). When looked at separately twin studies, compared to family and adoption studies have found that genetic effects can explain approximately 60–90% of variance in BMI (Hinney et al., 2010). Previous research has examined twins who were reared apart, and found that the genetic heritability was similar to twins who were raised together (Koeppen-Schomerus, Wardle, & Plomin, 2001; Pietilainen et al., 1999; Stunkard, Harris, Pedersen, & McClearn, 1990).

A recent systematic review and meta-analysis investigated the fat mass and obesity associated (FTO) gene and weight-loss intervention success (via physical activity, diet or pharmacotherapy interventions) in 9563 individuals (Livingstone et al., 2016). They found that individuals who were carriers of the FTO minor allele, responded just as well to weight-loss interventions, and that there was no significant differences in adiposity. While some individuals may have a genetic predisposition to obesity associated with the FTO gene, this can be partly counteracted, because they respond just as well to physical activity, diet or pharmacotherapy weight-loss interventions (Livingstone et al., 2016).

1.3.3 Psychological.

There are a number of psychological factors which may also contribute to excessive weight gain. Previous research has found that obesity on its own does not appear to be systematically connected with psychopathological outcomes (Fabricatore & Wadden, 2004; Shaw et al., 2005). However, this is in contrast with the clinical impression, which has found that some obese individuals are at a
greater risk of psychiatric disorder, particularly depression and anxiety (Shaw et al., 2005).

Overweight and obese women are especially vulnerable to depression and anxiety, reduced quality of life, lower self-esteem, and higher rates of suicide ideation, and suicide intent (Carpenter, Hasin, Allison, & Faith, 2000; Fabricatore & Wadden, 2004; Jorm et al., 2003; Renzaho et al., 2010). Obese individuals have higher rates of psychopathology, including binge eating disorder, night eating syndrome, body shape dissatisfaction and approximately 25% increase in the odds of mood and anxiety disorders (Colles, Dixon, & O'Brien, 2007; Harriger & Thompson, 2012; Jorm et al., 2003; Preiss, Brennan, & Clarke, 2013; Simon et al., 2006; Stunkard, 2002; World Health Organization, 2000; Zhao et al., 2009). One study found that as BMI increased (i.e., from healthy weight to class III obesity) that the prevalence of night eating syndrome increased, and that there was a significant difference between BMI groups (p < .001; Colles et al., 2007).

These psychological comorbidities can also have negative effects upon an individual’s weight loss treatment adherence and outcomes (Star, Hay, Quirk, & Mond, 2015).

A bidirectional relationship between obesity and depression has been proposed (Markowitz, Friedman, & Arent, 2008; Preiss et al., 2013). When an individual is depressed they can experience a range of symptoms, such as negative thoughts; lack of social support; and poor adherence to and lack of exercise, which can in turn result in them gaining weight and becoming obese. This can have flow on effects of binge eating disorder, dieting, social stigma, perceived weight cycling, which can all exacerbate symptoms of depression as well as obesity (Markowitz et al., 2008; Preiss et al., 2013). Some obese
individuals can be more vulnerable to developing depression, and this can be dependent on certain moderators, such as severe obesity; gender; socioeconomic status (SES); and body image dissatisfaction. However, it is almost impossible to ascertain if obesity causes depression, or vice versa.

Weight-based discrimination and prejudice experienced by obese individuals is thought to be largely associated with negative psychological consequences (Puhl & Heuer, 2009, 2010; Puhl & King, 2013; Williams, Mesidor, Winters, Dubbert, & Wyatt, 2015). Weight based teasing across all stages of life has consistently been associated with greater body image dissatisfaction (Gavin, Simon, & Ludman, 2010; Puhl & King, 2013; Sarwer, Thompson, & Cash, 2005). It has been proposed that body image can act as both a mediator and moderator between weight and mental health (Markowitz et al., 2008).

Finally, a lot of interest and research has also investigated whether there are other cognitive/psychological factors which are directly associated with obesity (Jokela et al., 2013; Provencher et al., 2008; Rydén et al., 2003; Shaw et al., 2005). A meta-analysis found that high conscientiousness (i.e., individuals who have low levels of impulsivity, good self-control, and are well organised) was associated with a reduced risk of obesity (Jokela et al., 2013). Thus, an important contributor in the area of obesity and addictive behaviour is impulsivity (Dawe & Loxton, 2004; Houben et al., 2014; Thamotharan, Lange, Zale, Huffhines, & Fields, 2013). Impulsivity is thought to be associated with an increased consumption of palatable food, and decreased levels of physical activity, both of which can contribute to the onset and maintenance of obesity (Thamotharan et al., 2013).
1.3.4 Social and environmental.

Some researchers have argued that the marked increase in prevalence rates of obesity in the past 30 years (a single generation) appears to be the result of social and environmental factors (Wadden et al., 2002a; Yang et al., 2007). Modernisation has resulted in changes in our physical activity levels and dietary patterns, such as increased sedentary behaviours and increased abundances of high calorie energy dense foods (Pearson & Biddle, 2011; Popkin & Gordon-Larsen, 2004; World Health Organization, 2010).

There have also been changes in the types of behaviours performed during leisure time (Popkin & Gordon-Larsen, 2004). Research has found that screen time (largely TV viewing), is related to unhealthy dietary behaviours in adults, adolescents and children, and that an increased rate of sedentary leisure time is associated with weight gain and obesity (for a review see Pearson & Biddle, 2011). Another shift has been in the modes of transportation that people use. Today, children appear less likely to walk to school and are more likely to travel in cars than they were a couple of decades ago (Anderson & Butcher, 2006). The job sector has also shifted away from the high-energy expenditure activities (e.g., mining, forestry and farming) towards more of the service sector (Australian Institute of Health and Welfare, 2016; Popkin & Gordon-Larsen, 2004).

Our neural systems have also become flooded with health-deterring stimuli (e.g., decreased necessity for physical activity, and abundant junk food advertisements), resulting in human food consumption being largely driven by ‘hedonic hunger’ or the pleasure of eating, instead of the as the result of the homeostatic principles of energy balance (Joseph et al., 2011; Lowe & Butryn, 2007). The consumption of a diet high in saturated fats, sugars, and refined foods,
but low in fibre (often termed the ‘Western Diet’), as well as lifestyles characterised by lower levels of physical activity have therefore become commonplace (Johnson, Pratt, & Wardle, 2012).

Social and environmental factors not only contribute to the development of obesity but they are also associated with substantial negative consequences. Overweight and obese individuals disproportionately encounter strong prejudice and discrimination, and this is particularly pervasive in Western countries (Puhl & Heuer, 2009, 2010; Puhl & King, 2013; Roehling, 1999). This stigmatisation or weight bias occurs in areas such as the media, healthcare, education, employment and interpersonal relationships (Puhl & Heuer, 2009, 2010; Puhl & King, 2013; Wadden et al., 2002b). Weight bias is usually due to the pervasive negative stereotypes that overweight and obese individuals are lazy, sloppy, less competent, less conscientious, disagreeable, emotionally unstable, unmotivated, and lacking self-discipline (Puhl & Heuer, 2009, 2010; Puhl & King, 2013; Roehling, 1999). For instance, Neumark-Sztainer et al. (2002) found that many overweight and obese adolescents experienced weight stigmatisation (e.g., name calling and teasing) from peers, as well as family members. This discrimination also translates into inequality in job hiring, job evaluation, wages and other employment choices (Caltabiano & Ricciardelli, 2012). In relation to direct health consequence, research has indicated that obese individuals are less likely to access healthcare services, even if they have good healthcare. For example, Amy, Aalborg, Lyons, and Keranen (2006) surveyed 498 overweight and obese women (who had high access to healthcare) and found that 68% of the heaviest women reported that they delayed their routine gynaecological cancer screening due to their weight. Typical barriers included negative attitudes from their healthcare
providers, small ineffective equipment, disrespectful treatment, and unwelcomed advice to lose weight. More recently, a nationally representative sample of 1064 adults found that 21% of individuals would find a new doctor, and 19% would avoid future medical appointments if they felt stigmatised by their local doctor about their weight (Puhl, Peterson, & Luedicke, 2013).

1.3.5 Economic.

Not only does obesity affect an individual’s health, but it also places a great economic strain on society and healthcare providers. The direct costs of obesity are staggering, and they include the costs of pharmaceuticals and research, operating healthcare facilities (e.g., care delivered in emergency departments, as well as in inpatient, and outpatient settings) and healthcare administration (Caltabiano & Ricciardelli, 2012). Indirect costs include transportation, equipment, productivity losses, early retirement, costs for respite programs, and carer costs (Dee et al., 2014; World Health Organization, 2000).

An analysis by Buchmueller and Johar (2015) investigated the individual health care claims from 2006-2009, in a random sample of 240,000 Australian adults aged 45 years and over. This particular group of individuals is a key consumer of healthcare, as they have an obesity rate of almost 30%. Buchmueller and Johar (2015) found that compared to the average annual healthcare expenditures of healthy weight adults, those with Class I obesity (BMI of 30–34.99) were 19% higher, and those with Class II/III obesity (BMI ≥ 35) were 51% higher in health care expenditures. In particular the greatest impact of obesity was found in women aged 60–74 years old, and men aged 75 years and over. In Australia in 2011–2012 the total financial cost of obesity was approximately AU$8.6 billion (van Smeerdijk et al., 2015). When the “conceptual” costs, which
take into account the impact that obesity has on health and wellbeing (e.g., depression, discrimination, quality of life) were investigated, the figure was estimated to be AU$47.4 billion (van Smeerdijk et al., 2015). Previous research has also found that the health and wellbeing costs, far surpass the direct and indirect costs of obesity. For example, Access Economics (2008) estimated the total financial cost of obesity at AU$58.2 billion.

It is predicted that the rise in severe obesity will have a significant economic impact on our healthcare system, compared with previous decades, which saw more of a shift from healthy weight to overweight BMI status (Hayes et al., 2016). If no action is taken to address the growth of obesity, it has been estimated that by 2025, there will be a total of AU$87.7 billion in additional indirect and direct costs to the Australian economy (van Smeerdijk et al., 2015). Hence, there is a strong need to decrease this healthcare expenditure burden on today’s society. While some obese individuals may try to lose a substantial amount of weight (e.g., 20–40% of their starting weight), previous research has found that even modest weight loss (i.e., >5% of an individual’s initial body weight) can produce significant health benefits, and a reduction of 10% or more is encouraged and supported (Anderson & Konz, 2001; Barte et al., 2010; Goldstein, 1992). Hence, even modest weight loss may assist with decreasing the economic impact associated with obesity, through improving an individuals overall health and decreasing their reliance upon the healthcare system. There are a number of different weight-loss methods, and each has their own advantages and disadvantages, which will now be described in greater detail.
1.4 Weight-loss Methods

Weight-loss methods are many and are quite varied. They include methods such as dietary and/or exercise interventions, psychological therapies, pharmacotherapy and surgery (Chen, Tseng, Kuo, & Chang, 2016; Colquitt, Pickett, Loveman, & Frampton, 2014; Dombrowski, Knittle, Avenell, Araujo-Soares, & Sniehotta, 2014; Greenway et al., 2010; Ruotsalainen, Kyngäs, Tammelin, & Kääriäinen, 2015; Shaw et al., 2005; Teixeira et al., 2015). The choice of treatment depends on an individual’s BMI, weight-loss history, health, risk factors, and preferences, in addition to accessibility, treatment safety, efficacy and affordability (National Health and Medical Research Council, 2013). While most weight-loss interventions can achieve short-term weight loss (i.e., within 6 months), individuals typically regain the weight in the medium to long-term (i.e., within 1-5 years; Phelan, Wing, Loria, Kim, & Lewis, 2010). The factors that predispose an individual to weight regain will be discussed in greater detail later on in this chapter.

In 2013 an executive summary on the guidelines for the management of adults who are overweight or obese was published by the American College of Cardiology/American Heart Association Task Force (Jensen et al., 2013). An extensive treatment algorithm was created as part of this report. It suggests that clinicians should measure an individual’s weight, and height, and calculate their BMI, as well as measure waist circumference for individuals who have a BMI between 25–34.9 kg/m², to provide further information on risk. It has been recommended that a cut-off point of >102 cm for men, and >88 cm for women, be used as a sign of greater cardio metabolic risk (Jensen et al., 2013). The clinician should also ask questions around an individual’s weight-loss history, including
specific details of previous weight-loss attempts, a history of their weight loss and regain, exercise and dietary habits, medication or medical conditions which may affect weight, and family history of obesity (Jensen et al., 2013). Answers to these questions will provide vital information about difficulties and success with previous weight-loss and/or maintenance efforts, as well as the origins of, or the maintaining factors of an individual becoming overweight or obese. In turn this will then help the clinician to assess an individual’s readiness to change, and help them select which treatment, and weight-loss method (if necessary), would be best for them based on research and individual preferences. The next section will provide specific information about dietary and exercise interventions, psychological therapies, pharmacotherapy and bariatric surgery.

1.4.1 Dietary and exercise interventions.

A review and meta-analysis of weight loss found that a combination of diet (typically energy reduced low-fat diets) and exercise (combination of resistance training and aerobic exercise) interventions were more effective at reducing body weight in overweight and obese participants, compared with either diet or exercise alone (Schwingshackl, Dias, & Hoffmann, 2014). There were also significantly more improvements in fat-mass, waist circumference and waist-to-hip ratio following a combination of diet and exercise, compared with either diet or exercise alone. When diet was compared with exercise, diet was more effective at reducing body weight (Mean Difference (MD) = –2.93 kg; Schwingshackl et al., 2014). Other meta-analyses have also found that interventions focusing on both diet and exercise can significantly improve diabetes risk factors (Appuhamy et al., 2014), improve weight loss across different BMI classes (Barte, Veldwijk, Teixeira, Sacks, & Bemelmans, 2014), and decrease weight regain (average
difference = $-1.56$ kg) compared to controls at one-year follow-up (Dombrowski et al., 2014).

The National Health and Medical Research Council (2013) also concluded that dietary interventions alone on average result in a 3–5 kg weight loss at one year, but a 0 kg loss at five years. Conversely, they found that exercise alone results in an average of a 0 kg weight loss at one year and also at five years. When dietary and exercise interventions are combined, on average a 5–10 kg loss at one year, and a 0–3 kg loss at five years (National Health and Medical Research Council, 2013).

In regards to physical activity interventions, a recent review investigated the effects of exercise on BMI and psychological symptoms in overweight and obese adolescents (12–18 years old; Ruotsalainen et al., 2015). They found that interventions that included supervised exercise had the greatest effect (0.36) on changes in adolescents BMI. Exercise interventions also had positive effects in regards to body satisfaction, eating disorder symptoms and physical self-perceptions, but there was no change in symptoms of depression (Ruotsalainen et al., 2015). Greater exercise intensity is also associated with more weight loss (Weighted Mean Difference (WDM) = $-1.5$ kg; Shaw et al., 2006). In terms of weight-loss maintenance, research has shown that while dietary interventions are useful for short-term weight loss, exercise appears to be imperative for long-term maintenance (Annesi & Whitaker, 2010; Reyes et al., 2012).

1.4.2 Psychological interventions.

The most commonly used and extensively evaluated psychological weight-loss interventions are behaviour therapy (BT) and cognitive behavioural therapy (CBT). This is largely because they have shown to enable increased
weight-loss maintenance than other therapies (Shaw et al., 2005). Behavioural interventions usually consist of goal setting, physical activity, nutrition, self-monitoring, problem solving, stimulus control, cognitive restructuring, and relapse prevention (Shaw et al., 2005; Wing et al., 2008).

A meta-analysis of 36 studies investigated the effects of psychological interventions for overweight and obesity (Shaw et al., 2005). While this is an older Cochrane review an update of this review is currently being undertaken. Shaw et al. (2005) determined that behaviour therapy when assessed as a stand-alone weight loss strategy resulted in significantly greater weight loss than placebo (WMD = −2.5 kg). However, when combined with an exercise or diet approach, and compared with exercise or diet alone, the combined intervention resulted in a greater weight loss. Weight loss also significantly increased when the intensity of the behavioural intervention increased (WMD = −2.3 kg). It appears that when cognitive techniques are added to traditional behavioural therapy, the programs success is improved and it helps to reduce weight regain (Cooper & Fairburn, 2001). Shaw et al. (2005) reported that CBT, when combined with an exercise or diet intervention, resulted in increased weight loss in comparison to diet or exercise alone (WMD = −4.9 kg).

While CBT approaches are typically utilised for weight-loss interventions, they are not generally used to address the psychological outcomes, such as decreased self-efficacy, anxiety, depression, social isolation or stigma, that are often present in contrast to an individual’s weight goals (Shaw et al., 2005). It has been proposed that mindfulness-based interventions could provide an alternative psychological approach, for adults who are overweight or obese, which could address the gaps in weight control treatments (Forman & Butryn, 2015; Lillis,
A recent meta-analysis of 15 studies, investigated the psychological and physical health outcomes of mindfulness-based interventions for adults who were overweight or obese (Rogers, Ferrari, Mosely, Lang, & Brennan, 2017). They determined that mindfulness-based interventions had a large significant effect for improving eating behaviours ($g = 1.08$), a medium significant effect for depression ($g = 0.64$), anxiety ($g = 0.62$) and problematic attitudes towards eating ($g = 0.57$), and a small significant effect for BMI ($g = 0.47$) and metacognition ($g = 0.38$), from pre-treatment to post-treatment. The average weight loss was 4.2 kg, and improvements in quality of life ($g = 0.66$), and stress ($g = 0.39$) approached significance (Rogers et al., 2017). While these results are promising, further research is required to better understand the role that mindfulness-based interventions can play in the treatment of obesity.

Finally, Teixeira et al. (2015) conducted a systematic review to identify mediators in successful obesity intervention programs. They found that self-regulation, autonomous motivation and self-efficacy were mediators of successful weight-loss maintenance, and physical activity.

### 1.4.3 Pharmacotherapy.

The use of weight-loss medications in addition to lifestyle approaches has been reported to increase weight reduction in overweight and obese adults (Franz et al., 2007). A systematic review and meta-analysis found that Orlistat (Xenical) when combined with behavioural interventions was associated with modest additional weight reductions (MD = −1.80 kg), compared to placebo (Dombrowski et al., 2014). Furthermore, a higher dose of Orlistat (i.e., 120 mg three times a day) was associated with greater weight-loss maintenance (−2.34 kg) compared to a lower dose (i.e., 60 mg and 30 mg three times a day; −0.70 kg).
However, Orlistat is also associated with some adverse side effects, such as gastrointestinal side effects, particularly steatorrhoea (fatty/oily stool), fatty faecal incontinence, and urgent or regular bowel movements (Padwal, Li, & Lau, 2003).

A review of the use of the combined therapy of Naltrexone/Bupropion (NB) for obesity, found that both of these agents have an effect on food craving, food intake, and other components of eating behaviour which affect body weight (Billes, Sinnayah, & Cowley, 2014). NB is thought to act in the hypothalamic brain regions, which regulate energy and appetite expenditure, as well as affecting eating behaviour, which is mediated by the reward system (Billes et al., 2014). Individuals, who have used NB for obesity, typically lose at least 5% or 10% of their starting weight. Side effects of NB include nausea, headaches and constipation in >10% of individuals, and dizziness, insomnia, and dry mouth in <10% of individuals (Greenway et al.; Sweeting, Hocking, & Markovic, 2015). While medications can facilitate weight loss they often result in weight regain once they are no longer being taken.

1.4.4 Bariatric surgery.

Bariatric (weight-loss) surgery is currently the only weight-loss method which achieves both substantial and sustained weight loss (Caltabiano & Ricciardelli, 2012). Laparoscopic adjustable gastric banding (LAGB), roux-en-Y gastric bypass (RYGB), biliopancreatic diversion (BPD), and sleeve gastrectomy (SG) are the procedures currently used in Australia (National Health and Medical Research Council, 2013). Each procedure has its own benefits, drawbacks and risk profile (Colquitt et al., 2014; Fisher & Schauer, 2002). In 2013 just over 10,000 bariatric operations were performed (Angrisani et al., 2015).
Bariatric surgery with maintained lifestyle changes (i.e., diet, exercise, and psychological therapy) is the most effective method in achieving weight loss in obese adults (Buchwald et al., 2009; Colquitt et al., 2014; National Health and Medical Research Council, 2013). Research across a number of studies consistently shows that individuals achieve >10% weight reduction, and weight loss is likely to be maintained for longer than five years, in some but not all individuals (Colquitt et al., 2014; National Health and Medical Research Council, 2013; O’Brien, MacDonald, Anderson, Brennan, & Brown, 2013). Specifically, a review of bariatric surgery in adults found that surgery was significantly more successful than lifestyle interventions, and that further research was still required to determine the effects of surgery on quality of life (Colquitt et al., 2014).

1.5 Weight-Loss Maintenance

As highlighted above, a large proportion of research has investigated the effectiveness of different weight-loss methods. However, most people do not succeed in maintaining long-term weight loss because they typically revert back to their old behaviours (Appelhans, French, Pagoto, & Sherwood, 2016; Look AHEAD Research Group, 2014; MacLean et al., 2015). Often individuals cannot sustain the large changes they have put in place (typically severely restricting their diet) to lose their initial weight. While previous research has investigated the predictors of successful weight-loss maintenance and failure (for reviews see; Barte et al., 2010; Elfhag & Rössner, 2005; Ohsiek & Williams, 2011; Ramage, Farmer, Eccles, & McCargar, 2014; Wing & Phelan, 2005) there is no one factor which consistently predicts success or failure. Given that obesity is such a large public health concern, further research is required to investigate these factors, to better understand this disease (Phelan et al., 2010). Debate exists around what the
optimal rate of initial weight loss should be, and how successful weight-loss maintainers (WLMs) and weight-loss regainers (WLRs) should be measured or defined (in the context of research). The factors and controversies surrounding successful weight-loss maintenance will now be explored in greater detail.

1.5.1 Factors that contribute to successful weight-loss maintenance.

Weight-loss maintenance is challenging. Therefore, a better understanding of the factors that contribute to successful weight-loss maintenance, will allow for greater knowledge around the behaviours that are required for sustaining a lowered body weight long-term.

Individuals who keep their weight off for two or more years have markedly increased odds of continuing to maintain their weight loss over the following years, and decrease their risk of subsequent regain by more than 50% (McGuire, Wing, Klem, Lang, & Hill, 1999; Thomas, Bond, Phelan, Hill, & Wing, 2014; Wing & Phelan, 2005). Throughout the first years of weight-loss maintenance, constant energy and attention is required to control weight (Ulen, Huizinga, Beech, & Elasy, 2008). After two years, it has been ascertained that successful WLMs are not as dependent upon weight loss strategies, and pay less attention and effort to controlling their weight, possibly indicating that a new habit has been integrated into their lifestyle (Klem, Wing, Lang, McGuire, & Hill, 2000). It has also been proposed that the positive consequences of weight loss (such as better fit of clothing, or a sense of achievement) initially offset the physical and cognitive strength required to lose weight. However, when the goal shifts to maintaining the lost weight, the positive results become less, compared with the effort needed to continue following the same regime (MacLean et al.,
2015). Hence, the costs associated with long-term weight-loss maintenance do not appear to justify the benefits any more.

A collection of studies have used data from the National Weight Control Registry (NWCR) to identify eight main behavioural strategies which are important for successful weight-loss maintenance (Niemeier, Phelan, Fava, & Wing, 2007; Raynor, Phelan, Hill, & Wing, 2006; Thomas et al., 2014; Wing & Phelan, 2005; Wyatt et al., 2002). The NWCR is a longitudinal database comprising information on over 10,000 self-selected individuals, (mostly white, educated women) who have maintained a weight loss of 13.6 kg or more, for at least one year (Ulen et al., 2008). Strategies of successful weight-loss maintenance include: limiting watching television to no more than a few hours a day, and engaging in high levels of physical activity (including leisure-time physical activity); maintaining a consistent pattern of eating across the week (as opposed dieting more strictly on weekdays); regularly eating breakfast; consuming a low-fat and low-calorie diet; controlling emotional eating; frequent self-monitoring; and recognising when slip ups happen, and initiating corrective behaviours before large weight regains can occur (Niemeier et al., 2007; Raynor et al., 2006; Thomas et al., 2014; Wing & Phelan, 2005; Wyatt et al., 2002).

As highlighted by the NWCR high levels of physical activity are associated with successful weight-loss maintenance. This finding has also been supported by other previous research (Jakicic, Marcus, Lang, & Janney, 2008; Karfopoulou, Mouliou, Koutras, & Yannakoulia, 2013; Santos et al., 2015; Swift, Johannsen, Lavie, Earnest, & Church, 2014; Weiss, Galuska, Kettel Khan, Gillespie, & Serdula, 2007). In particular, animal models of obesity have found that both regimented and leisure-time physical activity attenuates weight regain
following weight loss, and that physical activity counterbalances the biological factors, which encourage weight regain, by increasing energy expenditure and decreasing intake (MacLean et al., 2009; Steig et al., 2011). The Look AHEAD Research Group (2014) discovered that individuals who participated in high levels of physical activity, were able to maintain the full ≥ 10% weight loss at eight years post intervention (intensive lifestyle intervention; ILI, verses diabetes support and education; DSE). Furthermore, individuals who exercise autonomous motivation (i.e., meaningful extrinsic and intrinsic motives, for example improving your health) are more likely to be successful at weight-loss maintenance (Santos et al., 2015; Teixeira et al., 2010). For example, Santos et al. (2015) found that women with high exercise autonomous motivation were significantly more likely to achieve ≥ 10% weight loss at three years (36%; n = 15), compared with those who had low exercise autonomous motivation (11%; n = 12). Alternatively, one study by Metzgar, Preston, Miller, and Nickols-Richardson (2015) found that women self-reported that they thought a lack of exercise was a large barrier to their inability to maintain their weight loss long-term. Some of the main issues for these women were finding ‘enjoyable activities’ and ‘time’ to exercise, while others reported ‘feeling guilty’ if they exercised and took time out for themselves.

Self-monitoring is also crucial for regulating and maintaining weight-loss behaviours (McKee et al., 2013; Wing, Tate, Gorin, Raynor, & Fava, 2006). One explicit example of this in successful weight-loss maintenance is self-weighing. While most studies acknowledge that regular self-weighing is necessary for long-term weight-loss maintenance, concerns have been raised that it could negatively affect mood and increase an individual’s risk of developing an eating disorder.
(Carrard & Kruseman, 2016; Dionne & Yeudall, 2005; Feller et al., 2015; Ogden & Whyman, 1997). Wing et al. (2007) investigated this issue and found that the opposite was true. Their “STOP Regain” clinical trial examined the relationship between frequency of self-weighing and possible negative effects in individuals who had successfully lost weight. They determined that increases in frequency of self-weighing was related to decreases in dietary disinhibition, decreases in depressive symptoms, and increases in dietary restraint (Wing et al., 2007). More recently Carrard and Kruseman (2016) conducted a qualitative analysis, investigating the role of self-weighing as a weight control strategy in 18 individuals with successful weight-loss maintenance compared to 18 lifelong healthy weight stable individuals. They determined that regular self-weighing was beneficial with helping them to control their physical activity and food intake. However, Carrard and Kruseman (2016) highlighted that an individuals psychological well-being, including their self-esteem, should be screened and addressed, as required, because while weight loss was associated with happiness, weight gain was connected with guilt, anger, anxiety, self-blaming, and sadness.

Psychological correlates of successful weight-loss maintenance have also been examined by Ohsiek and Williams (2011). They reported that avoiding disinhibited eating (loss of control over eating), eating to regulate mood (emotional eating) and dichotomous (i.e., ‘all-or-nothing’ or ‘black-and-white’) thinking were associated with better weight-loss maintenance. Perceived benefits outweighing costs (i.e., compliments from others vs. guilt over weight control failures), increased dietary restraint, more positive body image, greater social support, lower or stable levels of depression, positive self-talk and productive problem-solving skills are also associated with successful weight-loss
maintenance (Elfhag & Rössner, 2005; Houben et al., 2012; Johnson et al., 2012; Ohsiek & Williams, 2011; Reyes et al., 2012; Wing & Hill, 2001; Wing et al., 2007).

It has also been suggested that some individuals may stop adhering to their regime because their long-standing habitual behaviours, which generated their original excess weight, reappear after a period of successful control (MacLean et al., 2015; McKee et al., 2013). This change has been associated with self-regulation failure (Annesi & Whitaker, 2010; Byrne et al., 2003; Houben et al., 2012; McKee et al., 2013). It has been suggested that the ability to inhibit behavioural impulses, in order to attain long-term health goals is a factor which contributes to successful weight-loss maintenance (Heatherton & Wagner, 2011). Lapses in health behaviours are often associated with stress or negative mood states (e.g., sadness; Baumeister & Heatherton, 1996; Hall & Fong, 2007). Some researchers suggest that individuals regain weight because they are only capable of regulating their emotions and behaviours to a certain degree before that ability becomes exhausted, and they can no longer inhibit the behavioural impulse (Baumeister & Heatherton, 1996; Baumeister, Heatherton, & Tice, 1994). The role of cognitive restraint (i.e., the amount of conscious self-control exerted over eating behaviours), for successful weight control and eating regulation has been the topic of considerable debate (Johnson et al., 2012; Lowe, 2003; Teixeira et al., 2015). Some researchers have found that individuals who exercise a rigid dietary restraint pattern (as opposed to a more flexible pattern) are positively associated with measures of disinhibited eating, and subsequent weight regain (Stewart, Williamson, & White, 2002; Westenhoefer, Stunkard, & Pudel, 1999). Epidemiological and field study evidence offers limited support that restrained
eating triggers disinhibited eating patterns (Johnson et al., 2012). It has been suggested that that even though a sustained effort and control over food intake is necessary for successful weight-loss maintenance, a more flexible attitude to eating (e.g., foods high in fat and sugar can be eaten in small quantities without guilt) is crucial for sustained weight loss (Johnson et al., 2012; Teixeira et al., 2010).

There is also contention about how successful weight-loss maintenance (in the context of research) should be defined. A limitation of the current literature on weight-loss maintenance is how to best define someone who is successful at weight-loss maintenance. For example, Phelan et al. (2011) define successful weight-loss maintenance as individuals who: are currently within a healthy weight range (but were obese at some point in their life (excluding pregnancy)); have maintained a weight loss of at least 15 kg for a minimum of three years; and for the past two years they have been weight stable to within 3 kg. Earlier research has suggested a less stringent criteria with successful weight-loss maintenance defined as individuals with an intentional weight loss of at least 10% of their initial body weight, and maintained this weight loss for at least one year (Wing & Hill, 2001). This definition is justified on the basis that weight loss of 5% to 10% of initial body weight is adequate to achieve clinically significant improvements in physical health (Wing & Hill, 2001). A number of different definitions have also been used to describe weight-loss regain (the flip side of successful weight-loss maintenance). Weight-loss regain has been defined as an individual who has regained a minimum of 95% of their total weight loss, from the past five years, and are currently obese (Wing & Hill, 2001; Wing & Phelan, 2005). However, at some point during the past five years they were not obese, and had lost ≥ 15 kg.
Alternatively, Byrne et al. (2003) define weight-loss regain as an individual who has had a history of obesity at some point during the past two years, lost at least 10% of their initial body weight, but regained weight to within 3.2 kg of their original weight. Therefore, it is clear that there are specific behaviours undertaken in successful weight-loss maintenance, but the criteria around what actually pertains to successful weight-loss maintenance is less clear.

1.6 The Influence of Impulsivity on Obesity and Weight-Loss Maintenance

As highlighted above obesity is a complex disease. While previous research has investigated a range of physical, psychological and psychosocial factors associated with the disease, specific factors related to impulsivity and decision-making (e.g., Davis, Levitan, Muglia, Bewell, & Kennedy, 2004a; Meule & Blechert, 2016; Mobbs et al., 2010; Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006c; Verdejo-García et al., 2010) have had less investigation. Impulsivity is a complex, multidimensional construct, which can be measured both at a trait level (i.e., self-report personality measures) and at a behavioural level (referred to as inhibitory control; Dalley, Everitt, & Robbins, 2011). Impulsivity is considered to sit within the executive function domain (Domínguez-Salas, Díaz-Batanero, Lozano-Rojas, & Verdejo-García, 2016). It can be measured in a number of ways, but essentially it taps into the construct of acting rashly without foresight (Dalley et al., 2011).

Recently, there has been a growing literature indicating that inefficient inhibitory control (a component of executive functioning) may be a contributing factor that underlies obesity development (Bartholdy et al., 2016; Fields et al., 2013; Jasinska et al., 2012; Lavagnino et al., 2016; Lawyer et al., 2015). Individuals who are overweight or obese, often report less inhibitory control
compared to healthy weight controls, when presented with palatable foods, usually resulting in greater calorie intake (Appelhans et al., 2011; Bartholdy et al., 2016). A recent systematic review and meta-analysis, investigating inhibitory control in binge-eating disorder and obesity, found that inhibitory control was significantly compromised in obese children and adults, compared to healthy weight controls (Standardised Mean Difference (SMD) = .30; Lavagnino et al., 2016).

Previous research has also found that inhibitory control may contribute to whether an individual is successful at maintaining long-term weight loss (specifically an individual's ability to utilise inhibitory control, and limit their consumption of highly palatable foods; Houben et al., 2012; McKee et al., 2013; Teixeira et al., 2015). For example, Appelhans et al. (2011) found that increased food reward sensitivity was associated with greater consumption of palatable foods, but only for individuals who also had diminished inhibitory control. Other research has also found that greater activity in the prefrontal cortex (PFC; the brain region related to executive functioning) is associated with more successful weight-loss maintenance, and that lower inhibitory control (as measured by a food related delay discounting task) is associated with worse weight-loss maintenance outcomes (Weygandt et al., 2015). The following chapter will present a theoretical argument for investigating impulsivity, and will then review the literature regarding the role of impulsivity in obesity, and weight-loss maintenance.
Chapter Two: Impulsivity

2.1 Introduction

The preceding chapter presented an overview of obesity and why some individuals can successfully maintain their weight loss while others fail to do so. It also highlighted the need for further exploration into the construct of impulsivity, to better understand obesity and successful weight loss. The focus of the current chapter is to introduce the concept of impulsivity, with consideration of the two-factor model of impulsivity and explore how it can be measured. Prior to discussing impulsivity a brief summary of the overarching concept of executive functioning will be provided.

2.2 Executive Function

Executive function is an umbrella term used to describe a range of different cognitive domains, which are involved in regulating behaviours and adaptively responding to novel situations (Gilbert & Burgess, 2008). Prickett, Brennan, and Stolwyk (2015) conducted a systematic literature review to investigate cognitive functioning in obese adults (18–65 years of age). They found that obese adults had impairment across a range of cognitive domains, and in particular in the area of executive function (which includes inhibitory control). This finding has been supported by other previous research (Calvo, Galioto, Gunstad, & Spitznagel, 2014; Fitzpatrick, Gilbert, & Serpell, 2013), and has also been found in obese children and adolescents (Maayan, Hoogendoorn, Sweat, & Convit, 2011; Reinert, Po’e, & Barkin, 2013; Verbeken, Braet, Goossens, & van der Oord, 2013). However, Prickett et al. (2015) found a number of methodological limitations as part of their review, such as the use of: suitable comparison groups; exclusion criteria; controlling for relevant confounds; and
standardised measures. Future research would therefore benefit from investigating whether executive functioning is impaired in obese individuals, and if it plays a role in successful weight loss.

Executive functions permit self-control, as they allow an individual to regulate their thoughts, emotions and behaviours towards higher order goals and plans (Verbeken et al., 2013). These advanced cognitive processes are dependent upon brain circuits located in the prefrontal cortex (PFC), and can halt the normal flow from impulse to action. In regards to food intake, previous research has found that executive functions are essential to regulate and inhibit the hedonic impulsive response to food (Guerrieri, Nederkoorn, & Jansen, 2008; Vainik, Dagher, Dubé, & Fellows, 2013). However, in the current obesogenic environment, these higher-level cognitive processes are under persistent strain, due to their limited capacity (Joseph et al., 2011).

2.2.1 Inhibitory control.

Inhibitory control can be defined as the “overriding of a planned or already initiated action” (Bari & Robbins, 2013, p. 44). As indicated in Chapter One of this dissertation, inhibitory control is measured at a behavioural level and is considered to consist of different sub processes (Dalley et al., 2011). Cognitive neuroscience research has proposed that successful inhibitory control is reliant upon top-down processing from the PFC over other subcortical regions involved in reward (e.g., the mesolimbic dopamine system; Heatherton & Wagner, 2011). Inhibitory control can override the automatic impulsive response to food, and executive functions can supress the desire to eat food, but only if this impulse is in line with an individual’s dietary goals (Joseph et al., 2011). In order to utilise inhibitory control, an individual must therefore suppress or delay impulses.
towards short-term ‘lower-level’ goals (e.g., eating a second slice of chocolate cake because the first one was nice) in favour of pursuing the long-term ‘higher level’ goals (e.g., becoming healthier, and successfully maintaining weight loss; Johnson et al., 2012). Individuals must therefore overcome a number of immediate temptations, habits, barriers and impulses, which may undermine their goal-directed behaviour (Baumeister & Heatherton, 1996; Metcalfe & Mischel, 1999). Higher levels of inhibitory control have been found to be associated with the ability to adopt and maintain healthy dietary habits. In particular, previous research has found that greater inhibitory control is predictive of successful weight-loss maintenance (Bond, Phelan, Leahey, Hill, & Wing, 2009; Teixeira et al., 2006).

Conversely, previous research has found that individuals with ineffective or insufficient inhibitory control may be more at risk of engaging in impulsive behaviours (Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010). In terms of overeating, one reason that an individual may overeat is that their strong motivation and desire to consume palatable food surpasses their ability to utilise inhibitory control over their eating (Appelhans et al., 2011). Previous research has determined that the overconsumption of palatable food (as seen in overweight/obese individuals, and weight-loss regainers; WLRs) will almost certainly occur in the context of greater food reward sensitivity and lower inhibitory control (Appelhans, 2009; Appelhans et al., 2011; Houben, 2011). Direct support for this hypothesised interaction has been found at the behavioural and neurobiological levels (Appelhans et al., 2011; Hare, Camerer, & Rangel, 2009; Nederkoorn et al., 2010). For example, Nederkoorn et al. (2010) investigated BMI, response inhibition and implicit preference for food in 74
university students (mostly normal weight females). They found that participants, who gained the most weight at the one-year follow-up, had lower inhibitory control, and greater preferences for snack food. Therefore, it appears that lower levels of inhibitory control may be associated with greater levels of impulsive behaviour, and an increased risk of obesity. As indicated in Chapter One, impulsivity is measured at a trait level, and recent work in this area has identified that trait measurements need to take into account its multidimensional nature.

2.2.2 Impulsivity.

Impulsivity is a complex, multidimensional personality trait characterised by a diminished regard for future consequences (Meda et al., 2009). Every individual will partake in some impulsive behaviour(s) occasionally, some of us more than others, and thus the term ‘impulsivity’ can be seen to reflect a continuum of a personality trait or behaviour (Dawe & Loxton, 2004). Impulsivity can be seen as both a normal dimension of human behaviour, as well as a fundamental pathological construct of many mental disorders, for example Antisocial and Borderline Personality Disorder, Attention-Deficit/Hyperactivity Disorder (ADHD), drug and alcohol addictions, eating disorders (i.e., anorexia/bulimia nervosa) aggressive and or suicidal behaviours, and pathological gambling (American Psychiatric Association, 2013; Meda et al., 2009).

Impulsivity is considered to be multifaceted (Quilty & Oakman, 2004; Sharma et al., 2014), and has been strongly linked to decision-making deficits and self-regulatory failure (Brogan et al., 2011; Davis & Carter, 2009). Impulsive individuals demonstrate noticeable weaknesses in learning appropriate connections between punishment and reward (Franken, van Strien, Nijs, & Muris, 2008). For example, after eating a large amount of palatable food (i.e., reward),...
impulsive individuals may feel unwell and gain weight (i.e., punishment), however they will often repeat this pattern of behaviour, even though they know the consequence. Previous research has found that individuals with higher levels of both trait and state measures of impulsivity lose less weight during a weight-loss program, and eat a greater proportion of food during a taste test challenge (Guerrieri, Nederkoorn, & Jansen, 2007; Nederkoorn, Jansen, Mulkens, & Jansen, 2006b). Given that impulsivity is multifaceted, it is not surprising that a number of questionnaires have been developed over time to measure it. The following section will go into further detail about the different types of measures used to assess impulsivity.

### 2.2.3 Measurement techniques of impulsivity.

Impulsivity can be measured in a number of ways, such as at the trait level (i.e., self-report questionnaires), via observer-report, or task-based assessment using behavioural measures of impulsivity (Hall & Fong, 2010; Sharma et al., 2014). Self-report questionnaires are considered to be ‘trait’ based, as they were primarily created to measure personality traits, which are thought to be stable over time. They are designed to reflect a broad range of impulsive characteristics which individuals will often perform across different situations and time points (Sharma et al., 2014). Self-report questionnaires usually ask individuals to rate how much they would agree with a particular statement, or how they would react to a particular situation. Some of the key impulsivity measures commonly found in research literature are the Impulsivity subscale of the Eysenck Impulsiveness Questionnaire (I7), and the Sensitivity to Reward (SR) subscale of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). Furthermore, there are a number of benefits of using self-report measures, such as: they are cost...
effective; easy to administer to a large sample of individuals; and they can be
completed in a range of settings (e.g., in the comfort of an individual’s home).
However, self-report measures can be highly sensitive to bias (i.e., honest
responding), insight and recall (Dougherty, Mathias, Marsh, & Jagar, 2005).

Unlike self-report measures, behavioural measures are designed to
measure what an individual will do in a particular situation, and hence they are
considered to be more ‘state’ like (Cyders & Coskunpinar, 2011). They were
typically designed by neuropsychologists, who have historically defined
impulsivity in a number of ways, consistent with the idea that that impulsivity
may be multifactorial (Sharma et al., 2014). Behavioural measures are designed to
tap into specific behavioural processes. These measures may add unique
variation, because they can be a more objective performance-based type of
assessment, and they are sensitive to temporary variations in behaviour
(Dougherty et al., 2005). Behavioural tasks of impulsivity have been consistently
reported to significantly predict unique variance across a range of health
behaviours, such as dietary and exercise behaviours (Hall, Elias, & Crossley,
2006), poor breakfast consumption (Wong & Mullan, 2009) and worse sleep
hygiene (Kor & Mullan, 2011). While behavioural measures can be administered
in controlled settings, administering these tasks to a large sample of individuals
can be very time-consuming and costly.

The use of behavioural and/or self-report measures of impulsivity to
investigate the relationship between impulsivity and obesity in previous research
has revealed some interesting findings. That is, research has found either a weak,
or no relationship between self-report and behavioural measures of impulsivity
and obesity in both adults (Calvo et al., 2014; Nederkoorn et al., 2006c) and
children (Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006a; Verdejo-García et al., 2010). It has been proposed that self-report (e.g., I7, SPSRQ, and BIS) and behavioural (e.g., IGT, GNG, and SSRT) measures are related, but tap into different aspects of impulsivity, i.e., self-report questionnaires are more ‘trait’ like; while behavioural measures are more ‘state’ like (Cyders & Coskunpinar, 2011; Sharma et al., 2014). Thamotharan et al. (2013) conducted a meta-analysis to examine the influence that the type of measure used, (i.e., self-report = 46% of studies, and behavioural = 64% of studies) had on the relationship between impulsivity and obesity in a paediatric sample. They discovered that there was a larger, significant effect size: $g = 0.559$, for behavioural measures (95% CI [0.338, 0.781], $p < 0.001$), compared to a smaller, non-significant effect size, for self-report measures ($g = 0.056$, 95% CI $[-0.310, 0.422]$, $p = 0.65$).

It appears that the type of measure used (i.e., self-report or behavioural) could influence whether a significant effect is found (Thamotharan et al., 2013). For example, Verdejo-García et al. (2010) only found a significant difference between healthy weight and excess weight (i.e., BMI range 24–51 kg/m$^2$) adolescents for the behavioural measure of reward sensitivity (the IGT), and found no significant difference for the self-report measure (the SPSRQ). However, Mobbs et al. (2010) found that overweight and obese individuals self-report higher levels of reward sensitivity (measured with the SPSRQ) compared to healthy weight controls. Yet, some existing research has only used self-report measures of impulsivity to examine the relationship between impulsivity and obesity (Annagur et al., 2015; Davis & Fox, 2008; Meule et al., 2016; Meule & Platte, 2015; Mobbs et al., 2010). Even though the correlations between self-report and behavioural measures of impulsivity are often non-significant or weak...
(Cyders & Coskunpinar, 2011, 2012), when both types of variables (i.e., self-report and behavioural) are used there is greater incremental validity in predicting impulsive behaviours (possibly linked to obesity and weight-regain) than by using either type of measure on their own (Sharma et al., 2014). Since each type of measure (i.e., self-report and behavioural) on their own predicts problematic impulsive behaviours found in our daily lives. Future research should therefore try to include both self-report and behavioural measures when investigating a construct like impulsivity.

There is also lack of consistency around how impulsivity should be best defined and measured. This may be because it is difficult to find a ‘pure’ measure of impulsivity, as several commonly used measures are capturing different aspects of impulsivity (Caseras, Ávila, & Torrubia, 2003; Miller, Joseph, & Tudway, 2004). Previous research has attempted to address this issue by conducting factor analyses on measures of impulsivity (e.g., Quilty & Oakman, 2004; Zelenski & Larsen, 1999). These studies have found that measures of impulsivity typically reflect two separate components of impulsivity, commonly termed ‘reward sensitivity’ and ‘rash-spontaneous impulsiveness’ (Dawe & Loxton, 2004). The following section will explore the two-factor model of impulsivity in greater detail.

2.3 The Two-Factor Model of Impulsivity

As highlighted earlier on in this chapter, impulsivity is not a homogenous construct. Impulsivity is multifaceted, and it is made up of a number of factors, which are thought to make a unique contribution to the development and maintenance of a range of conditions, including obesity (de Wit & Richards, 2004; Quilty & Oakman, 2004). A number of theoretical models have been
created to reflect impulsivity, such as Eysenck’s Model of Personality (Eysenck, 1967); Zuckerman’s Sensation Seeking Model (Zuckerman, 1984); Barratt’s Model of Impulsivity (Barratt, 1985); Gray’s Neuropsychological Theory of Personality (Gray, 1987b); Cloninger’s Biosocial Model of Impulsivity (Cloninger, 1987); Dickman’s Model of Impulsivity (Dickman, 1990); the Five-Factor Model of Impulsivity (Cyders et al., 2007; Whiteside & Lynam, 2001); and the Two-Factor Model of Impulsivity (Dawe & Loxton, 2004); and these models have directly influenced how impulsivity is measured and conceptualised (Dawe et al., 2004).

The two most predominantly accepted models of impulsivity are the two-factor model by Dawe and Loxton (2004) and the five-factor model by Whiteside and Lynam (2001), and Cyders et al. (2007). While both models of impulsivity are relevant, it is argued in this dissertation that the two-factor model of impulsivity underlines more closely with neural mechanisms, and appears to better reflect the process of overeating, which are seen in obesity and weight-loss maintenance (Appelhans et al., 2011; Gullo, Loxton, & Dawe, 2014).

The two-factor model of impulsivity stipulates that there are two independent but related dimensions of impulsivity: rash impulsivity, and reward sensitivity or drive (Dawe et al., 2004; Dawe & Loxton, 2004; de Wit & Richards, 2004; Quilty & Oakman, 2004). It was proposed by Dawe and colleagues (Dawe et al., 2004; Dawe & Loxton, 2004) to better understand the underlying neural processes involved in addictive behaviours. They suggest that there are two separate yet related components of impulsivity: (1) reward sensitivity or drive, which can be described as the purposeful drive to obtain and utilise rewarding stimuli, and is based on heightened reward sensitivity; and (2) rash impulsivity,
which describes a propensity to participate in reckless spontaneous behaviour that has a cognitive component, in which an individual has an inclination to ignore potential risks, or weigh up future consequences (Dawe et al., 2004). Each component of the two-factor model has been linked to alterations in different brain systems.

Previous research has suggested that an understanding of the brain mechanisms associated with impulsivity may provide a useful insight into how individuals regulate and manage their behaviours and thoughts (Heatherton & Wagner, 2011). The influence that natural differences in the functioning of both the mesolimbic dopamine system (reward sensitivity), and the PFC (rash impulsivity), has been emphasised in biologically based models of impulsivity (e.g., Cloninger, 1987; Depue & Collins, 1999; Gray, 1970). The following sections will discuss the theoretical and biological foundations of reward sensitivity and rash impulsivity respectively, how each factor can be measured, and how each factor relates to obesity and weight-loss.

2.3.1 Reward sensitivity.

Reward sensitivity or drive, is often labelled as the fundamental reward system. It is involved in hedonic rewarding behaviours, such as in natural reinforcers like sex, and food, and more recently from pharmacological rewards like addictive drugs (Berridge, Ho, Richard, & DiFeliceantonio, 2010; Davis et al., 2007). Reward sensitivity or drive is thought to reflect one of the main dimensions of Gray’s personality theory, the Behavioural Approach System (BAS; Cyders et al., 2007; Gray, 1970, 1987a). The BAS reflects unique differences in sensitivity to rewarding stimuli, both unconditioned and conditioned (Dawe & Loxton, 2004). Individuals who are higher in reward
sensitivity may have greater risk of substance misuse or overeating, according to neuropsychological studies (Costumero et al., 2013; Dawe & Loxton, 2004; Verdejo-García et al., 2010).

### 2.3.1.1 Measures of reward sensitivity

Common self-report measures that are used to assess reward sensitivity or drive include: the Behavioural Activation Scales (i.e., BAS-Fun seeking, BAS-Drive, and BAS-Reward Responsiveness), of the Behavioural Inhibition and Behavioural Activation Scales Questionnaire (BIS/BAS; Carver & White, 1994); the Sensitivity to Reward (SR) subscale of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Ávila, Moltó, & Caseras, 2001); and Dickman’s Impulsivity Inventory (DII; 1990). The SR subscale of the SPSRQ will be utilised in this dissertation as a self-report measure of reward sensitivity as it correlates with weight gain, and overeating (as seen in overweight/obese individuals; Davis & Fox, 2008; Davis et al., 2007; Franken & Muris, 2005).

Behavioural measures of impulsivity that assess reward sensitivity include: the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994); the Card Arranging Reward Responsivity Objective Test (CARROT; Siegel, 1978); the Food Reinforcement Task (Epstein, Bulik, Perkins, Caggiula, & Rodefer, 1991); and the Door Opening Task (Daugherty & Quay, 1991). Currently, there is no one preferred measure of reward sensitivity used in the literature, and each behavioural measure listed above typically taps into multiple components. The IGT will be utilised in this dissertation as a behavioural measure of reward sensitivity. One study by Edge, Johnson, Ng, and Carver (2013) also used the IGT as a measure of reward sensitivity, when investigating individuals with Bipolar I disorder. The IGT has been validated with a wide range
of clinical populations (e.g., Dunn, Dalgleish, & Lawrence, 2006), and is commonly used in the obesity literature because of the complexity of the measure. The IGT assesses a number of aspects of an individual’s behaviour, such as an evaluation of rewards and punishments, risk and doubt (Billieux, Gay, Rochat, & Van der Linden, 2010). Originally, the IGT was designed to assess decision making, which incorporates both emotions and cognitions. However, other traits such as sensitivity to punishment can also impact one’s decision making. While the IGT will be utilised as a measure of reward sensitivity in this dissertation, it is not a ‘pure’ measure of reward sensitivity. As discussed earlier on in this chapter, it is difficult to find a ‘pure’ or ‘perfect’ measure of impulsivity, and some previous research has used the IGT as a measure of decision-making, while other research has used it as a measure of reward sensitivity (e.g., Davis et al., 2004a; Edge et al., 2013; Kobayakawa, Tsuruya, & Kawamura, 2010). From here on in, when the IGT is mentioned in this dissertation, it will be referring to reward sensitivity, unless a study has classified it differently.

### 2.3.2.2 Obesity and reward sensitivity

Previous research has investigated the relationship between reward sensitivity and obesity (Davis et al., 2004a; Davis, Strachan, & Berkson, 2004b; Verdejo-García et al., 2010). Davis and colleagues collected self-report questionnaire data, and behavioural task data to investigate whether sensitivity to reward could influence food preferences, overeating and weight gain, and whether it was associated with a higher BMI (Davis et al., 2004a; Davis et al., 2007). Obese individuals compared to healthy weight controls, were found to have heightened levels of reward sensitivity, and higher BMIs were associated with greater impairment on the IGT (Davis et al.,
Furthermore, obese individuals often fail to show improvements and learning across the IGT (Davis et al., 2004a; Pignatti et al., 2006). Verdejo-García et al. (2010) determined that excess weight \( n = 27 \), BMI range 24–51 kg/m\(^2\) participants performed significantly worse (i.e., had a lower net score) than healthy weight controls \( n = 34 \), BMI range 17–24 kg/m\(^2\)) on blocks four \( (p = .05) \), and five \( (p = .04) \), and marginally worse on block three \( (p = .09) \) of the IGT. This is consistent with other research, which has found that overweight and obese individuals have higher sensitivity to reward, compared to healthy weight controls (Mobbs et al., 2010; Verdejo-García et al., 2010).

However, the study by Verdejo-García et al. (2010) only found a significant association for the behavioural measure of reward sensitivity (the IGT), and found no significant difference between groups on the self-report measure (the SR). Alternatively, Mobbs et al. (2010) did find a significant difference when they used the same self-report measure of reward sensitivity (the SR), but unlike Verdejo-García et al. (2010) they only measured reward sensitivity at the trait-level.

**2.3.1.3 Biological basis of reward sensitivity.** The mesolimbic dopaminergic pathways, encompassing projections from the ventral tegmental area (VTA), the nucleus accumbens, and the amygdala are thought to be the brain regions involved in reward sensitivity (Dawe et al., 2004; Dawe & Loxton, 2004; Jentsch & Taylor, 1999; Volkow, Wang, & Baler, 2011). These regions are the main neural substrate of the BAS, and they share a lot of parallels to the neural pathways underlying the strengthening effects of natural reinforcers, like sex, food and addictive drugs (Dawe & Loxton, 2004). Individuals who have high BAS (i.e., reward sensitivity) are more likely to participate in approach
behaviour, and experience positive effects when they are exposed to reward cues (Carver & White, 1994).

Brain-imaging studies have found some common characteristics between obesity and addictive behaviours (e.g., drug addiction) and outline some of the overlapping brain circuits (Volkow, Wang, Tomasi, & Baler, 2013). In particular brain-imaging studies have found that both drugs and food have powerful reinforcing effects, which are somewhat mediated by the immediate increase of dopamine in the brains reward centres. After prolonged exposure to highly palatable foods, or addictive drugs, the neurons of the mesolimbic dopamine reward system in obese and substance-dependent individuals’ can become sensitised, making them more receptive to the reinforcing effects of the rewarding stimuli (i.e., food or drugs; Berridge et al., 2010; Jentsch & Taylor, 1999; Robinson & Berridge, 2003; Volkow et al., 2013).

2.3.2 Rash impulsivity.

Rash impulsivity is all about the tendency to act rashly and without consideration of future consequences. Dawe et al. (2004) propose that rash impulsivity is connected with a failure to inhibit approach tendencies, or response disinhibition. Rash impulsivity is thought to be conceptually similar to Eysenck and Eysenck (1985), Zuckerman (1984), Barratt (1985), and Cloninger (1987) description of impulsivity.

2.3.2.1 Measures of rash impulsivity. Rash impulsivity can be measured with several self-report questionnaires including: the Barratt Impulsivity Scale (BIS; Patton, Stanford, & Barratt, 1995); the Impulsivity subscale of the Eysenck Impulsiveness Questionnaire (I7; Eysenck, Pearson, Easting, & Allsopp, 1985); the Novelty-seeking (NS) dimension of Cloninger’s personality taxonomy
(Cloninger, 1987); the Sensation Seeking Scale (SSS; Zuckerman, Eysenck, & Eysenck, 1978); and the Temperament and Character Inventory (TCI; Cloninger, Przybeck, & Svrakic, 1991; Cloninger, Svrakic, & Przybeck, 1993). While there are several measures that capture rash impulsivity, the I7 will be utilised in this dissertation, as it is a widely used and validated measure of rash impulsivity.

Rash impulsivity can also be measured with the following behavioural tasks: the Go/No-Go task (GNG; Simmonds, Pekar, & Mostofsky, 2008), and the Stop-Signal Reaction Time Task (SSRT; Lappin & Eriksen, 1966). The GNG task will be used as a behavioural measure of rash impulsivity in this dissertation, as previous research has found a significant difference between obese individuals and healthy weight controls on the task (Calvo et al., 2014; Mobbs et al., 2011).

2.3.2.2 Obesity and rash impulsivity. Previous research has found that both overweight and obese adults and children have greater levels of rash impulsivity than healthy weight controls on behavioural tasks of rash impulsivity (Mobbs et al., 2011; Nederkoorn et al., 2006b; Nederkoorn et al., 2006c). A study by Nederkoorn et al. (2006b) investigated impulsivity in 26 obese children who participated in a behavioural treatment program for obesity. They measured rash impulsivity (using SSRT) prior to treatment commencement, and measured weight and length, prior and post treatment, as well as at six and 12 months follow-ups. Impulsivity was found to predict success of the weight loss program, with the most impulsive children losing the least amount of weight. Furthermore, higher levels of impulsivity were significantly related to weight status at all times points (i.e., children who had higher levels of impulsivity were the most overweight).
Previous research has also found that overweight and obese individuals self-report higher levels of rash impulsivity (Meule & Blechert, 2016; Meule & Platte, 2015; Rydén et al., 2003). One study by Meule and Blechert (2016) used linear regression analysis to assess the relationship between impulsivity (as measured by the short form of the BIS) and BMI in 3073 individuals (aged between 16–71 years). After controlling for sex and age, they found that only scores on the motor and attentional impulsivity subscales were predictive of higher BMIs (non-planning impulsivity was not significant). It therefore appears that specific aspects of trait rash impulsivity may be associated with ones BMI. However, two studies have not found a relationship between greater levels of rash impulsivity and higher BMIs (Batterink, Yokum, & Stice, 2010; Jasinska et al., 2012), and two reported no significant difference between healthy weight controls and obese individuals on self-report and behavioural measures of rash impulsivity (Hendick, Luo, Zhang, & Li, 2012; Loeber et al., 2012).

2.3.2.3 Biological basis of rash impulsivity. The PFC (especially the orbitofrontal cortex; OFC, and the anterior cingulate cortex; ACC) is thought to be the brain region associated with rash impulsivity, as it plays an important role in inhibitory control (Dawe et al., 2004; Volkow et al., 2013). Previous research has investigated individual differences in the PFC in relation to obese and substance-dependent individuals (Cohen, Yates, Duong, & Convit, 2011; Goldstein & Volkow, 2002; Jentsch & Taylor, 1999; Volkow et al., 2009; Weygandt et al., 2015; Whelan et al., 2012). Functional imaging research has revealed that impairment in the PFC may have an impact on disinhibited behaviour (i.e., spontaneous, rash impulsivity) in substance-dependent individuals (Goldstein & Volkow, 2002; Volkow et al., 2011). An inverse relationship
between BMI and brain glucose metabolism in the PFC, and in the ACC, has also been found in healthy adults (Volkow et al., 2009). Enhancing activity in the PFC (i.e., increasing an individual’s level of inhibitory control) with non-invasive brain stimulation can suppress an individual’s desire to consume food (e.g., Gluck et al., 2015).

Furthermore, previous research has investigated the PFC in relation to successful weight-loss maintenance (DelParigi et al., 2007; Sweet et al., 2012; Weygandt et al., 2015). Neuroimaging studies have shown that obese individuals have less activation in their PFC in response to food being placed in front of them, compared to successful WLMs (i.e., individuals who were overweight or obese in the past, but who have now successfully lost weight and maintained their weight loss) who have higher activation in their PFC (DelParigi et al., 2007; Le et al., 2006; Le et al., 2007; McCaffery et al., 2009; Sweet et al., 2012). One study by Weygandt et al. (2015) investigated the mechanisms associated with long-term weight regain, in individuals who participated in a 12-week weight program. They measured activity in the dorsolateral prefrontal cortex (DLPFC) during a food-specific delay-discounting task at two time points. Twenty-three individuals were measured prior to starting the program, and of those 19 were tested again at the one-year follow up. They found that greater activity in the DLPFC was associated with more successful weight-loss maintenance, and that lower inhibitory control was associated with worse weight-loss maintenance outcomes (Weygandt et al., 2015). However, they applied a criterion of needing to achieve a reduction in body weight by 8% after the initial 12-week program, and hence further research would be recommended in this area. Particularly because a large proportion of the current weight-loss maintenance literature requires an initial
reduction of at least 10%, and to maintain this weight loss for a minimum of 12 months, to be classified as a successful WLM.

The increased activation in the PFC, which is seen in WLMs, may be partly due to them trying to improve their inhibitory control, as well as them being more hyper-vigilant around their weight (McCaffery et al., 2009; Xu et al., 2017). It therefore appears that the degree of activation (e.g., low, medium, or high) in particular brain regions related to rash impulsivity (i.e., the PFC) may have an influence on whether an individual is successful at weight-loss maintenance or not. It may be possible that individuals who regain their weight lost have less inhibitory control than individuals who are successful at weight-loss maintenance, and hence they are more likely to act rashly around food, because of impairment in their PFC. Future research would benefit from investigating the differences between brain activation in both individuals who are successful at weight-loss maintenance, and those who are not, however this is not within the scope of this dissertation.

2.4 Summary

There is growing evidence to indicate a positive relationship between impulsivity and obesity. However, obesity is known to be a multifaceted illness comprising more than just food and eating behaviour. As discussed in Chapter One, physical activity appears to be an essential behaviour required for successful weight-loss maintenance, and lower levels of physical activity are typically observed in weight-loss regainers (Metzgar et al., 2015; Thomas et al., 2014). When developing interventions that target weight loss and weight-loss maintenance, it is important to understand the impact that physical activity and diet have on weight loss, and how these components can positively influence
other behaviours (e.g., impulse control). A model proposed by Joseph et al. (2011) attempted to link the complex relationship between impulsivity and obesity, while also incorporating the role that physical activity plays on both impulsivity and obesity. The following chapter will explore the model proposed by Joseph et al. (2011) in greater detail.
Chapter Three: The Relationship between Impulsivity, Obesity and Physical Activity

3.1 Introduction

The preceding chapter presented a theoretical argument for why impulsivity may be an important factor when trying to better understand obesity and weight-loss maintenance. It explored some measurement issues associated with impulsivity and examined the use the two-factor model of impulsivity (i.e., rash impulsivity and reward sensitivity as separate constructs). Finally, the previous chapter highlighted that physical activity appears to play a role in obesity, weight-loss maintenance, and impulsivity. The emphasis of the current chapter is to examine the model proposed by Joseph et al. (2011), and the commonalities between physical activity, impulsivity, obesity and weight-loss maintenance.

Physical activity is essential to help improve both the physical and mental health of all individuals (Heisz & Kovacevic, 2016; Physical Activity Guidelines Advisory Committee, 2008). However, as highlighted in Chapter One modernisation has resulted in changes in our physical activity levels and dietary patterns. Historically, decreases in food intake and supply were commonly matched by decreases in physical activity levels (Davis, 2013; Neel, 1999). Yet, research has found that physical activity often increases in the face of food shortages or deprivation, and that the reverse occurs in times of abundant food resources (i.e., increased consumption of food and decreased levels of physical activity; Chakravarthy & Booth, 2004; Swinburn et al., 2011). Swinburn et al. (2011, p. 807) proposed that there was an “energy balance flipping point” in the
1960s where population energy output, no longer matched input. He proposed that this occurred due to the emergence and availability of high calorie energy dense foods, which disrupted the homeostatic principles of energy balance, and consequently resulted in an increase in the rate of obesity.

While physical activity can assist with weight-loss maintenance through calorie burning, interestingly recent studies have suggested that physical activity may also enhance an individual’s executive functioning (Annesi & Porter, 2014; Joseph et al., 2011; Loprinzi & Kane, 2015; Lowe, Kolev, & Hall, 2016). The following section will detail the model proposed by Joseph et al. (2011), and will provide a theoretical rationale for investigating the relationship between physical activity, impulsivity and weight-loss maintenance in this dissertation.

3.2 Neurocognitive Link between Physical Activity and Eating Behaviour

Joseph et al. (2011) proposed that eating behaviour and physical activity share a common neurocognitive link. They suggest that the link between physical activity and eating behaviour relates to executive functions. As highlighted in Chapter Two, executive functions are advanced cognitive processes, which are made up of a number of fundamental components, such as inhibitory control. However, as indicated in Chapter Two executive functions are under persistent strain in the current obesogenic environment, due to their limited capacity (Joseph et al., 2011). Previous research has suggested specifically that if inhibitory control could be strengthened, that this may enhance successful weight-loss maintenance (Appelhans et al., 2011). Furthermore, if the neurocognitive link between physical activity and eating behaviour (i.e., executive function) is better understood this could assist with the development of more effective weight-loss maintenance interventions (Joseph et al., 2011).
In particular, Joseph et al. (2011) propose that the over-learned impulsive drive to eat (specifically overeating), which can be detrimental to an individual’s health (e.g., obesity) could be counteracted by enhancing executive functioning (especially inhibitory control), through regular physical activity (see Figure 3.1 for a schematic depiction of the model by Joseph et al., 2011). This is based on previous research, which has found that physical activity can enhance an individual’s neurocognitive functioning in terms of executive functions (specifically improved inhibitory control) and goal-orientated behaviours (due to greater neuroplasticity and increased prefrontal cortex (PFC) activity; Colcombe et al., 2003; Colcombe et al., 2006; Hötting & Röder, 2013; Lambourne & Tomporowski, 2010; Loprinzi & Kane, 2015; Lowe et al., 2016; McMorris & Hale, 2012; Smith et al., 2010; Voss et al., 2010). For example Chen et al. (2016) conducted a three-month intervention with obese adolescents who either participated in a physical activity program ($n = 25$), or were on the wait-list (i.e., the control group; $n = 25$). They found that obese adolescents who completed the physical activity program had improved executive function (specifically set-shifting performance; $p < .001$), better parasympathetic response (which may be related to enhanced executive function; $p < .012$), and increased fitness. An earlier meta-analysis also found that 20 minutes of acute aerobic physical activity is required to detect a significant positive effect on cognitive functions, with the greatest effect being detected 11-20 minutes after the exercise session (Chang, Labban, Gapin, & Etnier, 2012). They found that cognitive tasks, which were used as a measure of executive functioning, produced a significantly larger effect compared to any other category of cognitive task used in the meta-analysis, e.g., memory or attention. Previous research has also found that the beneficial effects
of physical activity may differ depending on an individual’s original executive function strength, with the greatest improvements seen in individuals with weaker inhibitory control (i.e., 91.67% of individuals showed improvements, with an average change in Stroop interference of 65.810ms), compared to stronger initial inhibitory control (i.e., 58.85% of individuals showed improvements, with an average change of 5.259ms; Drollette et al., 2014; Lowe et al., 2016).

Figure 3.1. A schematic depiction of the hypothesis, linking physical activity to eating behaviour via executive functioning. Taken from Joseph et al. (2011, p. 807).

Sedentary behaviour and low levels of physical activity have also been associated with deficits in certain brain structures (e.g., cerebellum, striatum, hippocampal plasticity, and grey matter volume; for a review see Voss, Carr, Clark, & Weng, 2014). For example, one study by Lipnicki et al. (2009)
investigated simulated prolonged weightlessness in 24 healthy men (aged 21–45 years of age) who participated in a 60-day bed-rest study. They found that individual’s scores on the Iowa Gambling Task (IGT), which is associated with reward sensitivity, were significantly lower during bed rest (i.e., when individuals were not performing any physical activity; \( p = .015 \)), compared to pre and post intervention scores.

The current literature is yet to fully understand the mechanisms that cause and/or influence improvements in executive function following physical activity, however it has been proposed that there are a number of possible factors (Erickson, Hillman, & Kramer, 2015). One possible mechanism that could contribute to this relationship is the notion of brain glycogen supercompensation (i.e., when the glycogen returns to above basal levels approximately six hours after physical activity; Matsui et al., 2012). It has been proposed that increased glycogen levels in the brain (in particular in the cortex and hippocampus) following regular physical activity, could decrease fatigue (caused by physical activity) and enhance cognitive functioning (Matsui et al., 2012). Another possible mechanism is that increased physical activity results in greater cerebral blood flow to the PFC (Endo et al., 2013; Giles et al., 2014; Yanagisawa et al., 2010). It has been suggested that increased blood flow enhances neural activity in the PFC, which could improve performance on executive function tasks (e.g., the Stroop test; Endo et al., 2013; Yanagisawa et al., 2010). Finally, brain-derived neurotrophic factor (BDNF; which is involved in plasticity and transmission) levels could also contribute to heightened executive function (Ferris, Williams, & Shen, 2007; Tsai et al., 2014). In particular, it has been found that regular physical activity enhances the serum BDNF levels in healthy adults, with these
increased levels being significantly correlated with local grey matter volume in
the cingulate and prefrontal cortices, and improved cognitive performance
(Ruscheweyh et al., 2011). Although additional research is still required to better
understand the mechanisms involved in physical activity induced enhanced
effective function, it has been shown that physical activity (both acute and
ongoing) can be utilised to enhance brain structures and neurochemistry (Lowe et
al., 2016).

Furthermore, it has been proposed that improved neurocognitive
functioning (i.e., strengthened executive functioning), due to physical activity can
improve eating behaviour (Joseph et al., 2011). As discussed in Chapter Two, the
notion that executive functions are also involved in regulating eating behaviour
has been frequently reported (Fregni et al., 2008; Goldman et al., 2011; Uher et
al., 2005). Joseph et al. (2011) propose that increased physical activity may be
able to help suppress, and counteract the hedonic drive to overeat by enhancing
the top-down inhibitory control processing in the PFC. Recently, Lowe et al.
(2016) examined the effects of physical activity on executive function,
(specifically inhibitory control), and eating self-regulation in 51 female
undergraduate students (aged 17–28 years of age). Each participant completed
one 20-minute session of both slow (control), and steady walking (moderate
intensity), with a seven day inter-sessional interval. Additionally, participants
completed a Stroop task both before and following each exercise session, as well
as a pseudo taste test (including both appetitive calorie dense and control foods).
They found that moderate intensity physical activity significantly improved
executive functioning (i.e., accuracy on the Stroop task; \( p = .001 \)), and eating self-
regulation of appetitive foods (i.e., decreased the amount of calorie dense food
consumed; \( p = .001 \), but did not have an effect on the amount of control foods consumed (\( p = .765 \); Lowe et al., 2016). Lowe et al. (2016) also determined that physical activity improved accuracy on the Stroop task, mediated the effects of moderate physical activity on the consumption of calorie dense foods.

It has been shown that regular physical activity is a major factor for long-term weight maintenance (e.g., Hankinson et al., 2010). Furthermore, as highlighted in Chapter One, high levels of physical activity are associated with successful weight-loss maintenance, while low levels are associated with weight regain (Jakicic et al., 2008; Karfopoulou et al., 2013; Santos et al., 2015; Swift et al., 2014; Thomas et al., 2014; Weiss et al., 2007). It appears that while regular physical activity may counterbalance the biological factors, which encourage weight regain following weight loss (i.e., decreasing intake, and increasing energy expenditure), it can also enhance an individuals executive function (particularly inhibitory control). Additionally, as indicated in Chapter Two successful weight-loss maintainers appear to have greater activity in their PFC (i.e., executive functioning), and lower levels of inhibitory control are associated with poorer weight-loss maintenance outcomes (Weygandt et al., 2015). Therefore, future research may benefit from investigating the relationship between physical activity, impulsivity and weight-loss maintenance, in a group of overweight and obese adults who have lost weight. The following section will provide an overview of this dissertation.

3.3 Proposed Empirical Research Chapters

Following a comprehensive review of the literature in the current and previous chapters, it was argued that impulsivity may be a contributing factor that underlies obesity development, and whether an individual is successful at
maintaining long-term weight loss (Appelhans et al., 2011; Bartholdy et al., 2016; Fields et al., 2013; Houben et al., 2012; Jasinska et al., 2012; Lavagnino et al., 2016; Lawyer et al., 2015; Teixeira et al., 2015). Furthermore, it was argued that physical activity may enhance an individual’s executive functions, and that there may be a relationship between physical activity, impulsivity and weight-loss maintenance (Joseph et al., 2011; Weygandt et al., 2015).

The primary aim of this dissertation is:

- To investigate the role of impulsivity in obese adults, with a particular focus on weight-loss maintenance.

One large cross-sectional study will be undertaken to investigate this overall aim, and reported across three separate chapters. To address limitations within the current literature, this dissertation will use the two-factor model of impulsivity (i.e., rash impulsivity and reward sensitivity as separate constructs), which is a theoretically driven model, and may be useful for conceptualising and measuring impulsivity when examining issues like obesity (Dawe & Loxton, 2004; de Wit & Richards, 2004; Gullo et al., 2014; Quilty & Oakman, 2004). Additionally, this dissertation will measure impulsivity with both self-report and behavioural methods, as there is greater incremental validity from using both types of variables (Sharma et al., 2014). Finally, this dissertation will measure self-reported mood. As discussed in Chapter One, there is a high prevalence rate of mood and anxiety disorders in overweight and obese individuals, and hence measuring mood is useful for clinical relevance of the sample.

The first of the three empirical chapters (Chapter Five) aims to examine whether rash impulsivity and/or reward sensitivity are significantly associated with BMI status (healthy weight, overweight and obese) in an adult population.
The study will expand upon previous research (i.e., Fields et al., 2013; Navas et al., 2016), by a) including individuals with a BMI over 40; b) not excluding individuals with mental health disorders/medical conditions associated with obesity; and c) utilising a theoretically derived model of impulsivity. In particular it will explore whether overweight and obese adults display higher levels of impulsivity (measured via both self-report and behavioural measures) compared to healthy weight controls. Furthermore, a more stringent criterion of having to be within a lifetime healthy weight BMI range will be applied to the healthy weight controls. A secondary aim of this empirical chapter is to explore whether there is a relationship between self-report and behavioural measures of rash impulsivity and reward sensitivity.

The second empirical chapter of this dissertation (Chapter Six) aims to measure impulsivity in weight-loss maintenance, comparing those who are successful in their weight loss and those who regain weight lost. This empirical chapter will investigate a group of overweight and obese adults who lost weight more than a year ago, and are now attempting to maintain this weight loss. This chapter will explore whether higher levels of impulsivity are positively associated with weight-loss regain. A secondary aim of this empirical chapter is to assess which component(s) of impulsivity (i.e., rash impulsivity or reward sensitivity, measured at both the self-report and behavioural level) best accounts for whether an individual is a successful WLM or a WLR.

The third and final empirical chapter of this dissertation (Chapter Seven) will draw on principles from the model proposed by Joseph et al. (2011). In particular, it aims to examine whether there is a relationship between physical activity, impulsivity and weight-loss maintenance. The same sample of
participants from the second empirical chapter will be utilised in the third empirical chapter. A secondary aim of this empirical chapter is to investigate whether those who maintain weight loss are more likely to: meet the physical activity guidelines (i.e., moderate physical activity or vigorous physical activity); and/or have lower levels of impulsivity (i.e., have an Iowa Gambling Task net score $\geq 0$), compared to those who regain weight. Finally, a third aim of this chapter is to examine whether individuals who have low levels of impulsivity, are more likely to meet the physical activity guidelines.

In order to test these three overarching research questions one large cross-sectional study was designed and conducted. The following chapter (Chapter Four) presents an overview of the methodological approaches utilised in the three empirical chapters, including details pertaining to each of the measures used, the procedure undertaken and the participant sample.
Chapter Four: Method

One large cross-sectional study was designed and implemented, and the overall method section is described below. Any specific methodological issues pertaining to the measures used in this dissertation will be discussed in each empirical chapter separately. The two primary dependent variables (DVs) in this dissertation were rash impulsivity (measured with the Go/No-Go Task (GNG), as well as with the Impulsivity subscale (I^7) of the Eysenck Impulsiveness Questionnaire) and reward sensitivity (measured with the Iowa Gambling Task (IGT), as well as with the Sensitivity to Reward (SR) subscale of the Sensitivity to Reward and Sensitivity to Punishment Questionnaire). Participants were recruited according to BMI and weight loss history (i.e., healthy weight, overweight and obese, and weight-loss maintainers (WLMs), and weight loss regainers (WLRs)).

4.1 Participants

The overall sample included 153 participants (19 males and 134 females, 88% female) aged between 19–65 years of age (M = 48.76, SD = 12.87). A variety of targeted sampling techniques were used for recruitment, increasing the likelihood of a representative sample of various BMIs, and weight-loss histories. Participants were recruited from online Facebook pages, via word of mouth, through TOWN (Taking off Weight Naturally) Clubs of Victoria, and at a number of Rotary Clubs across Melbourne. In total 29 TOWN clubs and six Rotary Clubs participated. TOWN is an official weight loss group, which has been running throughout Victoria for almost 50 years. Members are encouraged to lose weight via nutritional based eating and changes in their lifestyle behaviours. At TOWN,
members can attend weekly meetings, which include weigh-ins and group therapy). Once TOWN members have reached their goal weight (which is discussed with their general practitioner prior to commencing at TOWN) they are provided with ongoing support to maintain their weight loss.

Eligibility criteria for the current study included being between ≤ 18 and ≥ 65 years of age, fluent in English, having no self-reported prior history of significant neurological impairment or injury, and no self-reported prior history of anorexia/bulimia nervosa. In addition, women who were currently pregnant, and/or individuals who had undergone bariatric surgery were excluded. Every participant was tested for eligibility criteria, and 15 participants were excluded from the study.

One hundred and thirty-two participants (86.3%) classified themselves as Anglo-Saxon for cultural identity, with the remainder being European (9.1%, n = 14), and Asian (2.6%, n = 4), and 2.0% (n = 3) did not specify. Most of the participants (64.8; N = 99) were employed (casually, part-time or full-time), 9.8% (N = 15) were retired, 7.8% (N = 12) were students, 15.7% (N = 24) did home duties, and 2.0% (N = 3) were unemployed but seeking work. A small percentage of participants, 10.5% (N = 16) reported having a household pre-tax income of less than $30,000, 14.4% (N = 22) between $30,000 and $50,000, 13.1% (N = 20) between $50,000 and $70,000, 12.4% (N = 19) between $70,000 and $90,000, 11.8% (N = 18) between $90,000 and $110,000, 8.5% (N = 13) between $110,000 and $130,000, 1.3% (N = 2) between $130,000 and $150,000, 7.8% (N = 12) more than $150,000, and 20.3% (N = 31) did not specify their household pre-tax income as this question was voluntary. Participants’ current self-reported medication and/or vitamin use is presented in Table 4.1.
Table 4.1  
*Participants’ Current Self-Reported Use of Medications and/or Vitamins*

<table>
<thead>
<tr>
<th>Medication/Vitamin Classification</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alimentary System (e.g., antidiarrhoeals or hyperacidity, reflux and ulcers)</td>
<td>9</td>
</tr>
<tr>
<td>Allergic Disorders (e.g., antihistamines)</td>
<td>2</td>
</tr>
<tr>
<td>Analgesia (e.g., simple analgesics and antipyretics)</td>
<td>10</td>
</tr>
<tr>
<td>Cardiovascular System (e.g., diuretics, antihypertensive, or hypolipidaemic agents)</td>
<td>46</td>
</tr>
<tr>
<td>Central Nervous System (e.g., antianxiety agent, antidepressants, antipsychotic agent, or sedatives and hypnotics)</td>
<td>11</td>
</tr>
<tr>
<td>Contraceptive Agents</td>
<td>9</td>
</tr>
<tr>
<td>Endocrine and Metabolic Disorders (e.g., gonadal hormones, hypoglycaemic agents or insulin preparations)</td>
<td>30</td>
</tr>
<tr>
<td>Immunology (e.g., immunomodifiers)</td>
<td>2</td>
</tr>
<tr>
<td>Infections and Infestations (e.g., other antibiotics and anti-infectives)</td>
<td>2</td>
</tr>
<tr>
<td>Musculoskeletal System (e.g., antirheumatoid agents or nonsteroidal anti-inflammatory agents)</td>
<td>11</td>
</tr>
<tr>
<td>Neoplastic Disorders (e.g., antimetabolites, or other antineoplastic agents)</td>
<td>2</td>
</tr>
<tr>
<td>Respiratory System (e.g., preventive aerosols and inhalations)</td>
<td>6</td>
</tr>
<tr>
<td>Skin (e.g., psoriasis, seborrhoea and ichthyosis)</td>
<td>2</td>
</tr>
<tr>
<td>Vitamins and/or Minerals</td>
<td>68</td>
</tr>
<tr>
<td>Nil Current Medication/Vitamin Use</td>
<td>44</td>
</tr>
</tbody>
</table>

*Note.* The classification system is based on the Monthly Index of Medical Specialties: MIMS. Participants can be counted in more than one classification, e.g., currently taking a vitamin, a contraceptive agent, and an antianxiety agent.
4.2 Procedure

Ethics approval was sought from Deakin University Human Ethics Committee prior to commencement of the study (see Appendix A). Permission was sought from the CEO of TOWN Clubs of Victoria to visit a range of clubs throughout Victoria, and from group leaders from a number of Rotary Clubs across Melbourne, where data were collected.

Prior to participating in the study all participants read and were given access to a copy of the plain language statement and provided consent (see Appendix B). Following consent, participants firstly completed the screening questionnaire, if they met all the inclusion criteria they then either a) completed the two behavioural tasks (the IGT and GNG) face-to-face (e.g., at a TOWN or a Rotary club meeting) using a laptop provided by the principal researcher, and then completed the online set of questionnaires which included the demographic and psychological questionnaires, or b) completed the online battery of questionnaires first, and then completed the behavioural tasks online, using a computer/laptop of the participant’s choice.

Where participants experienced difficulties with the online completion of questionnaires a paper and pencil version of the questionnaire was provided to the participant and returned via reply paid mail. For participants who completed the questionnaires and measures online they could save their responses as they went, and they did not have to answer all of the questions at the one time. The total time that it took consenting participants to complete the battery of measures (including both questionnaires and tasks) was approximately 1–1.5 hours.

The screening questionnaire, demographic questionnaire and self-report measures were either completed online via a computer or tablet device, or with a
hard-copy paper and pencil version, or a combination of the three. The experimental tasks were completed on a computer, either in person or online in the participant’s own time.

4.3 Screening Questionnaire

This measure was used to assess the inclusion and exclusion criteria of the study (detailed above). This questionnaire included 16 questions, which asked about age, contact details, self-reported diagnosed psychiatric illness, history of eating disorders (anorexia/bulimia nervosa), and head injuries (see Appendix C).

4.4 Self-Report Measures

4.4.1 Demographic questionnaire.

The demographic questionnaire comprised items that related to ethnicity, gender, the country that participants currently resides in, postcode, highest level of education completed, occupation and job history, household pre-tax-income, marital status, current medication use, and smoking history (see Appendix D). Participants were asked to report their height, weight, waist circumference, as well as provide a detailed weight history. Additional items included pregnancy history, completion of a 24hr food recall, and motivation around weight loss and/or maintaining their current weight.

4.4.2 Questionnaires.

Information on three psychological variables/traits related to obesity and weight-loss maintenance was collected. The literature discussed in the introductory chapters provides a rationale for the main variables that were included in each study. The following sections will detail the primary outcomes, and covariate measures used in this dissertation.
4.4.2.1 Impulsivity. Impulsivity was assessed using two separate scales, the Impulsivity subscale of the Eysenck Impulsiveness Questionnaire (I⁷; Eysenck et al., 1985) and the Sensitivity to Reward (SR) subscale of the Sensitivity to Reward and Sensitivity to Punishment Questionnaire (SPSRQ; Torrubia et al., 2001). The Impulsivity subscale was employed to measure the rash impulsivity component of impulsivity. It includes 19 dichotomously scored (i.e., ‘yes’ and ‘no’) items. The Impulsivity subscale was used in this dissertation to assess an individual’s propensity to act without deliberation and forethought of consequences. As highlighted in earlier chapters of this dissertation, the I⁷ is associated with the rash impulsivity component of the two-factor model of impulsivity.

The Impulsivity subscale contains items such as, “Do you generally do and say things without stopping to think” and “Do you often buy things on impulse?” A total score was created, ranging from 0 to 19, where higher scored signified higher levels of impulsivity. Three items (5, 16 and 17) were reverse scored, to show impulsive tendencies. The Impulsivity subscale has good psychometrics with an internal consistency of .84, and .83, for males and females respectively (Eysenck et al., 1985). In this dissertation, the I⁷ demonstrated excellent internal consistency, with an alpha coefficient of .88.

The Sensitivity to Reward (SR) subscale was employed to measure the reward sensitivity component of impulsivity. It includes 24 items and was developed to assess the Behavioural Activation System (BAS) dimension of Grey’s model of personality (Torrubia et al., 2001).

The SR subscale measures reward sensitivity or appetitive reinforcing behaviour (e.g., “Do you like to compete and do everything you can to win?”). A
total score was obtained by adding all of the ‘yes’ answers together, and higher scores indicated a greater level of sensitivity to reward. The SR subscale has good internal consistency of .78 and .75, for males and females respectively (Torrubia et al., 2001). Test-retest reliability has also been found for the SR scale of .87 over a three-month period, and .61 over a three year period (Torrubia et al., 2001). The SR subscale demonstrated a very good level of internal consistency (α = .91) in the current study.

4.4.2.2 Physical activity. Physical activity was measured using the short form of the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). The short form IPAQ contains nine items assessing the frequency and duration of vigorous-intensity activity (e.g., aerobics), moderate-intensity activity (e.g., leisure cycling), walking, and time spent sitting during weekdays (Craig et al., 2003; Tehard et al., 2005). Scores for each activity were calculated in METs (i.e., the energy required to perform each activity). Total physical activity was then calculated by adding the three activity scores together (i.e., vigorous + moderate + walking MET-minutes/week). Participants were classified as either meeting the guidelines (having moderate or high levels of physical activity) or not meeting the guidelines (having low levels of activity).

Participants who either did not report any physical activity, or who did not meet the criteria for moderate or vigorous-intensity physical activity, were classified as not meeting the guidelines. Moderate-intensity physical activity was classified as meeting one of the following three criteria: vigorous activity on three or more days for at least 20 minutes each day; moderate-intensity activity and/or walking on five or more days, for at least 30 minutes each day; or a combination of vigorous, moderate-intensity or walking on five or more days, achieving at
least 600 MET-minutes/week. Vigorous-intensity physical activity was classified as meeting one of the following two criteria: vigorous activity on three of more days, achieving at least 1500 MET-minutes/week; or a combination of vigorous, moderate-intensity or walking on seven or more days, achieving at least 3000 MET-minutes/week.

The IPAQ was developed to monitor physical activity and inactivity across countries, and was validated against the CSA (now MTI) accelerometer (Craig et al., 2003). The measure has good reliability ($\rho = 0.76$), and is weakly correlated ($\rho = 0.30$) with a seven-day measurement of accelerometers (Craig et al., 2003). The IPAQ assessment of physical activity is centred on the current recommendations for moderate and vigorous activity (Tehard et al., 2005). In this dissertation, the Spearman correlation coefficients between each subscale of IPAQ ranged from medium to large ($\rho = .60$, .30 and .34, for vigorous by moderate; vigorous by walking; and moderate by walking, respectively).

4.4.2.3 Mood. Mood was assessed using the Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995), which contains 21 items, made up of three seven-item self-report scales. The DASS-21 is a short form of the DASS, which is a 42-item scale. Questions on DASS-21 include “I found it hard to wind down”, and “I felt that I had nothing to look forward to”.

Participants responded on a four-point Likert scale (0 = did not apply to me at all, to 3 = applied to me very much of the time) rating the severity and frequency of experiencing negative emotions over the past week. Higher scores on each scale indicates greater level of severity, with scores of $\geq 14$, $\geq 10$ and $\geq 17$ indicating extremely severe scores for depression, anxiety and stress respectively.
The DASS-21 shows acceptable internal consistency for all scales ($\alpha = .91, .90$ and $.84$, for depression, anxiety and stress, respectively), and good internal consistency for the overall scale score ($\omega = .89$; Osman et al., 2012; Sinclair et al., 2012). It has also been validated with other respective measures of depression and anxiety (e.g., Beck Depression Inventory [BDI]; Beck Anxiety Inventory [BAI]; Antony, Bieling, Cox, Enns, & Swinson, 1998). In this dissertation, the DASS-21 had acceptable internal consistency, for all scales ($\alpha = .92, .73$ and $.88$, for depression, anxiety and stress, respectively), and very good internal consistency for the overall scale $\alpha = .94$.

4.5 Behavioural Tasks

4.5.1 Go/No-Go Task (GNG).

A computerised version of the flanker Go/No-Go task (GNG; based on Jasinska et al., 2012) using Inquisit v.4.0 was employed to investigate rash impulsivity. The GNG task is a measure of impulsive action, specifically motor disinhibition. It assesses an individual’s level of inhibitory control or response inhibition, as indicated by the number of commission errors (i.e., false alarms, the number of times a participant responds when they are not meant to) on No-Go trials. The GNG also measures a participant’s response reaction time (i.e., the time it takes participants to respond to each trial presented on the screen). A greater number of commission errors, and shorter reaction times are indicative of greater deficits in inhibitory control, and higher levels of rash impulsivity.

Food-distracter stimuli were included in some of the Go/No-Go trials to increase the number of commission errors completed for each category. For the current dissertation, participants saw a target letter (“G”) in the middle of the
screen, flanked by two identical images (either a food stimuli, or a non-food stimuli), and were instructed to press the space bar to all letters except the letter “X” (the “Go” trials were presented 70% of all trials) and to inhibit their response to the letter “X” (the “No-Go” trials, 30% of all trials). Each trial was 1500ms in duration, the stimuli were presented for 500ms followed by a white screen was presented for 1000ms (see figure 4.1). The instructions highlighted that participants should respond as quickly as possible (speed), while making the fewest errors possible (accuracy). In total there were 334 trials, which included 68 different food-distractor images and 68 different non-food distractor images. The order of trials was randomized between each participant.

**Figure 4.1.** A schematic depiction of a trial in the Go/No-Go task (adapted from Jasinska et al., 2012).

### 4.5.2 Iowa Gambling Task (IGT).

A computerised version of the Iowa Gambling Task (IGT; Bechara et al., 1994) was employed using Inquisit v.4.0. The IGT is a measure of impulsive
choice, specifically impulsive decision making. It assesses various aspects of an individual’s decision making, such as risk, doubt, and evaluation of rewards and punishments (Billieux et al., 2010). In the IGT individuals need to sacrifice short-term benefits, for longer-term rewards. Individuals, who have a lower net score on the IGT, are thought to have heightened reward sensitivity and impairment in their decision-making ability, and slower learning rate (Bull, Tippett, & Addis, 2015).

Participants were initially presented with $2000 (of hypothetical money), and asked to select one card at a time from four possible decks (A, B, C or D) presented on the computer screen. Prior to starting the IGT, participants were advised that some decks would be more profitable than others (but they did not know which decks were more advantageous), and that they should select cards from the most profitable decks, as the aim of the task was for their total winnings to be as high as possible. Following each trial the participants were provided with feedback showing the dollar amount won or lost for that trial and their running overall total (see figure 4.2). Earnings were shown on the screen after each trial. There were 100 trials in total. Deck A and B are classified as “disadvantageous” decks as while they both produced gains they also resulted in larger losses (regular selection of these decks leads to net loss). Decks C and D are seen as “advantageous” as they produce small gains, and small punishments (regular selection of these decks leads to net gain).

In this dissertation, the programmed schedules of reward and punishment were based on the original version of the task (Bechara et al., 1994). Scoring of the IGT was also consistent with a recent study by Brogan, Hevey, and Pignatti (2010). Participant’s performance was divided into five separate blocks (20 cards
per block), in order to explain the progression of their learning and their decision-making ability. In each of the five blocks, the number of cards chosen from the advantageous decks (C and D) was calculated. An overall net score \(((\text{Decks C + D}) - (\text{Decks A + B}))\) and a net score for each of the five blocks, was also computed.

**Figure 4.2.** A schematic depiction of the IGT Task. The participant has clicked on Deck 1 and received a $100 ‘hypothetical reward’.

### 4.6 Summary

The overall methodology of this dissertation was described above. The first question that will be investigated is whether overweight and obese adults have higher levels of impulsivity compared to healthy weight controls. Chapter Five of this dissertation will address this very important question.
Chapter Five: An Investigation of Rash Impulsivity and Reward Sensitivity in Healthy Weight, Overweight and Obese Adults

The purpose of this chapter is to report on the findings that examine whether overweight and obese adults display higher levels of impulsivity (self-report and behavioural measures), compared to healthy weight controls.

5.1 Introduction

Research into the psychological factors that influence obesity development is important, in order to improve preventive measures and treatment. As discussed in the introductory chapters’ impulsivity may play a significant role in the development of a range of problematic behaviours. For example, previous research has investigated the relationship between impulsivity and the development and maintenance of conditions such as eating disorders, substance-use disorders, and pathological gambling (Annagur et al., 2015; Brevers et al., 2012; Brogan et al., 2010; Davis et al., 2007; Dawe & Loxton, 2004; Dissabandara et al., 2014; Gullo, Ward, Dawe, Powell, & Jackson, 2011; Meule & Platte, 2015). There has also been a growing literature indicating that impulsivity may be a contributing factor that underlies obesity development (Bartholdy et al., 2016; Fields et al., 2013; Jasinska et al., 2012; Lavagnino et al., 2016; Lawyer et al., 2015).

As discussed in Chapter Two, impulsivity is a multifaceted construct, and each factor could make a unique contribution to the development and maintenance of obesity. Yet, previous research generally only focuses on measuring rash impulsivity, which may limit the overall understanding of the relationship between impulsivity and obesity (Houben, 2011; Houben et al., 2014;
Jasinska et al., 2012; Loeber et al., 2012; Mobbs et al., 2011; Reyes et al., 2015).

The two-factor model of impulsivity (i.e., rash impulsivity and reward sensitivity as separate constructs) is a theoretically driven model, which may be useful for conceptualising and measuring impulsivity when examining issues like obesity (Dawe & Loxton, 2004; de Wit & Richards, 2004; Gullo et al., 2014; Quilty & Oakman, 2004).

Impulsivity is generally measured at both the self-report and behavioural level, as indicated in Chapter Two. Yet, previous research has found either no relationship or a weak one between self-report and behavioural measures of impulsivity and obesity (Calvo et al., 2014; Nederkoorn et al., 2006a; Nederkoorn et al., 2006c; Verdejo-García et al., 2010). However, as discussed in Chapter Two, there is greater incremental validity from using both types of variables in predicting impulsive behaviours (like obesity) than using either type of measure on its own (Sharma et al., 2014). Future research should therefore try to incorporate both types of measures when investigating impulsivity.

A further factor to consider is that previous research often only specifies that participants are ‘currently’ within a healthy weight range. Just because someone is ‘currently’ a healthy weight, does not mean that they have always been within this weight range, and they could have been overweight or obese in the past. Previous research has found that the amount of weight control behaviours that long-term healthy weight controls, and weight-loss maintainers (i.e., participants who were overweight or obese at some point in their life, who are currently within a healthy weight range) engage in may differ (Phelan, Lang, Jordan, & Wing, 2009; Phelan, Roberts, Lang, & Wing, 2007). Individuals who have been a healthy weight all their life, are thought to represent a pure sample of
healthy weight participants. It is argued in this dissertation that research should consider applying a more stringent criterion of having to be within a lifetime healthy weight range, to provide a clearer understanding of the differences between obesity and impulsivity.

Similarly, overweight and obese individuals are often grouped together when investigating differences in impulsivity and obesity (e.g., Cohen et al., 2011). Yet some studies have found significant differences between impulsivity and weight status when separating overweight and obese participants, and comparing them with healthy weight controls (Chamberlain, Derbyshire, Leppink, & Grant, 2015; Fields et al., 2013). For example Chamberlain et al. (2015) found that obese, but not overweight young adults had greater levels of impulsivity, on a behavioural measure of impulsivity. So separating overweight and obese individuals may be important when investigating the association between obesity and impulsivity. One study which has recently looked at this issue in a group of adolescents is Fields et al. (2013).

5.1.1 Recent literature.

A study conducted by Fields et al. (2013) with adolescents, aged 14–16 years of age, examined differences between BMI groups (i.e., healthy weight ($n = 20$), overweight ($n = 20$) and obese ($n = 21$)) and various dimensions of impulsive behaviour (behavioural disinhibition, delay discounting, and sustained attention). They found no differences between groups for the Go/Stop Task (behavioural measure of disinhibition), or the self-report measure of impulsive behaviour (Barratt Impulsiveness Scale-Adolescents). Yet they did find that overweight and obese adolescents were more impulsive on the computerised monetary delay-discounting task than healthy weight adolescents (where they received actual
money at the end of the task). A recent meta-analysis found that when delay-discounting tasks use hypothetical food or monetary rewards (which participants do not receive), the results were more likely to be non-significant (Barlow, Reeves, McKee, Galea, & Stuckler, 2016). However, when studies use actual money or food-based rewards (where they receive the reward at the end), the results were strong, and were more likely to be significant. Fields et al. (2013) also found that obese adolescents committed more omission errors than healthy weight and overweight participants on the Conners’ Continuous Performance Test-II (measure of sustained attention). Similarly, a paediatric meta-analysis assessed the effects of impulsivity (using self-report and behavioural measures) on paediatric obesity (Thamotharan et al., 2013). They found that disinhibition and decision-making had significant moderate-to-large effects sizes on weight-status, while overall impulsivity and inattention produced small or no effect sizes. It is unclear whether disinhibition and decision-making also have an impact on weight status in adults.

Navas et al. (2016) extended the study by Fields et al. (2013) by investigating decision making under risk (measured by the Wheel of Fortune Task; WoFT), under ambiguity (measured by the Iowa Gambling Task; IGT), and reward sensitivity (measured by the Sensitivity to Punishment and Sensitivity to Reward Questionnaire; SPSRQ) in 79 adults, aged 18–45 years of age. Participants were recruited based on their BMI status, to create three groups, healthy weight ($n = 38$), overweight ($n = 21$), and obese ($n = 20$). They found that there was no difference in performance on the IGT or in scores on the SPSRQ for groups, but that obese individuals made riskier choices on the WoFT, compared to overweight and healthy weight controls (Navas et al., 2016).
While Fields et al. (2013) and Navas et al. (2016) add to the existing literature around obesity and impulsivity, there were some limitations that future research needs to address. Firstly, individuals who had a current mental health or neurological disorder (as determined by a clinical interview conducted by a psychologist), a co-morbid medical condition associated with obesity (such as hypertension, as measured by an accredited nurse, fatty liver disease, or diabetes), and/or those with a BMI over 40 were excluded from the Navas et al. (2016) study. Previous research has found that overweight and obese individuals report significant levels of depression and other mental health conditions, and excluding these individuals from this research may not provide a representative sample (Onyike, Crum, Lee, Lyketsos, & Eaton, 2003; Williams et al., 2015). Additionally, excluding participants who have a BMI over 40 may make it harder to draw conclusions about the relationship between obesity and impulsivity, as previous research has found that higher BMIs are associated with greater impulsivity. As highlighted in Chapter One, the level of BMI is also increasing in the general population with the average BMI in excess of 40 in most developed countries. Therefore, excluding these individuals will limit generalisability of the findings to the general population. Finally, while each study used self-report (i.e., the BIS-A, and the SPSRQ respectively) and behavioural measures (i.e., Go/Stop Task, and the IGT respectively) of impulsivity, they only focused on one aspect of impulsivity (i.e., they did not utilise the two-factor model). As discussed above, it is important to consider both factors of impulsivity.

5.2 The Current Empirical Chapter

The two-factor model of impulsivity will be utilised to investigate whether rash impulsivity and/or reward sensitivity (measured via both self-report and
behavioural methods) will vary significantly depending on different BMI groups (i.e., healthy weight, overweight and obese). Using the detailed weight history for all participants, this empirical chapter applied a more stringent criterion of needing to be within a healthy BMI range throughout their lifetime (excluding pregnancy, and post pregnancy) for the healthy weight controls. Furthermore, overweight adults were included in addition to obese and healthy weight controls, in accordance with the literature presented above.

5.2.1 Aims and hypotheses.

The primary aim of this empirical chapter is to examine whether rash impulsivity and reward sensitivity are significantly associated with BMI status (healthy weight, overweight and obese) in an adult population. On the basis of previous research reviewed above, the following is hypothesised:

1. That overweight and obese participants will have higher levels of rash impulsivity and reward sensitivity compared to healthy weight controls, and obese individuals will have comparable or higher levels than overweight for:
   a. Self-report measures of impulsivity, and
   b. Behavioural measures of impulsivity.

A secondary aim of this empirical chapter is to examine the relationship between self-report and behavioural measures of impulsivity. It is hypothesised:

2. That there will be a weak to moderate relationship between self-report and behavioural measures of:
   a. Rash impulsivity (between the I⁰ and the GNG), and
   b. Reward sensitivity (between the SR and the IGT).
5.3 Method

5.3.1 Participants.

A total of 70 individuals were included in this empirical chapter, 24 healthy weight controls, 24 overweight participants, and 22 obese participants (drawn from the larger participant pool). Inclusion criteria was based on participants BMI (defined as [weight (kg)/ (height (m²))] for healthy weight controls, a BMI between 18.50 and 24.99 throughout their life (excluding pregnancy, and post pregnancy), for overweight participants a BMI between 25.00 and 29.99, and for obese participants a BMI ≥ 30 (World Health Organization, 2000).

The majority of participants currently lived in Australia (96%), and classified themselves as being of Anglo-Saxon for cultural identity (87%). In relation to educational attainment, 23% of obese participants, 37.5% of overweight participants, and 92% of healthy weight controls had commenced or completed tertiary education. Fifty-five per-cent of obese participants, 71% of overweight participants, and 63% of healthy weight controls reported being in a romantic relationship. Eight per-cent of healthy weight controls stated that they were current smokers. Additional descriptive participant characteristics are presented in Table 5.1.
Table 5.1
Comparison of Demographic and Descriptive Statistics among Healthy weight, Overweight and Obese Participants

<table>
<thead>
<tr>
<th></th>
<th>Healthy weight&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Overweight&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Obese&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Test Statistic</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender [% Female (n)]</td>
<td>70.8 (17)</td>
<td>87.5 (21)</td>
<td>90.9 (20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age [years; M (SD)]</td>
<td>38.04 (12.88)</td>
<td>48.38 (15.63)</td>
<td>48.68 (10.98)</td>
<td>4.85&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2, 67.00</td>
<td>.011</td>
</tr>
<tr>
<td>Age range</td>
<td>23–65</td>
<td>19–65</td>
<td>26–64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Mass Index [BMI; M (SD)]</td>
<td>21.43 (1.79)</td>
<td>27.59 (1.44)</td>
<td>42.06 (5.70)</td>
<td>198.07&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2, 27.72</td>
<td>.000</td>
</tr>
<tr>
<td>BMI range (kg/m&lt;sup&gt;2&lt;/sup&gt;)</td>
<td>18.93 – 24.54</td>
<td>25.21 – 29.84</td>
<td>35.22 – 58.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual household income [% (n)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 30,000</td>
<td>4.2 (1)</td>
<td>16.7 (4)</td>
<td>4.5 (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$30,000 – $90,000</td>
<td>25.0 (6)</td>
<td>41.7 (10)</td>
<td>72.7 (16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$90,000 and above</td>
<td>65.0 (13)</td>
<td>33.3 (8)</td>
<td>18.2 (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not reported</td>
<td>16.7 (4)</td>
<td>8.3 (2)</td>
<td>4.5 (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASS-21: Depression [M (SD)]</td>
<td>2.38 (2.99)</td>
<td>1.96 (2.12)</td>
<td>5.31 (4.52)</td>
<td>6.66&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2, 46.44</td>
<td>.003</td>
</tr>
<tr>
<td>Moderate and above [% (n)]&lt;sup&gt;e&lt;/sup&gt;</td>
<td>8.3 (2)</td>
<td>0 (0)</td>
<td>31.8 (7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASS-21: Anxiety [M (SD)]</td>
<td>2.17 (1.79)</td>
<td>1.54 (1.93)</td>
<td>3.64 (3.58)</td>
<td>3.94&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2, 43.08</td>
<td>.027</td>
</tr>
<tr>
<td>Moderate and above [% (n)]&lt;sup&gt;f&lt;/sup&gt;</td>
<td>8.3 (2)</td>
<td>8.3 (2)</td>
<td>27.3 (6)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*<sup>Note</sup>. <sup>a</sup>n = 24. <sup>b</sup>n = 24. <sup>c</sup>n = 22. <sup>d</sup>One-way ANOVA. <sup>*</sup>Due to the low numbers, test statistic could not be calculated (Tabachnick & Fidell, 2013). <sup>e</sup>Depression moderate severity range (7-10). <sup>f</sup>Anxiety moderate severity range (6-7).
5.3.2 Materials and procedure.

Details regarding the materials and procedures utilised in the present chapter were explained in Chapter Four (see p. 57 for method). For the current empirical chapter demographic information, impulsivity measures (I7, GNG, SR and IGT), and the DASS-21 were utilised.

5.3.3 Data analysis.

The participant sample size used in the current empirical chapter was based on the study conducted by Fields et al. (2013). Data were inspected for errors, missing values and outliers using z values of ± 3.29 ($p < .001$) as suggested by Tabachnick and Fidell (2013), and to determine if the distributional assumptions for normality were met. Cases with missing data for the self-report impulsivity measures were retained and missing values replaced via the Expectation Maximization (EM) method. Go/No-go (GNG) data were removed for seven participants, as they did not meet the criteria of needing to complete a minimum of 50% of the GO trials, and/or being identified as an extreme outlier, on one or more of the GNG variables. Re-inspection of the four GNG variables did not reveal any additional outliers. All statistics were run using SPSS (version 23).

Normality of the variables was inspected using Kolmogorov-Smirnov statistic, which revealed that the distribution of the I7, SR, IGT net score, and GNG food commission errors were significantly different from normal ($p < .05$) for one or more of the weight groups (i.e., healthy weight, overweight, or obese). However, Tabachnick and Fidell (2013) highlight that the Kolmogorov-Smirnov statistic is an overly sensitive measure. Visual inspection of the histograms, and calculation of skewness and kurtosis values were then conducted for each variable.
for the three weight groups. This indicated that the \( I^7 \) was positively skewed, and slightly peaked for the obese group. It was decided that they would remain in the subsequent analyses. Finally, inspection of Levene’s test of equality of variance indicated that the assumption of homogeneity of variance was violated \((p < .05)\) for the independent samples t-test investigating mean age across each weight group, and for both of the ANCOVA’s exploring the self-report measures of impulsivity. The Brown-Forsythe test statistic was then utilised for mean age as suggested by Pallant (2010).

Mean and standard deviation scores for all impulsivity variables are presented in Table 5.2. To test hypothesis 1a and 1b five between-groups analysis of covariance (ANCOVA) were conducted to determine if differences in impulsivity existed between healthy weight controls, overweight, or obese individuals, whilst controlling for participants’ ages. Five ANCOVAs were run instead of one MANCOVA, as the analysis plan undertaken by Fields et al. (2013) was followed in the current empirical chapter. Fields et al. (2013) studied adolescents, and this empirical chapter wanted to replicate their analysis plan with an adult population. Participants’ ages were entered as a covariate in the analyses, as a one-way analysis of variance, identified that there was a significant difference in age between healthy weight controls and obese participants. Results are displayed in Table 5.3. Levene’s test of homogeneity of variance was violated for both the \( I^7 \) and SR. Inspection of both variables indicated that there was a significant difference between weight groups on the \( I^7 \) (i.e., self-reported rash impulsivity). A between-groups analysis of variance (ANOVA) was then conducted (without controlling for age), and the Brown-Forsythe test statistic was then utilised. Planned comparisons were then run for both the ANCOVA
(controlling for age), and ANOVA (see Table 5.4). To test the hypotheses 2a and 2b correlation analyses were conducted to explore the relationship between self-report and behavioural measures of rash impulsivity, and reward sensitivity. Results are displayed in Table 5.5.

5.4 Results

5.4.1 Demographic and clinical characteristics.

As shown in Table 5.1, there was a difference for age (which was controlled for), and as expected BMI differences between the groups. Furthermore, differences between depression and anxiety scores were found, but because the values were within the lower ranges of depressive and anxiety symptoms, the difference was not clinically relevant. It can be observed from inspecting Table 5.2 that means for self-reported rash impulsivity and reward sensitivity (\( \text{I}^7 \) and SR respectively) were lower for healthy weight controls compared to overweight and obese participants. However, there was only a significant difference for the \( \text{I}^7 \).
Table 5.2  
*Means and Standard Deviations (in brackets) for Impulsivity Measures Included in the Analyses, for Overall Sample (N = 70), and Each Group*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Overall Sample</th>
<th>Healthy weight&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Overweight&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Obese&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sup&gt;7&lt;/sup&gt;</td>
<td>5.87 (4.98)</td>
<td>3.42 (3.89)</td>
<td>5.83 (4.29)</td>
<td>8.59 (5.48)</td>
</tr>
<tr>
<td>SR</td>
<td>8.21 (5.56)</td>
<td>7.83 (3.67)</td>
<td>8.04 (6.42)</td>
<td>8.81 (6.42)</td>
</tr>
<tr>
<td>IGT Net Score (Trials 1-100)</td>
<td>-9.26 (36.23)</td>
<td>-14.25 (33.16)</td>
<td>-6.42 (44.02)</td>
<td>-6.91 (30.71)</td>
</tr>
<tr>
<td>IGT Block 1 Net Score</td>
<td>-2.62 (8.18)</td>
<td>-4.67 (7.66)</td>
<td>-1.50 (9.40)</td>
<td>-1.63 (7.16)</td>
</tr>
<tr>
<td>IGT Block 2 Net Score</td>
<td>-2.66 (9.17)</td>
<td>-5.83 (8.65)</td>
<td>-0.08 (10.67)</td>
<td>-2.00 (7.09)</td>
</tr>
<tr>
<td>IGT Block 3 Net Score</td>
<td>-2.49 (10.27)</td>
<td>-5.33 (9.59)</td>
<td>-1.58 (10.65)</td>
<td>-0.36 (10.32)</td>
</tr>
<tr>
<td>IGT Block 4 Net Score</td>
<td>-1.23 (10.13)</td>
<td>0.47 (10.38)</td>
<td>-2.67 (10.54)</td>
<td>-1.45 (9.59)</td>
</tr>
<tr>
<td>IGT Block 5 Net Score</td>
<td>-0.26 (10.22)</td>
<td>1.17 (11.54)</td>
<td>-0.58 (11.20)</td>
<td>-1.45 (7.49)</td>
</tr>
<tr>
<td>GNG Food Reaction Time</td>
<td>387.24 (27.42)</td>
<td>375.72 (25.67)</td>
<td>394.96 (27.27)</td>
<td>391.05 (26.68)</td>
</tr>
<tr>
<td>Commission Errors</td>
<td>6.36 (4.76)</td>
<td>5.38 (3.44)</td>
<td>6.81 (5.26)</td>
<td>6.90 (5.39)</td>
</tr>
<tr>
<td>GNG Non-Food Reaction Time</td>
<td>386.98 (26.52)</td>
<td>374.77 (22.91)</td>
<td>396.40 (26.27)</td>
<td>389.77 (26.58)</td>
</tr>
<tr>
<td>Commission Errors</td>
<td>6.59 (4.77)</td>
<td>5.62 (4.15)</td>
<td>6.95 (5.47)</td>
<td>7.19 (4.68)</td>
</tr>
</tbody>
</table>

*Note.* <sup>a</sup><sup>n</sup> = 24. <sup>b</sup><sup>n</sup> = 24. <sup>c</sup><sup>n</sup> = 22. I<sup>7</sup> = Impulsivity subscale of the Eysenck Impulsiveness scale; SR = Sensitivity to Reward subscale; IGT = Iowa Gambling Task; GNG = Go/No-go.
5.4.2 Hypothesis 1a: ANCOVA’s comparing weight groups for self-report measures of impulsivity.

Two ANCOVAs were conducted to test the hypothesis that overweight and obese participants will have higher levels of rash impulsivity and reward sensitivity compared to healthy weight controls for self-report measures of impulsivity, whilst controlling for age (see Table 5.3). The analyses revealed that there was a significant difference between the three weight groups for self-reported rash impulsivity, however the assumption of equal variance was violated. Consequently, a one-way between-groups ANOVA was run (without including age as a covariate) to explore the impact of weight status on self-reported rash impulsivity (as measured by the I7). The analyses revealed that there was a significant difference in the I7 scores for the three weight groups ($F = 7.21, df = 2, 58.88, p < .01$).

Table 5.3

One-Way Analysis of Covariance Comparing Weight Groups on Impulsivity Measures, whilst Controlling for Age

<table>
<thead>
<tr>
<th>Measure</th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>$\frac{2}{p}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I7</td>
<td>2, 66</td>
<td>5.91</td>
<td>.01</td>
<td>.15</td>
</tr>
<tr>
<td>SR</td>
<td>2, 66</td>
<td>0.25</td>
<td>.78</td>
<td>.01</td>
</tr>
<tr>
<td>IGT Net Score</td>
<td>2, 66</td>
<td>0.04</td>
<td>.96</td>
<td>.00</td>
</tr>
<tr>
<td>GNG Food Reaction Time</td>
<td>2, 59</td>
<td>0.84</td>
<td>.44</td>
<td>.03</td>
</tr>
<tr>
<td>GNG Food Commission Errors</td>
<td>2, 59</td>
<td>2.16</td>
<td>.12</td>
<td>.07</td>
</tr>
</tbody>
</table>

*Note. I7 = Impulsivity subscale of the Eysenck Impulsiveness scale; SR = Sensitivity to Reward subscale; IGT = Iowa Gambling Task; GNG = Go/No-go.*
Conversely, overweight and obese participants were not significantly higher on self-reported reward sensitivity (as measured by the SR), compared to healthy weight controls. There was no significant relationship between participants’ ages and the SR variable ($p = .69$, $\hat{\rho} = .002$).

5.4.2.1 Planned comparisons. Planned comparisons were run for both the ANCOVA and ANOVA (see Table 5.4) to explore weight status (three groups) on self-reported rash impulsivity. It can be observed from inspecting Table 5.4 that there was a significant difference between the healthy weight controls and obese participants for self-reported rash impulsivity for both the ANCOVA and ANOVA. However, contrasting results were found for the other two planned comparisons, depending on whether age was controlled for or not.

Table 5.4

Planned Comparisons for ANCOVA (Controlling for Age) and ANOVA for the

<table>
<thead>
<tr>
<th>Planned comparison</th>
<th>ANCOVA</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$df$</td>
<td>$F$</td>
</tr>
<tr>
<td>Healthy vs. Obese</td>
<td>1, 66</td>
<td>11.67</td>
</tr>
<tr>
<td>Healthy vs. Overweight</td>
<td>1, 66</td>
<td>2.33</td>
</tr>
<tr>
<td>Overweight vs. Obese</td>
<td>1, 66</td>
<td>4.11</td>
</tr>
</tbody>
</table>
5.4.3 Hypothesis 1b: ANCOVA’s comparing weight groups for 
behavioural measures of impulsivity.

Three ANCOVAs were conducted to test the hypothesis that overweight 
and obese participants will have higher levels of rash impulsivity and reward 
sensitivity compared to healthy weight controls for behavioural measures of 
impulsivity, whilst controlling for age. The analyses revealed that there was no 
significant difference between healthy weight controls, overweight or obese 
participants for the IGT net score or either of the GNG food variables. There was 
no significant relationship between participants’ ages and the IGT net score ($p = .15$, $\hat{p} = .03$). Conversely, for the GNG task there was a significant relationship 
between participants’ age and food reaction time ($p < .01$, $\hat{p} = .18$), and food 
commission errors ($p < .02$, $\hat{p} = .11$).

5.4.4 Hypothesis 2a: Relationship between rash impulsivity variables.

Correlation analyses were conducted to test the hypothesis that self-report 
and behavioural measures of rash impulsivity would be significantly associated 
(see Table 5.5). The analyses indicated that there was a small significant positive 
correlation between self-reported rash impulsivity and GNG food reaction time ($r = .27$, $n = 63$, $p < .05$). However, self-reported rash impulsivity was not 
significantly correlated with GNG food commission errors ($r = .02$, $n = 63$, $p = .87$).

5.4.5 Hypothesis 2b: Relationship between reward sensitivity 
variables.

Correlation analyses were conducted to test the hypothesis that self-report 
and behavioural measures of reward sensitivity would be significantly associated.
The analyses revealed a small, albeit significant, negative correlation between self-reported reward sensitivity, and IGT net score ($r = -.25$, $n = 70$, $p < .05$). Higher IGT net scores are associated with better decision-making.

### 5.4.6 Additional correlation analyses.

Additional correlation analyses were run to investigate the relationship between different self-report measures, as well as between behavioural measures of impulsivity (see Table 5.5). The analyses revealed a large significant positive correlation between self-reported rash impulsivity, and reward sensitivity, measured by the $I^7$ and SR ($r = .60$, $n = 70$, $p < .01$). Conversely, there was no significant correlation between behavioural measures of impulsivity (as measured by the IGT net score), and each of the food-related GNG variables, i.e., reaction time ($r = .15$, $n = 63$, $p = .23$), and commission errors ($r = .03$, $n = 63$, $p = .84$).

<table>
<thead>
<tr>
<th></th>
<th>$I^7$</th>
<th>SR</th>
<th>IGT Net Score</th>
<th>GNG Food RT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I^7$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGT Net Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNG Food RT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNG Food Commission</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Errors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.5

*Correlation Matrix for all Measures of Impulsivity*

<table>
<thead>
<tr>
<th></th>
<th>$I^7$</th>
<th>SR</th>
<th>IGT Net Score</th>
<th>GNG Food RT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I^7$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGT Net Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNG Food RT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNG Food Commission</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Errors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $I^7$ = Impulsivity subscale of the Eysenck Impulsiveness scale; SR = Sensitivity to Reward subscale; IGT = Iowa Gambling Task; GNG = Go/No-go. RT = Reaction Time

**$p < .01$  
* $p < .05$
5.4.7 Additional analysis: Task learning on the IGT.

It was also predicted that healthy weight controls would demonstrate improvement over trials on the IGT, compared to overweight and obese participants. Block mean net scores for the healthy weight, overweight and obese groups are presented in Figure 5.1. It can be observed that the mean net score for both the overweight and obese groups did not vary much across the five blocks. Conversely, the healthy weight controls appear to show an increase in their preference for the advantageous decks across the task. This is shown by an improvement in their learning, especially between blocks three and four, where there is the most noticeable increase in their mean net score. A Mixed Between-Within Subjects ANOVA was then conducted to examine whether the changes between the groups differed during the task (whilst controlling for participants’ ages). There was no significant interaction between groups and IGT blocks, Wilks’ Lambda = .80, \( F(8, 126) = 1.88, p = .07 \). Additionally, there was no significant effect for time (i.e., across the five blocks), Wilks’ Lambda = .97, \( F(4, 63) = 0.44, p = .78 \), partial eta squared = .027. The main effect comparing the three groups was not significant, \( F(2, 66) = .04, p = .97 \), partial eta squared = .001.
5.5 Discussion

The objective of the present chapter was to examine whether overweight and obese adults display higher levels of impulsivity (self-report and behavioural measures), compared to healthy weight controls. The findings partly supported the predictions made by hypothesis 1a, as obese participants self-reported significantly higher levels of rash impulsivity (i.e., $I^7$) compared to healthy weight controls. In contrast to the predictions made by hypothesis 1b, there was no significant differences found between healthy weight controls and overweight and obese adults for behavioural measures of impulsivity. Hypothesis 2a and 2b were also partly supported, in that self-report and behavioural measures of rash impulsivity and reward sensitivity were moderately associated. Interestingly, hypothesis 2a was only partly supported, as self-reported rash impulsivity was
only significantly correlated with GNG food reaction time, but was not significantly correlated with GNG food commission errors.

5.5.1 The influence of obesity on rash impulsivity and reward sensitivity for self-report and behavioural measures of impulsivity.

The primary aim of this empirical chapter was to test whether differences in rash impulsivity and reward sensitivity existed between healthy weight controls, overweight, or obese individuals, for self-report and behavioural measures of impulsivity (whilst controlling for participants’ ages). The present findings indicate that hypothesis 1a was partly supported, as there was a significant difference between the three weight groups for self-reported rash impulsivity (as measured by the I7) for both the ANCOVA and ANOVA (Levene’s was violated for both analyses). However, this was not the case for self-reported reward sensitivity (as measured by the SR), as there was no difference between the three weight groups. This finding is inconsistent with previous research which has found a curvilinear relationship between BMI and reward sensitivity, where healthy weight and overweight individuals had higher levels of sensitivity to reward than obese individuals (Davis & Fox, 2008).

Planned comparisons revealed that there was a significant difference in I7 scores between healthy weight controls and obese participants, regardless of whether the ANCOVA or ANOVA results were investigated. Therefore, it appears that age does not seem to have an effect on this significant difference, as even when age was not controlled for in the ANOVA it was still significant. Alternatively, inconsistent results were obtained for the other two planned comparisons (i.e., between healthy weight controls vs. overweight participants, and between overweight vs. obese participants) that further explored differences
in I^7 scores, between the three weight groups. The differences observed in the current empirical chapter, were dependent upon whether the ANCOVA or ANOVA results were investigated. This suggests that age may be a factor, in whether a significant difference in I^7 scores between the groups (i.e., between healthy weight controls vs. overweight participants, and between overweight vs. obese participants) was found. Due to the inconsistencies further research is recommended.

Unlike hypothesis 1a, the findings of the present chapter did not support hypothesis 1b, which predicted that overweight and obese participants would have higher levels of rash impulsivity and reward sensitivity for behavioural measures of impulsivity, compared to healthy weight controls. The findings are consistent with a study by Loeber et al. (2012), which did not find a significant difference between obese and healthy weight control on a food specific GNG task. However, this is inconsistent with other research, which has found significant differences between obese and healthy weight controls on the GNG task (Calvo et al., 2014; Mobbs et al., 2011). In regards to the IGT findings, the current empirical chapter is consistent with findings by Navas et al. (2016) as they also did not find a significant difference between BMI groups (i.e., healthy weight, overweight and obese) and IGT net scores.

It appears that there are mixed findings in the literature, which may be due to a range of factors. For the IGT, previous research has found conflicting results around whether educational attainment has an influence on task performance. The inconsistencies in IGT results may be partly due to this, and if studies have controlled for educational attainment, or if the BMI groups were matched on this variable. Furthermore, the type of measure used could have influenced the
findings. For example with the GNG task, images or words can be used as the main stimuli, and some studies use food specific stimuli, while others are non-food specific.

5.5.2 The relationship between self-report and behavioural measures of impulsivity.

A secondary aim of the present chapter was to report on findings that examine whether there is a relationship between self-report and behavioural measures of rash impulsivity and reward sensitivity. Hypothesis 2a was partly supported, as self-reported rash impulsivity (I7) was positively associated with GNG food reaction time. Interestingly, the present findings also indicated that self-reported rash impulsivity (I7) was not significantly associated with GNG food commission errors. Consistent with hypothesis 2b, the present findings demonstrate that self-reported reward sensitivity (SR) and IGT net scores are significantly associated. These findings indicate that participants who score higher on self-reported reward sensitivity had lower IGT net scores. Overall, the present findings are consistent with previous research and theoretical perspectives, which have found no relationship (e.g., Krishnan-Sarin et al., 2007; Reynolds, Penfold, & Patak, 2008), or a weak relationship between self-report and behavioural measures of impulsivity (e.g., Calvo et al., 2014; Heyman & Gibb, 2006). The lack of association between self-report and behavioural measures of impulsivity could be due to the differences in the behaviours that each type of measure assesses (Reynolds, Ortengren, Richards, & de Wit, 2006).

Furthermore, the relationship between each of the self-report measures, and the association between the two behavioural measures of impulsivity was also of theoretical interest. The analyses revealed a large significant positive
correlation between self-report rash impulsivity and reward sensitivity. The findings are consistent with previous research, which has found associations between self-report measures of impulsivity (Dawe et al., 2004; Gullo et al., 2011; Torrubia et al., 2001). However, there was no significant association between the behavioural measures (i.e., IGT and GNG). Previous research has found that there is often variability between behavioural measures and that the internal reliability for reaction time measures is particularly low (Christiansen, Mansfield, Duckworth, Field, & Jones, 2015). This could explain why the behavioural measures of rash impulsivity and reward sensitivity were not significantly related. It is possible that the two-factor model of impulsivity only holds for the self-report measures (Dawe & Loxton, 2004).

**5.5.3 Task learning on the IGT.**

Analyses revealed that healthy weight controls appeared to show improvement across the IGT, as indicated by their preference for the advantageous decks. The present findings are consistent with previous research, as obese participants appear to exhibit impaired performance on the IGT, compared to healthy weight controls, (Brogan et al., 2011; Brogan et al., 2010; Danner, Ouwehand, Haastert, Hornsveld, & Ridder, 2012; Davis, Patte, Curtis, & Reid, 2010) as they often fail to show improvements and learning across the task (Davis et al., 2004a; Pignatti et al., 2006). However, findings regarding healthy weight controls having the lowest mean net score of the three groups is inconsistent with previous research findings, that obese participants have significantly lower mean net scores on the IGT, compared to healthy weight controls (Brogan et al., 2011; Fagundo et al., 2012). This inconsistent finding could be because the healthy weight controls in this study, may exhibit
heightened reward sensitivity in other areas of their life (e.g., reckless driving, gambling, or substance use). Finally, the additional analyses (i.e., the mixed between-within subjects ANOVA) revealed that there was no significant effect for time (across the five blocks), no effect for groups (i.e., between healthy weight, overweight and obese participants), and no interaction effect.

5.5.4 Clinical characteristics.

The one-way ANOVAs revealed that there was a significant difference between mean scores for self-reported depression, and anxiety (as measured by the DASS-21) for the three groups. While a significant difference was found the majority of participants from each group were well below the moderate severity ratings for both depression and anxiety. Depression and anxiety were therefore not controlled for in the current empirical chapter. As highlighted above, previous research has found that overweight and obese individuals often report significant levels of depression and other mental health conditions, but in order to provide a representative sample these individuals should be included in analyses (Markowitz et al., 2008; Onyike et al., 2003; Williams et al., 2015). The current chapter showed that there are significant differences between healthy weight controls, overweight and obese individuals in regards to symptoms of anxiety and depression. Future research may want to further investigate these differences, in order to better understand the relationships.

5.5.5 Limitations.

While attempts were made to match the three groups, the findings presented in this chapter may have been limited by the fact that there was a significant difference between healthy weight controls and obese participants for age. Some previous research has also found gender differences in self-report and
behavioural measures of impulsivity (for a meta-analysis see Cross, Copping, & Campbell, 2011). However, inconsistent results have been obtained, and due to the sample size, gender was not included as a covariate. Furthermore, while participants were asked to report their highest level of education achieved, they did not report years of educational attainment. Previous research has found conflicting results about whether a significant effect is still found when educational attainment is controlled for, when investigating differences in task performance (e.g., IGT) between weight status groups (Brogan et al., 2010; Davis et al., 2010; Pignatti et al., 2006). Future research may therefore benefit from including gender as a covariate, and investigating the influence of educational attainment on task performance. Additional limitations will be presented in the general discussion.

5.6. Conclusions

In conclusion, the findings reported in the present chapter indicate that obese participants self-reported significantly higher levels of rash impulsivity compared to healthy weight controls. Moreover, the present findings indicated that self-report and behavioural measures of rash impulsivity and reward sensitivity are weakly associated and that self-reported measures of impulsivity are strongly associated. Additionally, healthy weight controls appear to show improvement across the IGT compared to overweight and obese adults, however further investigation is recommended, as the three weight status groups did not differ significantly on the IGT. Therefore, the present findings hold important clinical implications and indicate that therapeutic interventions around weight loss and weight management would benefit from development of appropriate treatment strategies that specifically target rash impulsivity.
Chapter Six: Is Impulsivity Associated with Weight-Loss Regain in Obese Individuals?

The purpose of this chapter is to determine whether higher levels of impulsivity (rash impulsivity or reward sensitivity) are positively associated with weight-loss regain, in a group of overweight and obese adults.

6.1 Introduction

Successful weight-loss maintenance can be challenging. Only 18% of individuals who participate in a behavioural weight management program are successful at maintaining 10% or more of their weight loss long-term (i.e., after three years; Santos et al., 2015). As discussed in Chapter One of this dissertation, previous research has investigated strategies that are important for successful weight-loss maintenance, which can include regular breakfast consumption; high levels of physical activity; and controlling emotional eating (Santos et al., 2015; Wing & Phelan, 2005; Wyatt et al., 2002). Previous research has also proposed that impulsivity may contribute to whether an individual is successful at maintaining long-term weight loss (Houben et al., 2012; McKee et al., 2013; Teixeira et al., 2015).

As discussed in the introductory chapters’, some previous research has investigated the differences between overweight/obese individuals and healthy weight controls for self-report and behavioural measures of rash impulsivity and reward sensitivity. However, the same investigations have not been examined in weight-loss maintenance and regain, using self-report and behavioural measures of impulsivity. Instead, brain-imaging research has looked at differences in brain activation in individuals who are successful at weight-loss maintenance (with
only one study also including a self-report measure; DelParigi et al., 2007; Le et al., 2007; McCaffery et al., 2009; Sweet et al., 2012; Weygandt et al., 2015). For example, Sweet et al. (2012) investigated the brain’s response to food stimulation in successful weight-loss maintainers (WLMs; \( n = 17 \)), lifetime healthy weight controls (\( n = 18 \)), and obese participants (\( n = 14 \)). They found that WLMs had greater activation in all brain regions, and scored significantly higher on restraint (measured with the Eating Inventory), compared with the other two weight status groups. The prefrontal cortex (PFC) is thought to be the main brain region associated with impulsivity (Volkow et al., 2013), and individuals who are successful at weight-loss maintenance demonstrate increased activation in their PFC (DelParigi et al., 2007; Le et al., 2007; McCaffery et al., 2009; Weygandt et al., 2015). As highlighted in Chapter Two of this dissertation, Weygandt et al. (2015) found that greater activity in the PFC was associated with more successful weight-loss maintenance. Alternatively, brain-imaging studies in obese women found that structural and functional abnormalities in the PFC were predictive of greater weight gain (Kishinevsky et al., 2012; Yokum, Ng, & Stice, 2012).

Therefore, the degree of activation (e.g., low, medium or high) in particular brain regions related to impulsivity (i.e., the PFC) may have an influence on an individual’s inhibitory control, and contribute to whether they are successful at weight-loss maintenance.

Additionally, as discussed in Chapter Two of this dissertation, functional imaging research suggests that impairment in the PFC may also contribute to disinhibited behaviour (i.e., spontaneous, rash impulsivity) in substance-dependent individuals (Goldstein & Volkow, 2002; Volkow et al., 2011; Volkow et al., 2009). Further support for investigating whether higher levels of
impulsivity are positively associated with weight-loss regain comes from the substance abuse literature. Previous research has found that individuals with substance use disorders, and high levels of impulsivity, have a greater propensity to relapse both during and following addiction treatment (for reviews see; Stevens et al., 2014; Verdejo-García, Lawrence, & Clark, 2008). A study by Stevens et al. (2015) found that behavioural measures of impulsivity (i.e., IGT and delay discounting) were more likely to predict short-term relapse to substance use, than self-report measures. Furthermore, there are a number of commonalities between relapse to substance use and failing at maintaining long-term weight loss. For example, previous research has proposed that there are parallels in the processing imbalances in a number of brain regions involved in emotion/stress reactivity, motivation, executive functioning, memory and reward (Koob & Volkow, 2016; Volkow et al., 2013).

Furthermore, as discussed in Chapter Two of this dissertation, impulsivity is multifaceted, and there is greater incremental validity from using both self-report and behavioural measures when predicting impulsive behaviours (seen in both substance-dependent individuals, and weight-loss regainers), than using either type of measure on its own (Sharma et al., 2014). Furthermore, using a theoretically derived model of impulsivity, like the two-factor model may provide a clearer picture of weight-loss maintenance. Finally, as discussed in Chapter One, there are inconsistencies in the literature around how to best define successful weight-loss maintenance and failure. For the purpose of this dissertation Wing and Hill’s (2001) classification of a WLM will be utilised (described below), because as described in Chapter One, a large proportion of the current weight-loss maintenance literature follows this definition. Future research
would benefit from measuring more ‘long-term’ weight-loss maintenance (3–5 years), however, this was not within the scope of this dissertation.

6.2 The Current Empirical Chapter

The two-factor model of impulsivity will be utilised to investigate which impulsivity measure (I, SR, IGT Net score, GNG Food Reaction Time) can best differentiate successful weight-loss maintenance from regain. The GNG Food Reaction Time variable was used as a measure of rash impulsivity in the current empirical chapter, as a shorter reaction time to food stimuli indicates higher levels of rash impulsivity. Alternatively, the GNG Food Commission Error variable, is a measure of inhibitory control, and represents the number of false alarms. Given that the current empirical chapter aims to measure rash impulsivity, rather than inhibitory control, the GNG Food Reaction Time variable was utilised. Furthermore, while previous research has investigated the relationship between impulsivity and weight-loss maintenance, these studies have typically examined the functional imaging of the brain, rather than using self-report and behavioural measures of impulsivity. Previous research has also not investigated this relationship using the two-factor model of impulsivity. Finally, no studies have examined which impulsivity measure best accounts for the greatest variance in whether an individual is successful at weight-loss maintenance or not. The current empirical chapter aims to investigate whether impulsivity levels can differentiate weight-loss maintainers (WLMs) from weight-loss regainers (WLRs), and secondly which type of impulsivity measure (i.e., rash impulsivity or reward sensitivity) best reflects this relationship.
6.2.1 Aims.

The primary focus of this chapter is to measure impulsivity in successful WLMs and WLRs, and assess which impulsivity variable best accounts for group membership.

In consideration of previous research, the following research questions are proposed in relation to WLMs and WLRs:

1. How much total variance does impulsivity account for in successful weight-loss maintenance?

2. Which component(s) of impulsivity (I^7, SR, IGT Net Score, or the GNG Food Reaction Time) predict significantly unique variance in differentiating WLMs from WLRs?

6.3 Method

6.3.1 Participants.

A total of 96 individuals were included in this empirical chapter, 62 weight-loss maintainers, and 34 weight-loss regainers. All participants were drawn from the larger participant pool. To be classified as successful weight-loss maintainer participants needed to maintain $\geq 10\%$ of their weight loss, or alternatively they were classified as a weight-loss regainer if they maintained $<10\%$ of their weight loss. To be eligible, participants needed to complete all questionnaire measures, to have been overweight or obese (Body Mass Index $\geq 25$) at some point in their life, to have undertaken their most recent weight loss attempt $>12$ months ago ($>365$ days), and they must have lost $\geq 10\%$ of their weight at the start of their most recent attempt. Thirteen participants did not complete both of the behavioural tasks, resulting in removal of those participants. Therefore, data from 83 participants were retained for the current empirical
chapter. The majority of participants lived in Australia (98%), and classified themselves as being of Anglo-Saxon for cultural identity (83%). In relation to educational attainment 42% of WLMs and 32% of WLRs had commenced or competed tertiary education. Sixty-one per-cent of WLMs, and 74% of WLRs, reported their marital status as either legally married, or de-facto/cohabitating. Additional descriptive participant characteristic are presented in Table 6.1.
Table 6.1

Demographics and Descriptive Statistics of the Sample Population

<table>
<thead>
<tr>
<th></th>
<th>Overall Sample</th>
<th>WLMs</th>
<th>WLRs</th>
<th>Test Statistic</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender [% Female (n)]</td>
<td>91.6 (76)</td>
<td>92.3 (48)</td>
<td>90.3 (28)</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age [M (SD)]</td>
<td>52.0 (10.80)</td>
<td>50.71 (12.13)</td>
<td>54.16 (7.80)</td>
<td>2.48^d</td>
<td>1, 80.47</td>
<td>.119</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>24 – 65</td>
<td>24 – 65</td>
<td>32 – 65</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight [M (SD)]</td>
<td>84.66 (20.02)</td>
<td>78.76 (14.06)</td>
<td>94.56 (24.45)</td>
<td>10.81^d</td>
<td>1, 42.03</td>
<td>.002</td>
</tr>
<tr>
<td>Weight range [kg’s]</td>
<td>54.00 – 167.10</td>
<td>54.00 – 116.00</td>
<td>63.00 – 167.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Mass Index [BMI; M (SD)]</td>
<td>31.29 (7.29)</td>
<td>28.99 (5.01)</td>
<td>35.16 (8.83)</td>
<td>12.71^d</td>
<td>1, 41.73</td>
<td>.001</td>
</tr>
<tr>
<td>BMI range [kg/m^2]</td>
<td>20.83 – 64.47</td>
<td>20.83 – 44.20</td>
<td>25.28 – 64.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max weight at start of last WLA [M (SD)]</td>
<td>98.68 (21.39)</td>
<td>99.43 (17.93)</td>
<td>97.42 (26.47)</td>
<td>0.17^d</td>
<td>1, 81.00</td>
<td>.681</td>
</tr>
<tr>
<td>Lowest weight during last WLA [M (SD)]</td>
<td>78.06 (17.52)</td>
<td>75.21 (13.89)</td>
<td>82.84 (21.76)</td>
<td>3.81^d</td>
<td>1, 81.00</td>
<td>.054</td>
</tr>
<tr>
<td>Number of days since last WLA [M (SD)]</td>
<td>2539.14 (2085.93)</td>
<td>2452.79 (2023.75)</td>
<td>2684.00 (2212.66)</td>
<td>0.24^d</td>
<td>1, 81.00</td>
<td>.628</td>
</tr>
<tr>
<td>Current % weight loss (max– current) (SD)</td>
<td>13.67 (11.39)</td>
<td>20.31 (8.36)</td>
<td>2.58 (5.71)</td>
<td>131.10^d</td>
<td>1, 79.40</td>
<td>.000</td>
</tr>
<tr>
<td>Current % weight loss range</td>
<td>-15 – 40</td>
<td>10 – 40</td>
<td>-15 – 9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Annual household income [% (n)]

<table>
<thead>
<tr>
<th>Income Level</th>
<th>&lt; 30,000</th>
<th>$30,000 – $90,000</th>
<th>$90,000 and above</th>
<th>Not Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>12.0 (10)</td>
<td>34.9 (29)</td>
<td>24.1 (20)</td>
<td>28.9 (24)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>4.0 (3)</td>
<td>4.0 (2)</td>
<td>3.0 (1)</td>
<td></td>
</tr>
</tbody>
</table>

### DASS-21: Depression [M (SD)]

<table>
<thead>
<tr>
<th>Level</th>
<th>M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate and above</td>
<td>3.60 (4.80)</td>
</tr>
</tbody>
</table>

### DASS-21: Anxiety [M (SD)]

<table>
<thead>
<tr>
<th>Level</th>
<th>M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate and above</td>
<td>2.13 (2.79)</td>
</tr>
</tbody>
</table>

**Note.**

- **a** $N = 83$. **b** $n = 52$. **c** $n = 31$. *Due to the low numbers, test statistic could not be calculated (Tabachnick & Fidell, 2013).**
- **d** One-way ANOVA.

WLA = Weight loss attempt. * Depression moderate severity range (7-10). ** Anxiety moderate severity range (6-7).
6.3.2 Materials and procedure.

Details of the materials and procedures utilised in the present chapter were explained in Chapter Four (see p. 57 for method). For the current empirical chapter demographic information, impulsivity measures (I7, GNG, SR and IGT) and the DASS-21 were utilised.

6.3.3 Data analysis.

Minimum sample size was discussed with a statistician prior to data collection and analysis. While a larger sample size would have been advantageous, data collection was stopped for pragmatic reasons. Data were inspected for errors, missing values and outliers using z values of ±3.29 (p < .001) as suggested by Tabachnick and Fidell (2013), and to determine if the distributional assumptions for normality were met. Cases with missing data for the self-report impulsivity measures were retained and replaced via the Expectation Maximization (EM) method. Go/No-go (GNG) data were removed for four participants, as they did not meet the criteria of needing to complete a minimum of 50% of the GO trials, and/or being identified as an extreme outlier on one or more of the GNG variables. Re-inspection of the GNG Food Average RT variable did not reveal any additional outliers. An additional nine participants did not complete the GNG task, and as such they were not included in the analysis.

Normality of the variables was inspected using Kolmogorov-Smirnov statistic, which revealed that the distribution of the I7, SR and GNG Food Reaction Time variables were significantly different from normal (p < .05). However, Tabachnick and Fidell (2013) highlight that the Kolmogorov-Smirnov statistic is a highly sensitive measure. Visual inspection of the histograms, and calculation of skewness and kurtosis values were then conducted for each variable.
for the overall sample, and indicated that each variable was adequately normally distributed.

Mean and standard deviation scores for all impulsivity variables are presented in Table 6.2. To test the aims, correlation analyses were first conducted to check for multicollinearity, which indicated that all variables could be retained (see Table 6.3). Next a logistic regression analysis was conducted to examine how well the impulsivity variables predict whether an individual is successful at weight-loss maintenance or not, and to determine which variable is the strongest predictor of successful weight-loss maintenance (see Table 6.4).

6.4. Results

6.4.1 Demographic and clinical characteristics.

As shown in Table 6.1, there was no significant difference for age, and as expected significant differences were found for current weight, current BMI, and current weight loss percentage between WLMs and WLRs. Furthermore, there was a significant difference for self-reported anxiety scores, with WLRs reporting higher levels of anxiety compared to WLMs. However, because the values were within the lower ranges of anxiety symptoms for both the WLMs and WLRs, the difference was not clinically relevant. It can be observed from inspecting Table 6.2 that the means for IGT net score (behavioural measure of reward sensitivity) were lower for WLRs than WLMs. Yet, overall both groups demonstrated impaired performance on the task (i.e., mean IGT Net scores of < 0).
Table 6.2

**Means and Standard Deviations (in brackets) for Impulsivity Measures**

*Included in the Analyses, for the Overall Sample (N = 83), WLMs (n = 52), and WLRs (n = 31).*

<table>
<thead>
<tr>
<th></th>
<th>Overall Sample</th>
<th>WLMs</th>
<th>WLRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>I7</td>
<td>6.90 (5.13)</td>
<td>7.05 (5.17)</td>
<td>6.64 (5.15)</td>
</tr>
<tr>
<td>SR</td>
<td>8.50 (6.52)</td>
<td>8.75 (6.69)</td>
<td>8.09 (6.30)</td>
</tr>
<tr>
<td>IGT Net Score</td>
<td>-10.19 (30.91)</td>
<td>-4.19 (27.19)</td>
<td>-20.25 (34.47)</td>
</tr>
<tr>
<td>Block 1 Net Score</td>
<td>-2.31 (7.32)</td>
<td>-1.38 (7.00)</td>
<td>-3.87 (7.69)</td>
</tr>
<tr>
<td>Block 2 Net Score</td>
<td>-2.99 (9.26)</td>
<td>-2.27 (8.80)</td>
<td>-4.19 (10.02)</td>
</tr>
<tr>
<td>Block 3 Net Score</td>
<td>-2.87 (10.35)</td>
<td>-1.15 (10.84)</td>
<td>-5.74 (8.91)</td>
</tr>
<tr>
<td>Block 4 Net Score</td>
<td>-0.80 (9.36)</td>
<td>0.27 (8.22)</td>
<td>-2.58 (10.93)</td>
</tr>
<tr>
<td>GNG Food RT</td>
<td>397.96 (29.78)</td>
<td>398.66 (30.12)</td>
<td>396.79 (29.67)</td>
</tr>
</tbody>
</table>

*Note.* I7 = Impulsivity subscale of the Eysenck Impulsiveness scale; SR = Sensitivity to Reward subscale; IGT = Iowa Gambling Task; GNG = Go/No-go; RT = Reaction Time.

**6.4.2 Relationship between rash impulsivity variables.**

The relationship between self-report and behavioural measures of rash impulsivity and reward sensitivity was investigated using correlation analyses. Results are displayed in Table 6.3. The analyses revealed a strong significant positive correlation between self-reported rash impulsivity and reward sensitivity, as well as a weak significant negative correlation between behavioural measures of rash impulsivity and reward sensitivity.
Table 6.3

Correlation Matrix for all Measures of Impulsivity

<table>
<thead>
<tr>
<th></th>
<th>$I^I$</th>
<th>SR</th>
<th>IGT Net Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I^I$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR</td>
<td>0.62**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGT Net Score</td>
<td>0.07</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>GNG Food Reaction Time</td>
<td>0.08</td>
<td>0.07</td>
<td>-0.27*</td>
</tr>
</tbody>
</table>

Note. $N = 83$. $I^I$ = Impulsivity subscale of the Eysenck Impulsiveness scale; SR = Sensitivity to Reward subscale; IGT = Iowa Gambling Task; GNG = Go/No-go.

** $p < .01$

* $p < .05$

6.4.3 Logistic regression.

A logistic regression analysis was conducted to determine which impulsivity measure is the strongest predictor of whether an individual is a successful WLM or a WLR. The analyses revealed that the full model, which included the four continuous variables ($I^I$, SR, IGT Net Score, and the GNG Food Reaction Time) was not statistically significant $\chi^2 (4, N = 83) = 6.60, p = .16$. This shows that the model was not able to differentiate successful WLMs from WLRs based on impulsivity. Overall, the model explained between 7.6% (Cox and Snell R square) and 10.4% (Nagelkerke R squared) of the variance in weight-loss maintenance status (success or failure), and accurately classified 63.9% of cases.

As shown in Table 6.4, only one of the independent variables made a unique statistically significant contribution to the model (IGT Net Score). IGT Net Score
was the strongest and only significant predictor of successful weight-loss maintenance, with an odd ratio of 1.02. Specifying that participants who had a higher IGT Net Score were one times more likely to be successful at weight-loss maintenance.

Notably, the small odds ratio for the significant IGT Net Score effect is a function of the extremely large range of scores for the variable (ranging from −94.00 to 78.00). When the scale of that variable was changed by diving the IGT Net Score by an arbitrary factor of 10, thus resulting in a unit change of one in the new variable (IGT_div10) and 10 in the original variable, the odds ratio increased to 1.24.

Table 6.4

*Logistic Regression Predicting Likelihood of Successful Weight-Loss Maintenance*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>p</th>
<th>Odds Ratio</th>
<th>95% CI for Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I⁷</td>
<td>-0.01</td>
<td>0.06</td>
<td>0.01</td>
<td>1</td>
<td>.93</td>
<td>1.00</td>
<td>.89</td>
</tr>
<tr>
<td>SR</td>
<td>0.01</td>
<td>0.05</td>
<td>0.03</td>
<td>1</td>
<td>.86</td>
<td>1.01</td>
<td>.92</td>
</tr>
<tr>
<td>IGT Net Score</td>
<td>0.02</td>
<td>0.01</td>
<td>5.42</td>
<td>1</td>
<td>.02</td>
<td>1.02</td>
<td>1.00</td>
</tr>
<tr>
<td>GNG Food RT</td>
<td>0.01</td>
<td>0.01</td>
<td>0.93</td>
<td>1</td>
<td>.33</td>
<td>1.01</td>
<td>.99</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.52</td>
<td>3.31</td>
<td>0.58</td>
<td>1</td>
<td>.45</td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Note. CI = confidence interval; LL = lower limit; UL = upper limit. I⁷ = Impulsivity subscale of the Eysenck Impulsiveness scale; SR = Sensitivity to Reward subscale; IGT = Iowa Gambling Task; GNG = Go/No-go; RT = Reaction Time.
6.4.4 Additional analysis: Task learning on the IGT.

The logistic regression analysis revealed that the IGT Net Score was a significant predictor of successful weight-loss maintenance, and consequently further investigation was conducted to better understand whether there were also differences between WLMs and WLRs for each of the five blocks. As discussed in Chapter Two of this dissertation, previous research has found differences in learning across the IGT task (based on weight status). Block mean net scores for the WLMs and WLRs are presented in Figure 6.1. It can be observed that the WLMs show an improvement in their learning across the five blocks, compared to the WLRs. The WLMs appear to have an increase in their preference for the advantageous decks as the task progressed, whilst the WLRs failed to learn across the task. A Mixed Between-Within Subjects ANOVA was then conducted to examine whether the changes between the groups differed during the task. There was no significant interaction between WLMs/WLRs and IGT blocks, Wilks’ Lambda = .98, $F (4, 78) = .37, p = .83$. Similarly, there was no significant effect for time (i.e., across the five blocks), Wilks’ Lambda = .95, $F (4, 78) = 1.14, p = .34$, partial eta squared = .055. However, the main effect comparing WLMs to WLRs was significant, $F (1, 81) = 5.54, p < .05$, partial eta squared = .064.
6.5 Discussion

The primary objective of this chapter was to examine if levels of impulsivity may differentiate successful weight-loss maintainers from regainers, and secondly to identify which measure of impulsivity (i.e., rash impulsivity or reward sensitivity) was the best predictor of whether an individual was a successful at weight-loss maintenance or not. The findings indicated that while the overall regression model was not significant in predicting weight-loss maintenance (which included all four impulsivity measures), the IGT net score was a significant unique predictor for whether an individual was successful at weight-loss maintenance or not. While both groups demonstrated impaired performance on the task (i.e., mean IGT Net scores of < 0), WLMs were less
significantly impaired on the IGT than WLRs. Finally, in light of the IGT net score being a significant predictor, additional analyses were conducted to better understand whether WLMs and WLRs differed across the task (i.e., whether there were significant difference between WLMs and WLRs for each block as a main effect of time). The Mixed Between-Within Subjects ANOVA revealed that there was no significant interaction effect, no effect of time (across the five blocks), but that there was a significant main effect for group (i.e., WLMs and WLRs significantly differed in IGT Net Scores). This finding is consistent with the findings from the regression analysis, which showed that the IGT net score was a significant predictor. These findings are now going to be discussed in greater detail in the context of the literature.

6.5.1 Best predictor of successful weight-loss maintenance.

The main focus of the current chapter was to test whether impulsivity levels can significantly differentiate whether an individual is a weight-loss maintainer, or weight-loss regainer, and secondly which type of impulsivity measure best reflects this relationship. The findings provide the first experimental evidence that a behavioural measure of reward sensitivity (IGT) significantly predicts whether an individual is more likely to regain their weight loss. This finding is somewhat consistent with previous research from the substance abuse field. For example, Stevens et al. (2015) investigated which dimensions of impulsivity (using both self-report and behavioural measures) best predicted short-term relapse in substance-dependent individuals. They found that impulsive decision making (measured with the IGT) and delay discounting (measured with the delay discounting task), were more likely to predict short-term relapse to substance use than self-report measures of impulsivity. As highlighted in the
introductory chapters’ of this dissertation, it is difficult to find a ‘pure’ measure of impulsivity, and some previous research has used the IGT as a measure of decision making, while other research has used it as a measure of reward sensitivity.

For example, Franken et al. (2008) investigated which behavioural measure of decision making (i.e., IGT, Rogers Decision Making Task, and Probalistic Reversal Task) was the most powerful predictor of self-reported impulsivity (measured with the I7), in a sample of 70 healthy undergraduate psychology students. A stepwise multiple regression analysis revealed that the IGT net score was the strongest predictor of self-reported impulsivity, explaining 27% of the variance. However, as Franken et al. (2008) used a sample of young students, and participants’ impulsivity status was based upon a median-split (i.e., low-impulsiveness group; n = 40, and high-impulsiveness group; n = 30), as opposed to clinical cut-off points, or extreme values, it is hard to generalise these findings to the wider population. Furthermore, the I7 and the IGT are different factors (i.e., rash impulsivity and reward sensitivity respectively) of the two-factor model of impulsivity, and also tap into different aspects of impulsivity (i.e., one is self-report while the other is behavioural). While previous research may not have typically used the IGT to compare weight-loss maintainers to regainers, taken together, the available evidence suggests that the IGT net score may be able to differentiate the two groups. Suggesting that higher levels of reward sensitivity are positively associated with weight-loss regain, and poorer decision-making abilities.
6.5.2 Task learning on the IGT.

Analyses revealed that overall individuals who are successful at weight-loss maintenance performed significantly better on the IGT than individuals who regained their weight lost. Existing literature has not specifically investigated the differences between maintainers and regainers in regard to performance on the IGT, yet the present findings are consistent with other research. Previous research has found that obese participants appear to exhibit impaired performance on the IGT, compared to healthy weight controls (Brogan et al., 2011; Brogan et al., 2010; Danner et al., 2012; Davis et al., 2010). Furthermore, the current findings regarding WLMs having the highest mean net score of the two groups is consistent with previous research, which has found that healthy weight controls have significantly higher mean net scores on the IGT, compared to obese participants (Brogan et al., 2011; Fagundo et al., 2012). Additionally, WLMs appeared to show improvements across the IGT, as indicated by their preference for the advantageous decks. Previous research has found significant differences on performance on the IGT in a group of adolescents aged 13–16 years old. Verdejo-García et al. (2010) determined that excess weight \( n = 27, \text{ BMI range 24–51 kg/m}^2 \) participants performed significantly worse (i.e., had a lower net score) than to healthy weight controls \( n = 34, \text{ BMI range 17–24 kg/m}^2 \) on blocks four \( (p = .05) \), and five \( (p = .04) \), and marginally worse on block three \( (p = .09) \). This finding is inconsistent with the current results, which upon further inspection revealed that there was no significant difference between WLMs and WLRs for time (i.e., across each block of the IGT). This may be because the study by Verdejo-García et al. (2010) investigated adolescents, while participants in the current sample were adults. Previous research has found that adolescents
prefrontal cortex, and their striatal systems, which are in control of motivation and reward processing are still under development, which could have made it easier to attain a significant block by group effect (Chambers, Taylor, & Potenza, 2003).

6.5.3 Clinical characteristics.

The one-way ANOVAs revealed that there was a significant difference between individuals who were successful at weight-loss maintenance, and those who were not, on mean scores for self-reported anxiety (as measured by the DASS-21), but this was not the case for self-reported depression scores. While a significant difference was found for anxiety (with WLRs reporting higher scores than WLMs), majority of participants from both groups were well below the moderate severity ratings for anxiety. Depression and anxiety were therefore not controlled for in the current empirical chapter. As highlighted in Chapter One, successful weight-loss maintenance is often associated with lower or stable levels of depression (Ohsiek & Williams, 2011). Previous research has also found that WLRs have identified that depression, or anxiety can be triggers for eating, as opposed to hunger (Golay et al., 2004).

6.5.4. Limitations.

The findings presented in this chapter may have been impeded by the differences in annual household pre-tax income, with 30.7% of WLMs, and 13.0% of WLRs reporting an annual income of ≥ $90,000. Discrepancies have been found in the existing literature around the influence of income on weight status and impulsivity, and therefore future research would benefit from investigating this further (Appelhans et al., 2011; Bongers et al., 2015). Furthermore, while participants’ highest level of education was recorded,
participants were not asked about their years of education. Previous research has found conflicting results about whether educational attainment (both years of education and/or highest level of educational attainment) is a significant predictor of IGT performance, when looking at differences between weight status groups (Brogan et al., 2010; Davis et al., 2010; Pignatti et al., 2006). As such, the impact of education on task performance on the IGT could not be controlled for in the current empirical chapter, which may have also impacted on the findings. Future research may therefore benefit from investigating the influence of educational attainment on task performance. Additional limitations will be raised in the general discussion.

6.6. Conclusions

To conclude, the findings presented in this chapter report on which component of impulsivity (i.e., I, SR, IGT Net Score, or the GNG Food Reaction Time) is the best predictor of whether an individual is successful at weight-loss maintenance or not. The findings indicate that higher levels of reward sensitivity (measured behaviourally with the IGT) are positively associated with weight-loss regain. Moreover, inspection of the findings indicated that WLMs appear to show improvement across the IGT, however there was no significant difference between WLMs and WLRs across each of the five blocks. The findings presented in this chapter are preliminary, because previous research has not investigated successful weight-loss maintenance in terms of the two-factor model of impulsivity. Hence, further research is required to provide additional support for the finding that reward sensitivity (as measured by the IGT) is a significant predictor in differentiating individuals who are successful at weight-loss maintenance and those who regain their weight lost.
Chapter Seven: The Relationship between Physical Activity, Impulsivity and Weight-Loss Maintenance

The purpose of the third and final empirical chapter is to draw on principles from the model proposed by Joseph et al. (2011) to test the relationship between physical activity, impulsivity and weight-loss maintenance.

7.1 Introduction

As reported in Chapter Six of this dissertation the behavioural measure of reward sensitivity (the Iowa Gambling Task; IGT) was the strongest predictor of successful weight-loss maintenance. In Chapter Three, the role and importance that physical activity may have on an individual’s executive functioning was discussed. As mentioned it appears that one factor that may have an influence on impulsivity is physical activity (Abramovitch, Goldzweig, & Schweiger, 2013; Joseph et al., 2011; Kulendran et al., 2014). Therefore, the aim of this empirical chapter is to investigate this relationship specifically in weight-loss maintenance, utilising the model proposed by Joseph and colleagues (Joseph et al., 2011). Empirically, the current chapter investigates the association between physical activity, impulsivity and weight-loss maintenance.

Previous research has investigated the relationship between physical activity and weight loss and/or weight-loss maintenance (Byrne et al., 2003; Hankinson et al., 2010; Phelan et al., 2007; Silva et al., 2011), and also the association between impulsivity and obesity (Bartholdy et al., 2016; Fields et al., 2013; Lavagnino et al., 2016). For example, Phelan et al. (2007) investigated the quantity and intensity of physical activity performed in successful weight-loss maintainers, compared to lifelong healthy weight individuals. While Fields et al.
(2013) compared multiple dimensions of impulsivity in obese, overweight and healthy weight controls. Therefore, this research has been done relatively independently in the past. The impact that physical activity has on weight-loss maintenance (via executive functioning) has consequently not been tested. As highlighted in Chapter Three, Joseph et al. (2011) propose a model looking at the relationship between physical activity, eating behaviour and executive functioning. As discussed in Chapter Three, a strength of this model is that it is proposes that physical activity and eating behaviour share a common neurocognitive link (i.e., executive functioning). Joseph et al. (2011) propose that the over-learned impulsive drive to eat (specifically overeating), which can be detrimental to an individual’s health (e.g., obesity) could be counteracted by enhancing executive functioning (especially inhibitory control), through regular physical activity. This is based on cognitive testing and neuroimaging studies, which have shown that increased levels of physical activity are associated with enhanced executive functioning (Chen et al., 2016; Hötting & Röder, 2013; Loprinzi & Kane, 2015).

Pervious research has determined that greater inhibitory control is predictive of successful weight-loss maintenance (Bond et al., 2009; Teixeira et al., 2006). Furthermore, as indicated in Chapter One, low levels of physical activity are associated with greater weight regain, while higher levels are associated with more successful weight-loss maintenance (Jakicic et al., 2008; Karfopoulou et al., 2013; Santos et al., 2015; Swift et al., 2014; Thomas et al., 2014; Weiss et al., 2007). Physical activity is important to help improve the mental and physical health of all individuals (Heisz & Kovacevic, 2016; Physical Activity Guidelines Advisory Committee, 2008). Therefore the association
between impulsivity, weight-loss maintenance and physical activity needs to be better understood. Finally, as highlighted in Chapter Two, successful weight-loss maintainers have greater activity in their PFC (i.e., executive functioning), and higher levels of impulsivity are associated with greater weight regain (Weygandt et al., 2015). Therefore, higher levels of physical activity may be associated with successful weight-loss maintenance, in individuals with lower levels of impulsivity (i.e., those who have enhanced executive functioning).

7.2. The Current Empirical Chapter

The current chapter will draw upon the physical activity component of the Joseph et al. (2011) model, that suggests that physical activity is thought to influence executive functioning and impulsivity (see Figure 7.1 for a schematic depiction of the model, with the red oval indicating the part of the model that the current chapter is specifically testing). It will investigate whether there is a relationship between physical activity, impulsivity and weight-loss maintenance. The short form of The International Physical Activity Questionnaire (IPAQ) will be used as the measure of physical activity in the current empirical chapter. As mentioned at the beginning of this chapter, based on the findings from the second empirical chapter (Chapter Six) the Iowa Gambling Task (IGT) will be utilised to measure the reward sensitivity component of impulsivity in the current chapter.
7.2.1 Aims and hypotheses.

The primary aim of this empirical chapter is to examine whether there is a relationship between physical activity, impulsivity and weight-loss maintenance, in a group of overweight and obese adults who have lost weight. On the basis of previous research summarised above, the following is hypothesised:

1. That weight-loss maintainers (WLMs) compared to weight-loss regainers (WLRs) are more likely to:
   a. Meet the physical activity guidelines (i.e., moderate-intensity physical activity; MPA, or vigorous-intensity physical activity; VPA), and or

Figure 7.1. A schematic depiction of the hypothesis, linking physical activity to executive functioning, taken from Joseph et al. (2011, p. 807).
b. Not be impaired (i.e., have lower levels of impulsivity) on the IGT.

2. That individuals who are not impaired on the IGT (have a Net score \( \geq 0 \)), are more likely to meet the physical activity guidelines.

3. That individuals who meet the physical activity guidelines are more likely to successfully maintain their weight loss, if they are also not impaired on the IGT.

7.3. Method

7.3.1 Participants.

Data from 83 participants were included in the analyses. Details regarding the same sample of participants utilised in the current empirical chapter were presented in Chapter Six (see p. 97 for participant demographics).

7.3.2 Materials and procedure.

Details of the materials and procedures utilised in this chapter were explained in Chapter Four (see p. 57 for method). For the current empirical chapter the IPAQ, and the IGT were utilised. The IPAQ was scored categorically and participants were classified as either meeting the physical activity guidelines (having MPA or VPA) or not meeting the guidelines (having low levels of activity).

The IGT was categorised, according to the criteria used by Verdejo-García et al. (2010) as either impaired or not impaired. Participants, who had an IGT Net score of \(< 0\) were classified as having clinically significant impairment on the task. Alternatively, individuals who had an IGT Net Score \( \geq 0 \) were classified as not being impaired on the task.
7.3.3 Data analysis.

Data were inspected for errors, missing values and outliers using z values of ± 3.29 \( (p < .001) \) as suggested by Tabachnick and Fidell (2013), and to determine if the distributional assumptions for normality were met. No missing values were found. All statistics were run using SPSS (version 23).

Normality of the variables was inspected using Kolmogorov-Smirnov statistic, which revealed that the distribution of the IPAQ Total Met Score was significantly different from normal \( (p < .05) \). However, Tabachnick and Fidell (2013) highlight that the Kolmogorov-Smirnov statistic is an overly sensitive measure. Visual inspection of the histograms, and calculation of skewness and kurtosis values were then conducted for the IPAQ Total Met Score. This indicated that the IPAQ Total Met Score was positively skewed and peaked. A square root transformation was then conducted as suggested by Tabachnick and Fidell (2013), and reinspection of the new histogram, and calculation of the skewness and kurtosis values indicated that the square root version of the IPAQ Total Met Score was normally distributed. All other variables were normally distributed, and as these variables were from the previous empirical chapter, there was no need for them to be re-checked.

Mean and standard deviation scores for all variables are presented in Table 7.1. To test hypothesis 1a, a chi-square test for independence (with Yates Correction) was conducted to test the prediction that WLMs, compared to WLRs, are more likely to meet the physical activity guidelines (i.e., MPA or VPA). To test hypothesis 1b, a chi-square test for independence (with Yates Correction) was conducted to test the prediction that WLMs, compared to WLRs, are more likely to not be impaired (i.e., have lower levels of impulsivity) on the IGT. Unlike
Chapter Six, the IGT was categorised in the current chapter, because the analysis plan required both variables to be measured categorically. Furthermore, the IGT and IPAQ were categorised in the current empirical chapter to make the findings more clinically relevant/meaningful, and to validate the IGT continuous findings from the second empirical chapter. Results for hypothesis 1a and 1b are displayed in Table 7.2. Furthermore, to test hypothesis 2, a chi square test of independence (with Yates Continuity Correction) was run to test whether individuals who were not impaired on the IGT (have an IGT Net score ≥ 0), also met the physical activity guidelines. Results are displayed in Table 7.3. Finally, to test the hypothesis 3 a moderation regression analysis was preformed to examine whether impulsivity (categorised as impaired or not impaired) moderates the association between levels of physical activity (categorised as met guidelines or not), and successful weight-loss maintenance (WLM or WLR).

7.4 Results

Five independent samples t-tests were conducted to compare WLMs to WLRs on each variable included in this empirical chapter. It can be observed from inspecting Table 7.1 that while the mean IPAQ Total Met score was approximately 1.5 times larger for WLMs than for WLRs, there was no significant difference in scores between the two groups. However, the mean values for the IGT Net Score were significantly different for WLMs and WLRs.
Table 7.1

Means and Standard Deviations (in brackets) for Variables included in the Analyses

<table>
<thead>
<tr>
<th></th>
<th>Overall Sample&lt;sup&gt;a&lt;/sup&gt;</th>
<th>WLMs&lt;sup&gt;b&lt;/sup&gt;</th>
<th>WLRs&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Test Statistic</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPAQ Total score</td>
<td>3844.58</td>
<td>4383.24</td>
<td>2941.02</td>
<td>-1.40&lt;sup&gt;d&lt;/sup&gt;</td>
<td>81.00</td>
<td>.17</td>
</tr>
<tr>
<td></td>
<td>(3930.15)</td>
<td>(4391.01)</td>
<td>(2845.18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigorous</td>
<td>1362.41</td>
<td>1623.85</td>
<td>923.87</td>
<td>-1.54&lt;sup&gt;d&lt;/sup&gt;</td>
<td>73.20</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>(1985.45)</td>
<td>(2073.07)</td>
<td>(1775.31)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>901.69</td>
<td>1121.92</td>
<td>532.26</td>
<td>-1.63&lt;sup&gt;d&lt;/sup&gt;</td>
<td>79.83</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>(1416.63)</td>
<td>(1614.79)</td>
<td>(909.65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td>1693.50</td>
<td>1817.86</td>
<td>1484.89</td>
<td>-0.72&lt;sup&gt;d&lt;/sup&gt;</td>
<td>81.00</td>
<td>.47</td>
</tr>
<tr>
<td></td>
<td>(2145.54)</td>
<td>(2322.82)</td>
<td>(1827.12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGT Net Score</td>
<td>-10.19</td>
<td>-4.19</td>
<td>-20.25</td>
<td>-2.35&lt;sup&gt;d&lt;/sup&gt;</td>
<td>81.00</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>(30.91)</td>
<td>(27.19)</td>
<td>(34.47)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. <sup>a</sup>N = 83. <sup>b</sup>n = 52. <sup>c</sup>n = 31. <sup>d</sup>Independent samples t-test. IPAQ = International Physical Activity Questionnaire; IGT = Iowa Gambling Task.

7.4.1 Hypothesis 1a: Relationship between physical activity and WLMs/WLRs.

A chi square test for independence (with Yates Continuity Correction) was conducted to test the hypothesis that WLMs, compared to WLRs will meet the physical activity guidelines (MPA or VPA). The results from the analysis are presented in Table 7.2. There was no significant difference in level of physical activity noted between WLMs and WLRs.
7.4.2 Hypothesis 1b: Relationship between impulsivity and WLMs/WLRs.

A chi square test for independence (with Yates Continuity Correction) was conducted to test the hypothesis that WLMs, compared to WLRs are more likely to not be impaired on the IGT (have a Net Score \( \geq 0 \)). The results from the analysis are presented in Table 7.2. There was a significant difference between whether an individual was a successful WLM or a WLR, and whether they were impaired, or not impaired on the IGT.

Table 7.2

Two Separate Chi Square Analyses for WLMs and WLRs, who Met/Did Not Meet the Physical Activity Guidelines, and who were Impaired/Not Impaired on the IGT

<table>
<thead>
<tr>
<th></th>
<th>WLMs(^a)</th>
<th>WLRs(^b)</th>
<th>Test Statistic</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not met guidelines [% (n)]</td>
<td>21.2 (11)</td>
<td>25.8 (8)</td>
<td>0.05(^c)</td>
<td>.79(^d)</td>
</tr>
<tr>
<td>Met guidelines [% (n)]</td>
<td>78.8 (41)</td>
<td>74.2 (23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impaired [% (n)]</td>
<td>53.8 (28)</td>
<td>77.4 (24)</td>
<td>3.66(^c)</td>
<td>.04(^d)</td>
</tr>
<tr>
<td>Not impaired [% (n)]</td>
<td>46.2 (24)</td>
<td>22.6 (7)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. \(^a\)n = 52. \(^b\)n = 31. \(^c\) Chi Square; \(^d\) Fishers Exact; PA = Physical Activity; IGT = Iowa Gambling Task.

7.4.3 Hypothesis 2: Relationship between physical activity and impulsivity.

A chi square test for independence (with Yates Continuity Correction) was conducted to test the hypothesis that individuals who are not impaired on the IGT
(have an IGT Net score $\geq 0$) are more likely to meet the physical activity guidelines (MPA or VPA). The results are presented in Table 7.3. The analyses indicated no significant association between physical activity and impulsivity.

Table 7.3

*Chi Square Analysis for Participants Who Met/Did Not Meet the Physical Activity Guidelines, Who Were Also Impaired/Not Impaired on the IGT*

<table>
<thead>
<tr>
<th></th>
<th>Iowa Gambling Task</th>
<th>Test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Impaired</td>
<td>Not impaired</td>
<td>Statistic</td>
</tr>
<tr>
<td>PA</td>
<td>Not met guidelines [% (n)]</td>
<td>26.9 (14)</td>
<td>16.1 (5)</td>
</tr>
<tr>
<td></td>
<td>Met guidelines [% (n)]</td>
<td>73.1 (38)</td>
<td>83.9 (26)</td>
</tr>
</tbody>
</table>

*Note. N = 83. \(^a\)Chi Square; \(^b\)Fishers Exact; PA = Physical Activity.*

7.4.4 Hypothesis 3: Interaction between physical activity, and impulsivity, associated with successful weight-loss maintenance.

A moderation logistic regression analysis was conducted to test the hypothesis that individuals who meet the physical activity guidelines (MPA or VPA) are more likely to be successful at weight-loss maintenance, if they are also not impaired on the IGT (have a Net score $\geq 0$). The results from the interaction between the IPAQ and IGT when both variables were categorical are presented in Table 7.4. They indicate no significant interaction effect. However, the confidence interval for the interaction effect was very large (ranging from 0.31 to 36.41), which suggests that the power to detect a true effect may be weak and likely due to the small sample size. Notably there was no change in interpretation.
of the effects when separate regression models were estimated, in which the IPAQ and the IGT variables were scaled to be continuous or categorical.

Table 7.4

**Moderation Logistic Regression Predicting Successful Weight-Loss Maintenance**

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>p</th>
<th>Odds</th>
<th>95% CI for Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LL</td>
</tr>
<tr>
<td>IPAQ</td>
<td>-0.18</td>
<td>0.63</td>
<td>0.08</td>
<td>1</td>
<td>.77</td>
<td>0.83</td>
<td>0.24</td>
</tr>
<tr>
<td>IGT</td>
<td>0.12</td>
<td>1.06</td>
<td>0.01</td>
<td>1</td>
<td>.91</td>
<td>1.13</td>
<td>0.14</td>
</tr>
<tr>
<td>IPAQ * IGT</td>
<td>1.21</td>
<td>1.22</td>
<td>0.99</td>
<td>1</td>
<td>.32</td>
<td>3.36</td>
<td>0.31</td>
</tr>
<tr>
<td>Constant</td>
<td>0.29</td>
<td>0.54</td>
<td>0.28</td>
<td>1</td>
<td>.59</td>
<td>1.33</td>
<td></td>
</tr>
</tbody>
</table>

*Note. CI = confidence interval; LL = lower limit; UL = upper limit. IPAQ = International Physical Activity Questionnaire; IGT = Iowa Gambling Task.*

### 7.5 Discussion

A primary objective of this chapter was to investigate whether there is a relationship between successful weight-loss maintenance and whether individuals: meet the physical activity guidelines, and/or had lower levels of impulsivity. Hypothesis 1a was not supported, as there was no significant relationship between physical activity and successful weight-loss maintenance. However, hypothesis 1b was supported as there was a significant relationship between weight-loss maintenance and a behavioural measure of reward.
sensitivity. That is, individuals with higher levels of impulsivity were more likely to regain their weight lost. Hypothesis two was not supported, as there was no significant relationship between impulsivity and physical activity. Finally, there was no association between meeting the recommended physical activity guidelines, and having lower levels of impulsivity being related to whether an individual was successful at weight-loss maintenance or not (hypothesis 3). These findings are now going to be discussed in detail.

7.5.1 Relationship between physical activity and WLMs/WLRs.

The findings presented in this chapter demonstrate that WLMs and WLRs did not differ significantly on whether they met the physical activity guidelines or not. This finding is consistent with a study by Cleanthous, Noakes, Keogh, Mohr, and Clifton (2007) who found no significant differences between WLMs and WLRs on measures of physical activity (e.g., Paffenbarger Physical Activity Questionnaire). On the other hand, the findings presented in this chapter are inconsistent with three existing studies which showed that WLMs participate in significantly more physical activity compared to WLRs (Jakicic et al., 2008; Phelan et al., 2007; Wadden et al., 2011). Swift et al. (2014), have proposed that there are a number of limitations of research into physical activity and weight regain, such as the retrospective and observational nature of some of the existing literature from randomised controlled trials. The variability in the above findings may be a result of these limitations. Furthermore, there have been mixed findings with regards to the role of physical activity intensity and duration, on weight loss and weight maintenance (Gebel, Ding, & Bauman, 2014; Gillen et al., 2016; Madjd et al., 2016). Previous research that has investigated the role of physical activity in our day-to-day lives indicates that small bursts of intense physical
activity may have more important health benefits, compared to longer durations of physical activity (Gillen et al., 2016; Gillen et al., 2014; McRae et al., 2012).

7.5.2 Relationship between impulsivity and WLMs/WLRs.

An additional objective of this chapter was to present findings regarding the association between impulsivity and successful weight-loss maintenance. The present findings indicate that there was a significant difference between whether an individual was successful at weight-loss maintenance, and whether they were impulsive (impaired vs. not impaired on the IGT). This finding is in line with the results obtained from Chapter Five, which found that the IGT (which was measured continuously) was the only significant predictor for whether an individual was successful at weight-loss maintenance.

Overall, these findings suggest that the IGT (behavioural measure of reward sensitivity) may be able to differentiate successful weight-loss maintenance from regain. This is one of the first studies (along with the results presented in Chapter Five) in the weight-loss field to show this. Administration of the IGT early on during a weight-loss intervention may therefore be able to help identify individuals who are more prone to weight regain (i.e., those who demonstrate greater impairment on the IGT) post intervention. Furthermore, post intervention IGT results could also help to reduce weight regain, through interventions targeted at enhancing executive function (McKee & Ntoumanis, 2014; Muraven, 2010; Verbeken et al., 2013). While future research is still required to support this finding, and test it longitudinally, this could help to improve successful long-term weight-loss maintenance, and decrease the costs associated with obesity.
7.5.3 Relationship between physical activity and impulsivity.

A focus of the present chapter was to report on findings that investigated the relationship between physical activity and impulsivity. The results indicated that there was no significant difference between meeting the physical activity guidelines and having lower levels of impulsivity. While there is limited literature in the weight-loss field, this finding is incongruent with previous research conducted by Abramovitch et al. (2013). They found that adults with ADHD who participated in high physical activity (any aerobic activity lasting at least 30 minutes on each occasion, at least twice a week) reported significantly less behavioural impulsivity, compared with those who engaged in low activity (engaging in physical activity once a week, for at least 30 minutes). However, as Abramovitch et al. (2013) used a specific population group (i.e., adults with ADHD), and did not use a validated measure of physical activity (i.e., they created a novel physical activity questionnaire), it is hard to compare these findings to other population groups, and generalise their results in terms of the current physical activity guidelines. Another study by Kulendran et al. (2014) investigated changes in obese adolescents after a lifestyle and physical activity intervention. They found that improvements in physical activity (measured by the two-mile challenge time), was a significant predictor of reduction in impulsivity (measured by the stop signal task).

Furthermore, Yanagisawa et al. (2010) investigated changes in neurocognitive activity in 20 healthy adults (aged between 19–24 years) who completed an acute bout of moderate intensity (i.e., 50% of a individuals peak oxygen uptake) physical activity. They found that moderate intensity physical activity resulted in significant enhanced activity in the left PFC, and improved
cognitive performance on the Stroop Task (measure of executive function).

Finally, Lowe et al. (2016) found that following moderate intensity physical activity, compared to minimal physical activity that individuals demonstrated significant improvements in inhibitory control. The variability in the above results may be due to the large variation in IPAQ scores, suggesting a low power to detect a true effect. Future research would benefit from looking at the association between impulsivity and physical activity in overweight/obese adults who have lost weight.

7.5.4 Interaction between physical activity and impulsivity, associated with successful weight-loss maintenance.

A main focus of this chapter was to investigate the influence of physical activity, on weight-loss maintenance, and impulsivity. Contrary to expectations individuals who met the physical activity guidelines (MPA or VPA) were not more likely to be successful WLMs if they also had lower levels of impulsivity. This finding is somewhat consistent with a study by Loprinzi and Kane (2015) who found that 87 young adults who completed 30 minutes of aerobic physical activity at low, moderate and vigorous intensity, compared to those in the inactive condition, did not have any effect on cognitive flexibility. On the other hand, the finding is inconsistent with previous research conducted by Chen et al. (2016) who found that obese adolescents who completed a physical activity program had improved executive function, better parasympathetic response, and increased fitness, compared to the control group. Furthermore, as highlighted in Chapters Two and Six, previous research has found parallels between weight-loss maintenance, obesity and substance abuse. A study by Leasure and Neighbors (2014) investigated different factors of impulsivity as moderators of the
relationship between physical activity and alcohol consumption in 198 undergraduate students. They found a significant positive relationship between moderate physical activity and greater alcohol consumption at higher, but not lower levels of impulsivity (sensation seeking and positive urgency were both significant moderators of this association). While these studies drew upon some principles of the Joseph et al. (2011) model, they did not specifically focus on weight-loss maintenance and impulsivity. It is therefore hard to compare the findings from the current empirical chapter with previous research. Future research would benefit from measuring WLMs and WLRs longitudinally, on measures of physical activity and impulsivity to provide further understanding around the relationship between these variables.

Finally, while the current empirical chapter has investigated the influence that physical activity may have on weight-loss maintenance and impulsivity, causality could occur in the other direction. For example, previous research has found that food restriction can often have an energising effect (up until some point), and/or that weight loss may encourage greater levels of physical activity, as it is less strenuous to move when an individual is lighter (Redman & Ravussin, 2011). However, given that this study was cross-sectional, this could not be investigated within the current dissertation. Future research may wish to look at the possible bidirectional relationship between executive functioning and physical activity in a longitudinal study.

7.5.5 Limitations.

The findings presented in this chapter may have been limited because of the large variation in IPAQ scores, as well as unequal cells in the chi square analyses. This may have had an effect on the power, and consequently influenced
the results. Furthermore, while the IPAQ is one of the most widely used self-report measures of physical activity (as it considered to be the best in terms of feasibility and practicality), the doubly labeled water method (DLW) is considered to be the gold standard way to measure physical activity (Sylvia, Bernstein, Hubbard, Keating, & Anderson, 2014). However, the DLW is usually not used in research studies because it is expensive, and not very practical. The current empirical chapter may have been enhanced if additional physical activity measures were included, such as an objective measure of physical activity (e.g., heart rate monitor, an accelerometer, or an observational measure), or a self-report physical activity diary (Sallis, 2010; Sylvia et al., 2014). Future research may benefit from utilising additional physical activity measures when looking at the association between impulsivity and weight-loss maintenance.

7.6 Conclusions

To conclude, this chapter found that physical activity and successful weight-loss maintenance were not significantly associated, and neither were impulsivity and physical activity. Additionally, individuals who met the physical activity guidelines were not more likely to be successful at weight-loss maintenance, in the context of them also having lower levels of impulsivity. However, the findings from the current chapter indicate that WLMs and WLRs differ significantly in their level of impulsivity (reward sensitivity). It appears that even though this empirical chapter did not report significant results, the wider literature suggests physical activity may enhance an individual’s executive functioning, and decrease their impulsive behaviours. While future research is still required, it is important to note that weight-loss regain was once again positively associated with higher levels of impulsivity, in this instance impaired
impulsivity. This finding could positively influence weight-loss interventions, by identifying individuals who are more prone to weight regain (based on their IGT performance), and reducing regain through targeted interventions that enhance executive functioning.
Chapter Eight: General Discussion

8.1 Overview

The primary aim of this dissertation was to investigate the role of impulsivity in obese adults, with a particular focus on weight-loss maintenance. It was argued that impulsivity (conceptualised in this dissertation as having two components – rash impulsivity and reward sensitivity) may contribute to obesity development, and influence whether an individual is successful at maintaining long-term weight loss. This argument is supported by at least ten studies which have found that overweight and obese adults report less inhibitory control (i.e., higher levels of impulsivity), compared to healthy weight individuals (e.g., Appelhans et al., 2011; Bartholdy et al., 2016; Brogan et al., 2011). Furthermore, neuroscience studies have found that greater activation in the prefrontal cortex (PFC; brain region linked to executive function) is associated with more successful weight-loss maintenance, and lower inhibitory control is associated with worse weight-loss maintenance outcomes (DelParigi et al., 2007; Sweet et al., 2012; Weygandt et al., 2015). Considerable attention has been given to examining factors associated with obesity, however less work has occurred in the area of weight-loss maintenance. Hence, two empirical chapters in this dissertation report on the question of whether high levels of impulsivity may be positively associated with weight-loss regain. Furthermore, an important consideration of the sample was to ensure that the definition of successful weight-loss maintenance followed current clinical consensus. Along similar lines, a significant contribution of this dissertation was ensuring that the healthy weight control group was strictly defined as having a lifetime history of healthy weight. This was an important methodological consideration as many previous studies
either did not report this information, or did not ensure that the control group was a “pure” group.

The following section will summarise the results of my three experimental chapters as discussed in Chapters Five, Six and Seven. This includes a discussion of the aims, hypotheses, and main findings from each empirical chapter, and a subsequent integrated discussion of the overall findings of this dissertation. The research and clinical implications will be discussed, with a subsequent discussion of the limitations and directions for future research.

8.2 Summary of Results

8.2.1 First Empirical Chapter: An investigation of rash impulsivity and reward sensitivity in healthy weight, overweight and obese adults.

The first of three empirical chapters investigated whether overweight and obese adults report higher levels of impulsivity (measured as self-report and behavioural tasks) compared to a strictly defined control group. Furthermore, consistent with the current literature, it was expected that there would be a weak to moderate relationship between self-report and behavioural measures of rash impulsivity and reward sensitivity. This chapter improves upon earlier research conducted by Fields et al. (2013) and Navas et al. (2016) by: a) including individuals with a BMI over 40; b) not excluding individuals with mental health problems/medical conditions; and c) utilising a theoretically derived model of impulsivity. The key findings from this empirical chapter were: 1) obese participants reported significantly higher levels of self-reported rash impulsivity compared to healthy weight participants; 2) The findings were less in relation to the differences between overweight individuals and healthy weight controls on impulsivity; 3) self-reported rash impulsivity was significantly positively
associated with GNG food reaction time; and d) self-reported reward sensitivity was significantly negatively associated with the IGT.

**8.2.2 Second Empirical Chapter: Is impulsivity associated with weight-loss regain in obese individuals?**

The aim of this empirical chapter was to investigate whether impulsivity was associated with weight-loss regain in a group of overweight and obese adults. Previous research has examined some of the predictors of successful weight-loss maintenance, however there is no one factor which consistently predicts success or failure. Therefore a better understanding of these factors is critical in assisting obese individuals to maintain long-term weight loss. Difficulties with inhibitory control has been considered an important candidate to consider, and hence has been the focus of this dissertation. The key finding was that overweight/obese adults were more likely to regain their weight loss if they displayed heightened reward sensitivity (as measured by the IGT).

**8.2.3 Third and Final Empirical Chapter: The relationship between physical activity, impulsivity and weight-loss maintenance.**

The final empirical chapter examined the relationship between physical activity, impulsivity and weight-loss maintenance. There is accumulating literature which suggests that physical activity may enhance executive functioning and hence be a protective factor regarding inhibitory control difficulties. This hypothesised relationship has not been examined in a group of obese individuals who have either regained or maintained their weight loss. An initial examination of this hypothesis was conducted utilising a cross-section design. The key findings were: 1) no reported significant difference in level of physical activity between weight-loss maintainers and regainers; 2) individuals
who were impaired on the IGT were more likely to be weight-loss regainers; 3) no significant association between physical activity and impulsivity; and 4) individuals who met the physically activity guidelines were not more likely to be weight-loss maintainers, if they also had lower levels of impulsivity.

8.3 Discussion of Integrated Findings

The three empirical chapters reported in this dissertation contribute to an expanding body of knowledge regarding the role of impulsivity in obesity and weight-loss maintenance. Specifically, the significant contribution of this dissertation increases our understanding of the important relationship between difficulties with inhibitory control and weight-loss maintenance. This finding will be discussed in the context of the current literature. In particular it will draw upon the significant methodological issues arising in the current literature, and touch upon suggestions for future research. A further overarching contribution of this dissertation was how it has attempted to draw on a strong theoretical framework as a solution to the current methodological issues in measuring impulsivity. These findings will now be discussed in detail.

8.3.1 Methodological issues in measuring impulsivity.

Over the last decade there has been a limited amount of research on the relationship between impulsivity and weight-loss maintenance (McCaffery et al., 2009). There has been research conducted in the neuroscience area (DelParigi et al., 2007; Le et al., 2007; McCaffery et al., 2009; Sweet et al., 2012; Weygandt et al., 2015), however finding simple and reliable tools that measure difficulties with inhibitory control may assist practitioners to facilitate greater success in weight-loss maintenance. Yet, there are a range of issues still to be understood for us to be confident in the accuracy of these tools. For example, my findings from the
first empirical chapter (Chapter Five) emphasise that self-reported rash impulsivity may play a significant role in differentiating obese from healthy weight individuals. While findings from the second and third empirical chapters (Chapters Six and Seven) highlight that reward sensitivity may be more influential with respect to predicting weight-loss regain, as evidenced by the significant findings when utilising the IGT. Consistent with a study by Navas et al. (2016) who also compared healthy weight, overweight and obese individuals on self-reported reward sensitivity, no significant differences were found in this dissertation. However, unlike previous literature I found that obese individuals self-reported significantly higher levels of rash impulsivity compared to healthy weight controls (Fields et al., 2013). Furthermore, I found that there was no significant differences between the three weight groups for behavioural level rash impulsivity or reward sensitivity, which is inconsistent with two previous studies (Fields et al., 2013; Navas et al., 2016).

It is likely that there are several key methodological differences that could be impacting the findings here, such as: the choice of behavioural tasks; self-report measures of impulsivity; and also what constitutes “healthy weight”. Firstly, the use of self-report measures used in this dissertation were not the same as in previous studies, and nor were the behavioural tasks. While Fields et al. (2013) used the Go/Stop Task, no differences were found between the three weight groups. However, they also used the Conners’ Continuous Performance Test-II (which is arguably a more sensitive measure of impulsivity than the IGT) and found a significant difference between the three weight groups. Furthermore, Navas et al. (2016) used both the IGT and the Wheel of Fortune Task (WoFT), but only found a significant difference between groups on the WoFT. It is likely
that all these measures tap into different aspects of impulsivity and this may be why the results differ. Indeed, a recent meta-analytic review which investigated the role of impulsivity in paediatric obesity, reported 25 different measures of impulsivity (in 23 articles; Thamotharan et al., 2013). It is not surprising then that the published research has failed to consistently indicate whether and how impulsivity may influence obesity and weight-loss maintenance. Furthermore, a key strength of this dissertation is the inclusion of the healthy weight group, which having always been healthy weight may facilitate in more clearly assessing differences in impulsivity based on weight. It is possible that previous research did not consistently report differences in impulsivity when comparing healthy weight to obese individuals, due to the healthy weight group not exclusively reporting a lifetime history of healthy weight. This would technically result in “healthy weight groups” potentially being obese individuals who were now successful weight-loss maintainers. I aimed to specifically address this point and the significant differences reported in the second and third empirical chapters suggest that reward sensitivity (measured behaviourally) may be able to differentiate whether an individual is successful at weight-loss maintenance. One potential reason for why I did not find significant differences between healthy weight and obese individuals on self-reported reward sensitivity, and both behavioural measures, unlike Fields et al. (2013) and Navas et al. (2016), is that I controlled for a lifetime healthy weight whereas they did not.

In summary, the findings of the three empirical chapters suggest a complex relationship between rash impulsivity and reward sensitivity, in obesity and weight-loss maintenance. Given the gold standard healthy weight group included in this dissertation, I found that rash impulsivity is associated with
obesity when compared to healthy weight individuals, suggesting that a potential
driver in the development of obesity could be a propensity to act impulsively.
When taking this one step further and attempting to understand why some
individuals are unable to maintain weight loss, it appears that reward sensitivity
plays a more important role here. This may be because the factors associated with
the development of obesity are different from those related to weight-loss regain.
The findings of this dissertation have important implications for the field, as they
touch on a range of methodological differences that currently exist, and suggest
directions for future research. The following section will explore some of these
methodological issues.

8.3.2 A lack of consistency in adopting a theoretical framework.

This dissertation adopted a strong theoretical framework of impulsivity,
and measured impulsivity with both self-report and behavioural instruments.
Surprisingly, research in the obesity area does not appear to have adopted a
consistent theoretical framework to understand and measure impulsivity, which
may explain the inconsistencies found in previous research. This is evidenced by
the choice of impulsivity measures involving both rash impulsivity and reward
sensitivity, with little discussion about the theoretical framework that they are
based on. Possible solutions to this issue may lie in the substance use literature.
This area has focused on adopting a theoretical framework when investigating
the association between impulsivity and substance use (e.g., Dawe et al., 2004;
Dissabandara et al., 2014; Gullo et al., 2014; Gullo et al., 2011). As I have
discussed throughout this dissertation, in particular in Chapter Two, experts in the
area appear to agree that impulsivity is a multidimensional construct (Quilty &
Oakman, 2004; Sharma et al., 2014). Yet there is no consistent definition or
theoretical framework that is currently used to examine this complex trait (Dick et al., 2010; Kocka & Gagnon, 2014). It has been argued that a possible explanation for this may be because the investigation of impulsivity in both the personality and cognitive fields has historically been relatively independent (Sharma et al., 2014). In order to progress this issue an open dialogue between the two fields may assist.

It is unclear whether the two-factor model of impulsivity as well as a multidimensional measurement approach is the best way forward. However, what is clear is that an open dialogue between the two psychology fields will allow for knowledge to be better integrated. This will hopefully reduce some of the methodological issues observed in the current literature, by creating a consistent measurement approach of impulsivity, which is based on a strong theoretical framework. The following two sections will explore the research and clinical implications associated with the findings from this dissertation.

8.4 Implications of This Dissertation

8.4.1 Research implications.

Firstly, in accordance with several lines of research, this dissertation demonstrates the value in utilising a two-factor conceptualisation of impulsivity in research. As reiterated throughout this dissertation, previous research has highlighted that rash impulsivity and reward sensitivity are independent but related dimensions of impulsivity (e.g., Dawe et al., 2004; Dawe & Loxton, 2004; de Wit & Richards, 2004; Quilty & Oakman, 2004). Consistent with this argument, the overall findings from the three empirical chapters suggest that rash impulsivity may be different in healthy weight and obese individuals, while reward sensitivity may be able to differentiate successful weight-loss maintainers
from regainers. Secondly, this dissertation reinforced the benefit of measuring impulsivity with both self-report and behavioural methods, based on the findings from the three empirical chapters. While the correlations between self-report and behavioural measures of impulsivity are often weak or non-significant (e.g., Cyders & Coskunpinar, 2011, 2012), previous research has highlighted that there is greater incremental validity in predicting impulsive behaviours when both types of measures are utilised (Sharma et al., 2014). In line with these arguments, the findings from the first empirical chapter of this dissertation indicates that obese individuals have significantly higher levels of self-reported impulsivity, compared to healthy weight controls. While results from the second and third empirical chapters highlight that maintainers and regainers may vary significantly on a behavioural measure of impulsivity.

Arguably, if only a unidimensional factor and measurement approach of impulsivity were employed in this dissertation, knowledge regarding how the different factors of impulsivity influence obesity and weight-loss maintenance would not have been revealed. Previous research has also found that there are clear gains in adding brain imaging information to behavioural task data (e.g., Weygandt et al., 2015). While this was not within the scope of this dissertation, future research may want to consider also including brain-imaging data to better understand the role of impulsivity in obesity and weight-loss maintenance. Overall, the findings provide credibility to the arguments that researcher who study impulsivity should not rely on measuring impulsivity with only one type of variable, and that they should not use a unidimensional approach of impulsivity (Sharma et al., 2014).
Thirdly, as I have discussed throughout this dissertation, in particular in Chapter Five, some previous research only specifies that participants are ‘currently’ within a healthy weight range (Mobbs et al., 2010; Navas et al., 2016; Verdejo-García et al., 2010). Yet, previous research has found differences between individuals who have a lifetime history of healthy weight and obese individuals in their levels of impulse control (e.g., Fagundo et al., 2012). The current dissertation demonstrates the value in utilising a more stringent criterion of having a lifetime healthy weight, to provide a clearer understanding of the differences between obesity and normal weight individuals in regards to impulsivity. Consistent with this argument, as reported in Chapter Five (the first empirical chapter) obese individuals self-reported significantly higher levels of rash impulsivity compared to healthy weight controls. Given the results of this dissertation future research should no longer only require participants to be ‘currently’ within a healthy weight range, but ensure that participants have a lifetime history of healthy weight (Carrard & Kruseman, 2016).

Finally, as highlighted in Chapter One of this dissertation, a limitation of the current weight-loss maintenance literature is that the definition of what constitutes a successful weight-loss maintainer and regainer is often unclear. Previous research has defined successful weight-loss maintenance and failure in a number of way (e.g., Byrne et al., 2003; Phelan et al., 2011; Wing & Hill, 2001; Wing & Phelan, 2005). This dissertation used Wing and Hill’s (2001) definition of a successful weight-loss maintainer, as a large proportion of the current weight-loss maintenance literature has used this definition. The findings from the second and third empirical chapters (Chapters Six and Seven) showed that weight-loss regainers had significantly higher levels of reward sensitivity (i.e.,
lower net scores on the IGT) compared to weight-loss maintainers. Suggesting that weight-loss regainers may learn at a slower rate than weight-loss maintainers, and have impairment in their decision-making ability (Bull et al., 2015).

8.4.2 Clinical implications.

The findings of this dissertation indicate that screening for impulsive traits to enhance assessment, prevention and treatment efforts amongst overweight and obese individuals may be beneficial. While it is not typical to screen for impulsivity prior to entering a weight-loss program, or following a weight-loss intervention it has previously been postulated that enhancing self-regulation and/or executive functioning may ultimately enhance weight-loss related outcomes (Appelhans et al., 2016; McKee & Ntoumanis, 2014; Verbeken et al., 2013; Wing et al., 2006). Furthermore, increased knowledge regarding the mechanisms underlying obesity and weight-regain will enhance opportunities to improve obese individuals health, and decrease the economic burden associated with obesity (van Smeerdijk et al., 2015).

A number of studies have recently developed behavioural and/or cognitive training programs, which are designed to target executive functioning (including impulsivity) in overweight and obese individuals. (e.g., Appelhans et al., 2016; Forman & Butryn, 2015; Jansen, Houben, & Roefs, 2015). For example, Verbeken et al. (2013) examined the effect of executive functioning (EF) training in 44 obese children (8–14 years old) who were participating in a 10-month inpatient healthy lifestyle program. Children either completed a six-week EF training condition, or standard care (control group) toward the end of their program. The EF intervention was a game, which was designed to train working-memory and inhibition across 25 sessions. Children in the EF training group
exhibited significant improvements on the childcare report on meta-cognition and working memory, and on the working memory task, compared to those in the standard care (Verbeken et al., 2013). Furthermore, they were more successful at weight-loss maintenance at 8-weeks post EF training, but at 12-weeks no significant difference was found. Based on the findings from this dissertation, future research may therefore benefit from utilising EF training to target specific factors of impulsivity, which may influence obesity and weight-loss maintenance.

Additionally, there is also evidence to suggest that acceptance based behavioural treatment (ABT) may assist with weight loss, weight-loss maintenance and inhibitory control (Forman & Butryn, 2015; Forman et al., 2013; Forman et al., 2016; Manasse et al., 2017). ABT strategies (i.e., slowing down decision making; learning to tolerate unpleasant states, such as resisting the urge to eat; and clarification of values) can improve inhibitory control in individuals who may have difficulty inhibiting automatic responses (Forman & Butryn, 2015; Manasse et al., 2017; Morrison, Madden, Odum, Friedel, & Twohig, 2014). One study by Forman et al. (2013), conducted a randomised controlled trial of ABT in 128 overweight/obese individuals (21–65 years old). Participants were either assigned to a year-long 40-session group based ABT or standard behavioural treatment (SBT). All of the core behavioural treatment components, as well as physical activity, weight loss and calorie intake recommendations were identical between the two conditions. Weight loss at the six month follow-up (i.e., weight loss at 18 months) was larger in those who received ABT compared to SBT (13.17% vs. 7.54%). Moderation analyses also demonstrated that weight loss in the ABT group was particularly effective in individuals who were more susceptible to eating cues (i.e., baseline symptoms of depression, disinhibition,
responsivity to food cues and emotional eating), compared to the SBT group. Furthermore, when the intervention was administered by an expert (i.e., clinical psychologist), compared to novice graduate trainee, weight loss was greater in ABT than SBT at the six month follow-up (11.0% vs. 4.8). Future research may therefore benefit from having clinicians who are experienced in behavioural weight interventions run weight-loss programs, as they appear to be more effective at incorporating principles of acceptance based treatment.

8.5 Study Limitations and Future Research Directions

The limitations and future directions relating to each empirical chapter have already been discussed, therefore overarching limitations will discussed here. Firstly, as cross-sectional data were used in this dissertation conclusions regarding causality are not possible. Future research would benefit from investigating longitudinal methodology (i.e., prospectively following an individual who enters a weight-loss program) to enhance knowledge regarding the role of impulsivity in obesity and weight-loss maintenance. Furthermore, previous research has determined that men and women tend to overestimate their height and underestimate their current weight, and dependent upon on an individual’s current BMI they can over or underestimate previous weight-loss attempts (Gorber, Tremblay, Moher, & Gorber, 2007; Tamakoshi et al., 2003). Future research could address this by measuring participants’ current weight and height, and also seek permission to access their weight-loss history, if available (e.g., individuals who attend TOWN Clubs keep a log book of their weight-loss history).

Additionally, data collected for this dissertation were from a convenience sample of participants, largely either seeking to lose weight or maintain their
current weight. Consequently, the results are only generalisable to those with comparable circumstances. Nonetheless, this limitation should be considered in light of the difficulty in finding participants with a lifetime history of healthy weight, and the unique opportunity to collect data from a longstanding weight-club (i.e., TOWN Clubs of Victoria). The participants who were used in the current dissertation were also ethnically homogenous. Majority of participants currently lived in Australia, and classified themselves as Anglo-Saxon. Therefore, results may not generalise to other ethnic groups. Future research would benefit from investigating the cross-cultural validity of the current findings.

Furthermore, future research should also consider an examination of gender differences in impulsivity and its relationship with obesity and weight-loss maintenance. This is an important area as some previous research has found gender differences in impulsivity (e.g., Cross et al., 2011; Cyders & Coskunpinar, 2012; Davis & Fox, 2008; Weller, Cook, Avsar, & Cox, 2008). Unfortunately, this was not possible in the current dissertation due to the uneven proportion of females and males. This is consistent with the majority of previous research in the obesity literature, which is predominantly or exclusively in female samples.

Whilst the study reported in this dissertation did not control for participants with a current mental health disorder, it would be interesting for future research to examine differences between impulsivity in those with a current mental health disorder (and different types of disorders), and those who do not. Even though the DASS-21 cannot be used to diagnose anxiety or depression, the empirical chapters in this dissertation found that obese adults and weight-loss regainers self-reported significantly higher levels of anxiety and/or depressive symptoms compared to overweight adults, healthy weight controls, and weight-
loss maintainers. It is possible that the relationships between obesity and/or weight-loss maintenance, and impulsivity may be greater in individuals with certain mental health disorders (American Psychiatric Association, 2013; Meda et al., 2009). Additionally, the present findings are likely to be impeded because only one distractor variable was included in the Go/No-Go task, as opposed to the recommended five. It is possible that this may have negatively influenced the results, as the empirical chapters found no significant differences on task performance. Future research should ensure that all distractor variables are included when creating the task.

Finally, the method that participants used to complete the behavioural tasks (i.e., online vs. in person) could have influenced the findings. A greater proportion of healthy weight participants completed the tasks online. In comparison to the majority of overweight and obese adults, as well as weight loss maintainers and regainers who completed the tasks in person. Participants who completed the tasks in person were stepped through the instructions. However, it is unknown whether the participants who completed them online read through the instructions and understood what was required. The Internet offers some advantages over traditional experimental research methods, such as reduced costs, and access to a more heterogeneous sample (Birnbaum, 2004). Future research may therefore want to examine whether the performance on behavioural tasks completed online is comparable to the performance on the tasks when completed in person.

8.6 Conclusions

The current dissertation utilised the two-factor model of impulsivity to examine obesity and weight-loss maintenance. Expanding on the findings from
previous research, there was evidence to suggest that obese adults self-report significantly higher levels of rash impulsivity compared to healthy weight individuals. Novel findings suggested that the behavioural measure of reward sensitivity can differentiate successful weight-loss maintainers from regainers. The findings from this dissertation add to an expanding body of literature, which suggests that impulsivity is a multidimensional construct made up of two related but distinct factors.

Furthermore, the overall findings raised important questions about the methodological differences in measuring impulsivity, and a lack of consistency in adopting a theoretical framework to examine impulsivity. The clinical implications point towards greater understanding of the specific factors, which may contribute to the development of obesity. In particular, they suggest that both executive functioning training and ABT could help with the prevention and treatment of obesity, and that they may also enhance long-term successful weight-loss maintenance.

While the findings of the current dissertation converge with and build upon previous research, it is important to recognise that research examining the role of impulsivity in obesity and weight-loss maintenance is still in its infancy. Therefore, additional research still needs to be conducted before considerable conclusions can be made about the specific roles that rash impulsivity and reward sensitivity play in this association. Nevertheless, it is hoped that the findings of this dissertation are integrated into future research, which could eventually improve outcomes for those at risk of, or currently suffering from obesity, and improve long-term successful weight-loss maintenance.
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Appendix A. Ethics Approval

Memorandum

To: Dr Melissa Hayden
   School of Psychology B
cc: Miss Jessica Newhouse

From: Deakin University Human Research Ethics Committee (DUHREC)

Date: 19 December, 2013

Subject: 2013-261
The impact of Obesity and the use of self-regulatory processes to examine the differences between successful weight loss maintenance and failure
Please quote this project number in all future communications

The application for this project was considered at the DU-HREC meeting held on 28/10/2013.

Approval has been given for Miss Jessica Newhouse, under the supervision of Dr Melissa Hayden, School of Psychology, to undertake this project from 19/12/2013 to 19/12/2017.

The approval given by the Deakin University Human Research Ethics Committee is given only for the project and for the period as stated in the approval. It is your responsibility to contact the Human Research Ethics Unit immediately should any of the following occur:

- Serious or unexpected adverse effects on the participants
- Any proposed changes in the protocol, including extensions of time.
- Any events which might affect the continuing ethical acceptability of the project.
- The project is discontinued before the expected date of completion.
- Modifications are requested by other HRECs.

In addition you will be required to report on the progress of your project at least once every year and at the conclusion of the project. Failure to report as required will result in suspension of your approval to proceed with the project.

DUHREC may need to audit this project as part of the requirements for monitoring set out in the National Statement on Ethical Conduct in Human Research (2007).

Human Research Ethics Unit
research-ethics@deakin.edu.au
Telephone: 03 9251 7123
Appendix B. Plain Language Statement and Consent Form

PLAIN LANGUAGE STATEMENT AND CONSENT FORM

Plain Language Statement

You are invited to participate in this research project. This Plain Language English Statement contains detailed information about the study. Its purpose is to explain to you as openly and clearly as possible all the procedures involved in this project before you decide whether or not to take part in it.

Please read the Plain Language English Statement carefully and feel free to ask any questions you may have concerning the study.

In order to take part in this study you must:
- Be between the ages of 18-65 years of age
- Speak English fluently
- Have no prior history of significant neurological impairment or injury
- Have no prior history of Anorexia or Bulimia Nervosa

Purpose and Background
The aim of this research is to better understand weight loss maintenance. In particular, we are interested in why some people following weight loss are successful at sustaining their lost weight while others regain it. We will use a range questionnaires and different cognitive tasks to help us answer this question.

Procedures
Individuals interested in the study will be asked to complete a survey (at a time of your convenience) either online, in person at Deakin University, or at a location convenient to you. It will take approximately one hour, and will include the completion of questions that relate to demographic information such as your age, weight, height, schooling, employment, and weight history. You will also be asked to complete several short computerised cognitive tasks (e.g. solving simple puzzles and some reaction time tasks). After participating in the online study, a subset of individuals will then be asked to complete follow-up questionnaires and cognitive tasks at 4 different time points, at 3, 6, 9 and 12 months. They will be quite short, less than 30 minutes.
Possible Benefits and Risks
This project has several benefits for the wider community. Intervention programs are needed to combat the high rate of weight regain following weight loss. Australian researchers can take a lead in this area of research but only when the factors that determine whether an individual is likely to regain weight or sustain weight loss are well understood. By exploring the differences between each group it will increase our understanding of the mechanisms involved.

These tasks are considered to be low risk, however, test anxiety may be experienced during the completion of the survey. If any distress or other side-effects is experienced during participation then it is recommended that you withdraw from participation immediately. In addition, a list of psychological services is provided with this explanatory statement that it is recommended you contact should participation in this research cause you any distress.

Funding
This research is funded by the Deakin University.

Privacy, Confidentiality and Disclosure of Information
Any information obtained in connection with this project that can identify you will remain confidential.

Results from this study will be published in peer-reviewed articles and presented at academic conferences. You can contact the principle researcher via email [jessica.newhouse@deakin.edu.au] if you would like to obtain a summary of the results or have any questions about the study. A preliminary summary of results is likely to be available from July 2015.

The information obtained from this study will be kept in secure storage in digital/hardcopy for at least 6 years after the final publication. If required by the publishers of journal articles arising from this study, a non-identifiable data set would be made publically available via a data repository. This data would be completely anonymous. You could not be identified from any publically available data relating to this study.

Participation is Voluntary
Once you understand what the project is about and if you agree to take part in it, by starting the survey you consenting to participate in this study. By consenting to participate you do not alter your legal rights, but you indicate that you understand the information and give your consent freely to participant in the study. Before you make your decision, the principle researcher will be available to answer any questions you have about the research project via email (jessica.newhouse@deakin.edu.au). You can ask for any information you want. Only consent to participate in the survey after you have received satisfactory answers to your questions.
You do not have to participate in this study. If you choose to take part, you can change your mind at any time and all unprocessed material relating to your participation will be destroyed. Your decision whether to take part or not to take part, or to take part and then withdraw, will not affect your relationship with Deakin University or with the researchers involved in this study.

**Ethical Guidelines**
This project will be carried out according to the *National Statement on Ethical Conduct in Human Research* (2007) produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies.

The ethics aspects of this research project have been approved by the Human Research Ethics Committee of Deakin University.

**Complaints**
If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact: The Manager, Research Integrity, Deakin University, 221 Burwood Highway, Burwood Victoria 3125, Telephone: 9251 7129, research-ethics@deakin.edu.au.

Please quote project number [2013-261].

**Reimbursement for your costs**
Participants will go into the draw to win 1 of 2 $100 online gift vouchers.

**Further Information, Queries or Any Problems**
If you require further information, wish to withdraw your participation, or if you have any problems concerning this project you can contact the researchers.

**The principal researchers responsible for this project are:**

Jessica Newhouse  
School of Psychology, Deakin University, 221 Burwood Highway.

Dr Melissa Hayden  
School of Psychology, Deakin University, 221 Burwood Highway. Phone: +61 3 9244 3001

A/Prof Petra Staiger  
School of Psychology, Deakin University, 221 Burwood Highway
Consent Form

I have read and I understand the attached Plain Language Statement. □

I freely agree to participate in this project according to the conditions in the Plain Language Statement. □

I have been given a copy of the Plain Language Statement and Consent Form to keep. □

The researcher has agreed not to reveal my identity and personal details, including where information about this project is published, or presented in any public form. □

Please check the following box if you are interested in being contacted for any future research □
PSYCHOLOGICAL SERVICES – CONTACT LIST

For participants of the research project:
“The Impact of Obesity and the Use of Self-Regulatory Processes to Examine the Differences between Successful Weight Loss Maintenance and Failure”

The following Community health centres have an Intake Service. An intake worker can assess your psychological service needs and determine if they offer an appropriate service, if not they are equipped to refer you. Their services are low cost and no service is denied due to inability to pay.

<table>
<thead>
<tr>
<th>Metropolitan Area</th>
<th>Community Health Services:</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Metro</td>
<td>MonashLinkCommunity Health Service Inc</td>
<td>(03) 9568 2599</td>
</tr>
<tr>
<td>Eastern Metro</td>
<td>Ranges Community Health Service Inc.</td>
<td>(03) 9739 4577</td>
</tr>
<tr>
<td>Eastern Metro</td>
<td>Whitehorse Community Health Service</td>
<td>(03) 9890 2220</td>
</tr>
<tr>
<td>North and West Metro</td>
<td>Darebin Community Health Service Inc.</td>
<td>(03) 8470 1111</td>
</tr>
<tr>
<td>North and West Metro</td>
<td>Djerrirwarh Health Services</td>
<td>(03) 8746 1100</td>
</tr>
<tr>
<td>North and West Metro</td>
<td>Doutta Galla Community Health Service Inc.</td>
<td>(03) 9377 7100</td>
</tr>
<tr>
<td>North and West Metro</td>
<td>ISIS Primary Care Inc.</td>
<td>(03) 9296 1200</td>
</tr>
<tr>
<td>North and West Metro</td>
<td>North Richmond Community Health Centre Inc.</td>
<td>(03) 9429 5477</td>
</tr>
<tr>
<td>North and West Metro</td>
<td>Plenty Valley Community Health Services Inc.</td>
<td>(03) 9409 8787</td>
</tr>
<tr>
<td>North and West Metro</td>
<td>Sunbury Community Health Centre Inc.</td>
<td>(03) 9744 4455</td>
</tr>
<tr>
<td>Southern Metro</td>
<td>Bentleigh Bayside Community Health Service Inc.</td>
<td>(03) 9575 5333</td>
</tr>
<tr>
<td>Southern Metro</td>
<td>Central Bayside Community Health Services Inc.</td>
<td>(03) 8487 0200</td>
</tr>
<tr>
<td>Southern Metro</td>
<td>Inner South Community Health Service Inc.</td>
<td>(03) 9534 0981</td>
</tr>
<tr>
<td>Southern Metro</td>
<td>Frankston Community Health Service</td>
<td>(03) 9784 8100</td>
</tr>
</tbody>
</table>

Other useful contacts:
- **Deakin University**: Low cost psychological assessment service; 9244 6300
- **Lifeline**: Free & confidential counselling and referral service; 13 11 14
- **Australian Psychological Association**: Psychological services referral service; 8662 3300

By pressing the 'Next' button, you consent to participate in this study.
## Appendix C. Screening Questionnaire

### CONSENT TO PARTICIPATE
Please select 5 answers. Please choose all that apply:

- [ ] I have read and I understand the attached Plain Language Statement.
- [ ] I freely agree to participate in this project according to the conditions in the Plain Language Statement.
- [ ] A copy of the Plain Language Statement was made available to me for download.
- [ ] The researcher has agreed not to reveal my identity and personal details, including when information about this project is published, or presented in any public form.
- [ ] By initiating this questionnaire I understand that I have given full and informed consent to taking part in this study.

Please choose all that apply:

- [ ] Please check the following box if you are interested in being contacted for any future research.

### IDENTIFYING INFORMATION
Please complete the following questions as accurately as possible.

<table>
<thead>
<tr>
<th>3 Title</th>
<th>Please choose only one of the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Miss</td>
<td>○ Ms</td>
</tr>
<tr>
<td>○ Mrs</td>
<td>○ Mr</td>
</tr>
<tr>
<td>○ Dr</td>
<td>○ Professor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4 First Name</th>
<th>Please write your answer here:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>5 Surname</th>
<th>Please write your answer here:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>6 Age in years</th>
<th>Please write your answer here:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>7 Date of birth</th>
<th>Please enter a date:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>8 Telephone number</th>
<th>Please write your answer here:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>9 Email address</th>
<th>Please write your answer here:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>10 Confirm your email address</th>
<th>Please write your answer here:</th>
</tr>
</thead>
</table>
IDENTIFYING INFORMATION Please complete the following questions as accurately as possible.

13 Do you currently have any medical conditions? Please choose only one of the following:
   ○ Yes
   ○ No

14 If Yes to Question 13 Please specify:

15 Have you ever been diagnosed with a psychiatric illness? Please choose only one of the following:
   ○ Yes
   ○ No

16 If Yes to Question 15 Please specify:

17 Have you ever experienced Anorexia Nervosa or Bulimia Nervosa? Please choose only one of the following:
   ○ Yes
   ○ No

18 If Yes to Question 17 Are you currently experiencing Anorexia or Bulimia?
   Please choose only one of the following:
   ○ Yes
   ○ No

19 Have you ever experienced a head injury? Please choose only one of the following:
   ○ Yes
   ○ No

20 If Yes to Question 19 Please provide details of your head injury Please write your answer here:
Appendix D. Demographic Questionnaire and Self-report Measures

Please complete the following questions as accurately as possible.

8 What country do you live in? *
   Please choose only one of the following. Please also fill in the “other comment” field.
   - Australia
   - Other

9 Postcode *
   Please write your answer here:

14 Gender *
   Please choose only one of the following:
   - Female
   - Male

15 Highest year of education completed *
   Please choose only one of the following:
   - Never attended school (primary or secondary)
   - Primary (prep – grade 8)
   - Completed secondary
   - Completed Trade course/Apprenticeship/TAFE course
   - Completed Tertiary course
   - Don't know

16 What is your ethnicity? *
   Please write your answer here:

17 What is your first language? *
   Please choose only one of the following:
   - English
   - Other

18 Do you speak English fluently? *
   Please choose only one of the following:
   - Yes
   - No
10 What is your occupation? *
Please write your answer here:

<table>
<thead>
<tr>
<th>20 Number of years at current job? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please write your answer here:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>21 What is your employment status? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please choose only one of the following:</td>
</tr>
<tr>
<td>□ Employed full time</td>
</tr>
<tr>
<td>□ Employed part time</td>
</tr>
<tr>
<td>□ Employed casually</td>
</tr>
<tr>
<td>□ Unemployed (but seeking work)</td>
</tr>
<tr>
<td>□ Homed duties</td>
</tr>
<tr>
<td>□ Student</td>
</tr>
<tr>
<td>□ Retired</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>22 How many hours a week do you currently work? *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please choose only one of the following:</td>
</tr>
<tr>
<td>□ Do not work</td>
</tr>
<tr>
<td>□ Less than 10hrs</td>
</tr>
<tr>
<td>□ 10-23hrs</td>
</tr>
<tr>
<td>□ 24-30hrs</td>
</tr>
<tr>
<td>□ 31-40hrs</td>
</tr>
<tr>
<td>□ 41-50hrs</td>
</tr>
<tr>
<td>□ More than 50hrs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>23 What is the total yearly pre-tax income of your current household (i.e., including a partner or parents if you live with them)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please choose only one of the following:</td>
</tr>
<tr>
<td>□ Less than $30,000</td>
</tr>
<tr>
<td>□ $30,000 - $50,000</td>
</tr>
<tr>
<td>□ $50,000 - $70,000</td>
</tr>
<tr>
<td>□ $70,000 - $90,000</td>
</tr>
<tr>
<td>□ $90,000 - $110,000</td>
</tr>
<tr>
<td>□ $110,000 - $130,000</td>
</tr>
<tr>
<td>□ $130,000 - $150,000</td>
</tr>
<tr>
<td>□ More than $150,000</td>
</tr>
</tbody>
</table>
24 What is your marital status? *
- Please choose only one of the following:
  - Never married
  - Married (legally)
  - De facto/cohabiting
  - Divorced/separated
  - Widower

34 Are you currently taking any medications (including vitamins and supplements)? *
- Please choose only one of the following:
  - Yes
  - No

35 If YES to 34 - Please specify *
- Please write your answer here:

36 Do you currently smoke cigarettes? *
- Please choose only one of the following:
  - Yes
  - No

37 If YES to 36 - How many do you smoke a day AND how many years have you smoked for? *
- Please write your answer here:

38 Have you ever smoked cigarettes and stopped? *
- Please choose only one of the following:
  - Yes
  - No

39 If YES to 38 - When did you stop smoking AND how many cigarettes did you smoke? *
- Please write your answer here:

40 If YES to 38 - Did you experience any weight gain after stopping smoking? *
- Please choose only one of the following:
  - Yes
  - No

41 If YES to 40 - How many kilograms? *
- Please write your answer here:
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>43 What is your height in centimeters? *</td>
<td></td>
</tr>
<tr>
<td>Please write your answer here:</td>
<td></td>
</tr>
<tr>
<td>44 How much do you currently weigh in kilograms? *</td>
<td></td>
</tr>
<tr>
<td>Please write your answer here:</td>
<td></td>
</tr>
<tr>
<td>45 What is your waist circumference in centimeters?</td>
<td></td>
</tr>
<tr>
<td>Please write your answer here:</td>
<td>How to measure your waist</td>
</tr>
<tr>
<td>1. Find the top of your hip bone and the bottom of your ribs.</td>
<td>2. Breathe out normally</td>
</tr>
<tr>
<td>3. Place the tape measure midway between these points and wrap it around your waist</td>
<td></td>
</tr>
<tr>
<td>4. Check your measurement.</td>
<td></td>
</tr>
<tr>
<td>46 What has been your highest weight ever (when not pregnant) in kilograms? *</td>
<td></td>
</tr>
<tr>
<td>Please write your answer here:</td>
<td></td>
</tr>
<tr>
<td>47 Select which statement best describes you. &quot;During the past six months my weight has ...&quot; *</td>
<td></td>
</tr>
<tr>
<td>Please choose only one of the following:</td>
<td></td>
</tr>
<tr>
<td>☐ Decreased 10kgs or more</td>
<td></td>
</tr>
<tr>
<td>☐ Decreased 5 to 10kgs</td>
<td></td>
</tr>
<tr>
<td>☐ Been</td>
<td></td>
</tr>
<tr>
<td>☐ relatively stable</td>
<td></td>
</tr>
<tr>
<td>☐ Increased 5 to 10kgs</td>
<td></td>
</tr>
<tr>
<td>☐ Increased by 10kgs or more</td>
<td></td>
</tr>
<tr>
<td>48 If you are Female - Are you pregnant? *</td>
<td></td>
</tr>
<tr>
<td>Please choose only one of the following:</td>
<td></td>
</tr>
<tr>
<td>☐ Yes</td>
<td></td>
</tr>
<tr>
<td>☐ No</td>
<td></td>
</tr>
<tr>
<td>49 IF YES to 48 - How many weeks? *</td>
<td></td>
</tr>
<tr>
<td>Please write your answer here:</td>
<td></td>
</tr>
<tr>
<td>50 If you are Female - Have you borne children? *</td>
<td></td>
</tr>
<tr>
<td>Please choose only one of the following:</td>
<td></td>
</tr>
<tr>
<td>☐ Yes</td>
<td></td>
</tr>
<tr>
<td>☐ No</td>
<td></td>
</tr>
</tbody>
</table>
### 51 If YES to 50 - What was your weight in kilograms

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the start of your first pregnancy?</td>
<td></td>
</tr>
<tr>
<td>At the delivery of your first child?</td>
<td></td>
</tr>
<tr>
<td>After delivery of your first child?</td>
<td></td>
</tr>
<tr>
<td>At the start of your second pregnancy?</td>
<td></td>
</tr>
<tr>
<td>At the delivery of your second child?</td>
<td></td>
</tr>
<tr>
<td>After delivery of your second child?</td>
<td></td>
</tr>
<tr>
<td>At the start of your third pregnancy?</td>
<td></td>
</tr>
<tr>
<td>At the delivery of your third child?</td>
<td></td>
</tr>
<tr>
<td>After delivery of your third child?</td>
<td></td>
</tr>
<tr>
<td>At the start of your fourth pregnancy?</td>
<td></td>
</tr>
<tr>
<td>At the delivery of your fourth child?</td>
<td></td>
</tr>
<tr>
<td>After delivery of your fourth child?</td>
<td></td>
</tr>
<tr>
<td>At the delivery of your fifth child?</td>
<td></td>
</tr>
<tr>
<td>After delivery of your fifth child?</td>
<td></td>
</tr>
<tr>
<td>At the delivery of your sixth child?</td>
<td></td>
</tr>
<tr>
<td>After delivery of your sixth child?</td>
<td></td>
</tr>
</tbody>
</table>

### 53 You said that you have been trying to maintain weight loss for at least 12 months. Can you please elaborate on this? *

Please write your answer here:

```
```

### 60 When (approximately) did you start your last weight loss attempt? *

Please enter a date:

```
```

### 62 What was your weight in kilograms at commencement of your last weight loss attempt? *

Please write your answer here:

```
```

### 64 What was your lowest weight in kilograms during your last weight loss attempt? *

Please write your answer here:

```
```
66 In general, how many months per year are you intentionally trying to lose weight (i.e., diet) (range from 0-12 months)? *
Your answer must be between 0 and 12. Please write your answer here:  

67 What is the longest you have maintained weight loss for? *
Please write your answer(s) here:
- Months:  
- Years:  

69 How many times in your life have you intentionally lost weight (when you weren’t sick)? *
Please write your answer here:  

70 Indicate the number of times you have intentionally lost: *
Please write your answer(s) here:
- <3 lbs:  
- 3-8 lbs:  
- 8-15 lbs:  
- 15-20 lbs:  
- 20-30 lbs:  
- 30-40 lbs:  
- 40+ lbs:  

71 Have you ever regained this weight you had lost? *
Please choose only one of the following:
- Yes  
- No  

73 IF YES to 71 - How many times? *

75 If you have lost weight how difficult or easy have you found weight loss? *
Please choose only one of the following:
- Extremely easy  
- Very easy  
- Somewhat easy  
- Neither easy/hard  
- Somewhat hard  
- Very hard  
- Extremely hard
76 If you have lost weight how difficult or easy have you found it to maintain weight loss? *
Please choose only one of the following:
- Extremely easy
- Very easy
- Somewhat easy
- Neither easy/hard
- Somewhat hard
- Very hard
- Extremely hard

77 How many times a week do you weigh yourself? *
Please choose only one of the following:
- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- >7

78 Overall, on a scale from 1 to 10 (1 being not at all, 10 being 100%) how motivated are you currently to maintain your weight loss? *
Please write your answer(s) here:

85
Please record your major weight loss efforts, (i.e., diet, exercise, moderation, Weight Watchers, Jenny Craig, Atkin diet, etc). Please include any efforts which did not result in significant weight loss as well as those that did. Take your time to think over your previous efforts, starting with the first one, whether in childhood or adulthood. You may have trouble remembering this information at first, but most people can if they take their time. Start with your first weight loss effort and proceed in order until you reach your most recent one.

<table>
<thead>
<tr>
<th>No.</th>
<th>Age at time of effort</th>
<th>Weight at start of effort</th>
<th>lgs lost</th>
<th>Method used to lose weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
86 How often do you (number days/week): *

<table>
<thead>
<tr>
<th>Item</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eat breakfast</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Eat lunch</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Eat dinner</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Eat takeaway, fast food</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Dine-out (restaurant/café-style meal)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Eat no set meals (i.e., grazing)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Snack between meals during the day</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Snack after dinner before bed</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Eat most of your caloric intake after 7pm</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

87 Do you eat at the same time(s) on most (7 days per week) days? *

- Yes
- No

88 Please list (as best you can) everything which you ate and drank in the past 24 hours *

Please write your answer here:

89 On average, how much time do you spend thinking about food every day? *

- 0 – 30 minutes
- 30 – 60 minutes
- 1 – 2 hours
- 3 – 4 hours
- 5 hours or more

90 On average, how much time do you spend thinking about your weight every day? *

- 0 – 30 minutes
- 30 – 60 minutes
- 1 – 2 hours
- 3 – 4 hours
- 5 hours or more
91 Since attempting to lose weight how has the way you think about food and your weight been affected? *

Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Time spent thinking about food</th>
<th>Increase</th>
<th>Same</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent thinking about weight</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

94 On a scale of 1-5, how important is each one to your desire to maintain your weight loss? *

Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Increased day-to-day mobility?</th>
<th>1 - Not at all</th>
<th>2 - Slightly</th>
<th>3 - Moderately</th>
<th>4 - Considerably</th>
<th>5 - Very important</th>
<th>6 - Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling more comfortable when socialising with others?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced occupational functioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved health?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved appearance?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved sex life?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved relationship with your partner/spouse?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

97 If you selected OTHER in 94, can you please elaborate on this? *

Please write your answer here:

---

99 The Australian National Guidelines for physical activity is 30 minutes of moderate intensity activity on most, if not all days. Moderate intensity activity will cause a slight, but noticeable increase in your breathing and heart rate.

100 Please indicate on which days during the past week you met the guideline for: *

<table>
<thead>
<tr>
<th>Physical Activity (30mins moderate intensity)</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>NA</th>
</tr>
</thead>
</table>

101 Please indicate to what extent the following statement is true of you: (where 1 = not at all true of me, 2 = slightly true of me, 3 = moderately true of me, 4 = very true of me, & 5 = extremely true of me) *

Please write your answer(s) here:

"I intend to meet the physical activity guidelines over the next 12 months."

"I will try to meet the physical activity guidelines over the next 12 months."

"I plan to meet the physical activity guidelines over the next 12 months."

102 The Australian National Guidelines for fruit & vegetable consumption is 2 serves of fruit and 5 serves of vegetables per day. 1 serve of fruit = 150g (e.g., a medium sized piece of fruit or 2 small pieces of fruit). One serve of vegetables = 75g (e.g., half a cup of cooked vegetables or one cup of salad)
103 Please indicate on which days during the past week you met the guideline for: *

<table>
<thead>
<tr>
<th>Fruit (2 serves) &amp; Vegetable Consumption (5 serves)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
</tr>
</tbody>
</table>

104 Please indicate to what extent the following statement is true of you: (where $1 = \text{not at all true of me}$, $2 = \text{slightly true of me}$, $3 = \text{moderately true of me}$, $4 = \text{very true of me}$, & $5 = \text{extremely true of me}$) *

Please write your answer(s) here:

- "I intend to meet the fruit and vegetable consumption guidelines over the next 12 months."
- "I will try to meet the fruit and vegetable consumption guidelines over the next 12 months."
- "I plan to meet the fruit and vegetable consumption guidelines over the next 12 months."

105 The Australian National Guidelines for breakfast consumption is daily consumption of breakfast.

106 Please indicate on which days during the past week you met the guideline for: *

<table>
<thead>
<tr>
<th>Breakfast Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
</tr>
</tbody>
</table>

107 Please indicate to what extent the following statement is true of you: (where $1 = \text{not at all true of me}$, $2 = \text{slightly true of me}$, $3 = \text{moderately true of me}$, $4 = \text{very true of me}$, & $5 = \text{extremely true of me}$) *

Please write your answer(s) here:

- "I intend to meet the breakfast consumption guidelines over the next 12 months."
- "I will try to meet the breakfast consumption guidelines over the next 12 months."
- "I plan to meet the breakfast consumption guidelines over the next 12 months."

108 The Australian National Guidelines for sleep is 7-8 hours on average, per night.

109 Please indicate on which days during the past week you met the guideline for: *

<table>
<thead>
<tr>
<th>Sleep (7-8hrs/night)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
</tr>
</tbody>
</table>

110 Please indicate to what extent the following statement is true of you: (where $1 = \text{not at all true of me}$, $2 = \text{slightly true of me}$, $3 = \text{moderately true of me}$, $4 = \text{very true of me}$, & $5 = \text{extremely true of me}$) *

Please write your answer(s) here:

- "I intend to meet the sleep guidelines over the next 12 months."
- "I will try to meet the sleep guidelines over the next 12 months."
- "I plan to meet the sleep guidelines over the next 12 months."
111 For the reduction of lifetime risk and reduction of risk of alcohol-related injury, the Australian National Guidelines for alcohol consumption is drinking no more than 2 standard drinks on any day, and drinking no more than 4 standard drinks on a single occasion.

A standard drink contains 10 grams of pure alcohol. 375 ml bottle or can of mid strength beer (3.5% alc. vol) = 1 standard drink, and 100 ml standard serve of red wine (13% alc. vol) = 1 standard drink.

112 Please indicate on which days during the past week you met the guideline for: *

<table>
<thead>
<tr>
<th>Alcohol Consumption (&lt;2 drinks/day)</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol Consumption (no more than 4 drinks on one occasion)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

113 Please indicate to what extent the following statement is true of you: (where 1 = not at all true of me, 2 = slightly true of me, 3 = moderately true of me, 4 = very true of me, & 5 = extremely true of me) *

Please write your answer(s) here:

"I intend to meet the alcohol consumption (<2 drinks/day) guidelines over the next 12 months." [ ]

"I will try to meet the alcohol consumption (<2 drinks/day) guidelines over the next 12 months." [ ]

"I plan to meet the alcohol consumption (<2 drinks/day) guidelines over the next 12 months." [ ]

"I intend to meet the alcohol consumption (no more than 4 drinks on one occasion) guidelines over the next 12 months." [ ]

"I will try to meet the alcohol consumption (no more than 4 drinks on one occasion) guidelines over the next 12 months." [ ]

"I plan to meet the alcohol consumption (no more than 4 drinks on one occasion) guidelines over the next 12 months." [ ]

114 The Australian National Guidelines for TV viewing is no more than 2hrs on any day.

115 Please indicate on which days during the past week you met the guideline for: *

<table>
<thead>
<tr>
<th>TV Viewing (&lt;2hrs/day)</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>NA</th>
</tr>
</thead>
</table>

116 Please indicate to what extent the following statement is true of you: (where 1 = not at all true of me, 2 = slightly true of me, 3 = moderately true of me, 4 = very true of me, & 5 = extremely true of me) *

Please write your answer(s) here:

"I intend to meet the TV viewing guidelines over the next 12 months." [ ]

"I will try to meet the TV viewing guidelines over the next 12 months." [ ]

"I plan to meet the TV viewing guidelines over the next 12 months." [ ]
117 Please select any of the following events that you have experienced in your life over the past 12 months * Please choose all that apply.

☐ Death of spouse or child
☐ Divorce
☐ Marital Separation
☐ Detention in jail or other institution
☐ Death of a close family member (e.g. parent or sibling)
☐ Major personal injury or illness
☐ Marriage
☐ Being fired from work
☐ Retirement
☐ Major change in health or behaviour of family member
☐ Pregnancy of spouse/partner
☐ Sexual difficulties
☐ Gaining a new family member (e.g. through birth, adoption etc.)
☐ Major business readjustment (e.g. merger, reorganisation, etc.)
☐ Major change in financial state (e.g. a lot worse off or a lot better off)
☐ Death of a close friend
☐ Changing to a different type of work
☐ Major change in the number of arguments with spouse (e.g. a lot more or less)
☐ Taking on a significant (to you) mortgage
☐ Foreclosure on a mortgage or loan
☐ Major change in responsibility at work (e.g. promotion, transfer, demotion)
☐ Son or daughter leaving home (marriage, college etc.)
☐ In-law troubles
☐ Outstanding personal achievement
☐ Partner beginning or ceasing work outside of the home
☐ Beginning or ceasing formal schooling
☐ Major change in living conditions (e.g. new house, renovating)
☐ Revision of personal habits (dress, manners, association etc.)
☐ Troubles with the boss
☐ Change in residence
☐ Changing to a new school
☐ Major change in usual type and/or amount of recreation
☐ Major change in church or spiritual activities (e.g. a lot more or less than usual)
☐ Major change in social activities (e.g. clubs, dancing, movies etc.)
☐ Taking on a small loan (e.g. purchasing car, TV, freezer etc.)
☐ Major change in sleeping habits (e.g. a lot more or less)
☐ Major change in number of family get-togethers (e.g. a lot more or less)
☐ Major change in eating habits (e.g. a lot more or less food intake)
☐ Holiday or vacation
☐ Christmas
☐ Minor violations of the law (e.g. traffic or parking infringement)
☐ None of the above
Please complete the following questions as accurately as possible.

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spend being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

119 During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling? *
Please choose only one of the following:

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ No vigorous physical activity

120 Only answer this question if you answered 1-7 for 119 - How much time did you usually spend on one of those days doing vigorous physical activities?

Please write your answer(s) here:

Hours per day

Minutes per day

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

122 During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. *
Please choose only one of the following:

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ No moderate physical activity

123 Only answer this question if you answered 1-7 for 122 - How much time did you usually spend doing moderate physical activities on one of those days? * Please write your answer(s) here

Hours per day

Minutes per day
Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

125 During the last 7 days, on how many days did you walk for at least 10 minutes at a time? *
Please choose only one of the following:
1
2
3
4
5
6
7
No walking

126 Only answer this question if you answered 1-7 for 125 - How much time did you usually spend walking on one of those days? * Please write your answer(s) here:

Hours per day

Minutes per day

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

128 During the last 7 days, how much time did you spend sitting on a week day? *
Please write your answer(s) here:

Hours per day

Minutes per day

120 Directions: Please select either ‘true’ or ‘false’ with regards to the following statements. *
Please choose the appropriate response for each item:

When I smell a sizzling steak or see my favourite food, I find it very difficult to keep from eating, even if I have just finished a meal.
True False

I usually eat too much at social occasions, like parties and picnics.
True False

I am usually so hungry that I eat more than three times a day.
True False

When I have eaten my quota of calories, I am usually good about not eating any more.
True False

Dieting is so hard for me because I just get too hungry.
True False

I deliberately take small helpings as a means of controlling my weight.
True False

Sometimes things just taste so good that I keep on eating even when I am no longer hungry.
True False

Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat.
True False

When I feel anxious, I find myself eating.
True False

Life is too short to worry about dieting.
True False
<table>
<thead>
<tr>
<th>Statement</th>
<th>True</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td>Since my weight goes up and down, I have gone on reducing diets more than once.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I often feel so hungry that I just have to eat something.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I am with someone who is overeating, I usually overeat too.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have a pretty good idea of the number of calories in common food.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes when I start eating, I just can't seem to stop.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is not difficult for me to leave something on my plate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At certain times of the day, I get hungry because I have gotten used to eating them.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being with someone who is eating often makes me feel hungry enough to eat also.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I feel blue, I often overeat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy eating too much to spoil it by counting calories or watching my weight.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I see a real delicacy, I often get so hungry that I have to eat right away.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I often stop eating when I am not really full as a conscious means of limiting the amount that I eat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get so hungry that my stomach often feels like a bottomless pit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My weight has hardly changed at all in the last ten years.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am always hungry so it is hard for me to stop eating before I finish the food on my plate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I feel lonely, I console myself by eating.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I consciously hold back at meals in order not to gain weight.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I sometimes get very hungry late in the evening or at night.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat anything I want, any time I want.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without even thinking about it, I take a long time to eat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I count calories as a conscious means of controlling my weight.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not eat some foods because they make me fat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am always hungry enough to eat at any time.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I pay a great deal of attention to changes in my figure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Directions: Please answer the following questions by selecting the response that is appropriate to you.

<table>
<thead>
<tr>
<th>Question</th>
<th>Response Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>131 * How often are you dieting in a conscious effort to control your weight?</td>
<td>rarely</td>
</tr>
<tr>
<td>132 * Would a weight fluctuation of 2.5kg (5lb) affect the way you live your life?</td>
<td>Not at all</td>
</tr>
<tr>
<td>133 * How often do you feel hungry?</td>
<td>Only at mealtimes</td>
</tr>
<tr>
<td>134 * Do your feelings of guilt about overeating help you to control your food intake?</td>
<td>Never</td>
</tr>
<tr>
<td>135 * How difficult would it be for you to stop eating halfway through dinner and not eat for the next few hours?</td>
<td>Easy</td>
</tr>
<tr>
<td>136 * How conscious are you of what you are eating?</td>
<td>Not at all</td>
</tr>
<tr>
<td>137 * How frequently do you avoid 'stocking up' on tempting foods?</td>
<td>Almost never</td>
</tr>
<tr>
<td>138 * How likely are you to shop for lower calorie foods?</td>
<td>Unlikely</td>
</tr>
</tbody>
</table>
130 * Do you eat sensibly in front of others and splurge alone?
Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Never</th>
<th>Rarely</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
</table>

140 * How likely are you to consciously eat slowly in order to cut down on how much you eat?
Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Unlikely</th>
<th>Slightly likely</th>
<th>Moderately likely</th>
<th>Very likely</th>
</tr>
</thead>
</table>

141 * How frequently do you skip dessert because you are no longer hungry?
Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Almost never</th>
<th>Seldom</th>
<th>At least once a week</th>
<th>Almost every day</th>
</tr>
</thead>
</table>

142 * How likely are you to consciously eat less than you want?
Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Unlikely</th>
<th>Slightly likely</th>
<th>Moderately likely</th>
<th>Very likely</th>
</tr>
</thead>
</table>

143 * Do you go on eating binges though you are not hungry?
Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>At least once a week</th>
</tr>
</thead>
</table>

144 On a scale of zero to five, where zero means no restraint in eating (that is, eating whatever you want, whenever you want it) and five means total restraint (that is, constantly limiting food intake and never 'giving in'), what number would you give yourself? *

Please choose only one of the following:

- 0 - Eat whatever you want, whenever you want it
- 1 - Usually eat whatever you want, whenever you want it
- 2 - Often eat whatever you want, whenever you want it
- 3 - Often limit food intake, but often 'give in'
- 4 - Usually limit food intake, rarely 'give in'
- 5 - Constantly limiting food intake, never 'giving in'

145 * To what extent does this statement describe your eating behaviour? 'I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow'.
Please choose the appropriate response for each item:

1. Not like me
2. Little like me
3. Pretty good description of me
4. Describes me perfectly
146 Please read each statement and select a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>0 Did not apply to me at all</th>
<th>1 Applied to me to some degree, or some of the time</th>
<th>2 Applied to me to a considerable degree, or a good part of time</th>
<th>3 Applied to me very much, or most of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>I found it hard to wind down</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I was aware of dryness of my mouth</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I couldn't seem to experience any positive feeling at all</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I found it difficult to work up the initiative to do things</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I tended to over-react to situations</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I experienced trembling (e.g., in the hands)</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt that I was using all nervous energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I was worried about situations in which I might panic and make a fool of myself</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt that I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I found myself getting agitated</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I found it difficult to relax</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt down-hearted and blue</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I was insensitive of anything that kept me from getting on with what I was doing</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt I was close to panic</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I was unable to become enthusiastic about anything</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt I wasn't worth much as a person</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt that I was rather toughty</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt scared without any good reason</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I felt that life was meaningless</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Please answer each question by selecting either 'YES' or 'NO'. There are no right or wrong answers, and no trick questions. Work quickly and do not think too long about the exact meaning of the question. *

Please choose the appropriate response for each item

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you often buy things on impulse?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you generally do and say things without stopping to think?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you often get into a jam because you do things without thinking?</td>
<td>☐</td>
</tr>
<tr>
<td>Are you an impulsive person?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you usually think carefully before doing anything?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you often do things on the spur of the moment?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you mostly speak without thinking things out?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you often get involved in things you later wish you could get out of?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you get so 'carried away' by new and exciting ideas, that you never think of possible snags?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you need to use a lot of self-control to keep out of trouble?</td>
<td>☐</td>
</tr>
<tr>
<td>Would you agree that almost everything enjoyable is illegal or immoral?</td>
<td>☐</td>
</tr>
<tr>
<td>Are you often surprised at people's reactions to what you do or say?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you think an evening out is more successful if it is unplanned or arranged at the last moment?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you usually work quickly, without bothering to check?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you often change your interests?</td>
<td>☐</td>
</tr>
<tr>
<td>Before making up your mind, do you consider all the advantages and disadvantages?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you prefer to 'sleep on it' before making decisions?</td>
<td>☐</td>
</tr>
<tr>
<td>When people shout at you, do you shout back?</td>
<td>☐</td>
</tr>
<tr>
<td>Do you usually make up your mind quickly?</td>
<td>☐</td>
</tr>
</tbody>
</table>
For each of the statements shown, please indicate whether or not the statement is characteristic of you.

1 = extremely uncharacteristic of you (not at all like you), 7 = extremely characteristic of you (very much like you) *

Please write your answer(s) here:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>I consider how things might be in the future, and try to influence those things with my daily behavior.</td>
<td></td>
</tr>
<tr>
<td>Often I engage in a particular behavior in order to achieve outcomes that may not result for many years.</td>
<td></td>
</tr>
<tr>
<td>I only act to satisfy immediate concerns, figuring the future will take care of itself.</td>
<td></td>
</tr>
<tr>
<td>My behavior is only influenced by the immediate (i.e., a matter of days or weeks) outcomes of my actions.</td>
<td></td>
</tr>
<tr>
<td>My convenience is a big factor in the decisions I make or the actions I take.</td>
<td></td>
</tr>
<tr>
<td>I am willing to sacrifice my immediate happiness or well-being in order to achieve future outcomes.</td>
<td></td>
</tr>
<tr>
<td>I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years.</td>
<td></td>
</tr>
<tr>
<td>I think it is more important to perform a behavior with important distant consequences than a behavior with less important immediate consequences.</td>
<td></td>
</tr>
<tr>
<td>I generally ignore warnings about possible future problems because I think the problems will be resolved before they reach crisis level.</td>
<td></td>
</tr>
<tr>
<td>I think that sacrificing now is usually unnecessary since future outcomes can be dealt with at a later time.</td>
<td></td>
</tr>
<tr>
<td>I only act to satisfy immediate concerns, figuring that I will take care of future problems that may occur at a later date.</td>
<td></td>
</tr>
<tr>
<td>Since my daily work has specific outcomes, it is more important to me than behavior that has distant outcomes.</td>
<td></td>
</tr>
<tr>
<td>When I make a decision, I think about how it might affect me in the future.</td>
<td></td>
</tr>
<tr>
<td>My behavior is generally influenced by future consequences.</td>
<td></td>
</tr>
</tbody>
</table>
149 Answer each question by selecting "YES" or "NO" after each one. There are no right or
wrong answers, or trick questions. Work quickly and don't think too much about the exact
meaning of the questions.*

Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the good prospect of obtaining money motivate you strongly to do some things?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are you frequently encouraged to act by the possibility of being valued in your work, in your studies, with your friends or with family?</td>
<td></td>
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<tr>
<td>Do you often meet people that you find physically attractive?</td>
<td></td>
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<tr>
<td>Do you like to take some drugs because of the pleasure you get from them?</td>
<td></td>
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<tr>
<td>Do you often do things to be praised?</td>
<td></td>
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<tr>
<td>Do you like being the center of attention at a party or a social meeting?</td>
<td></td>
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<tr>
<td>Do you spend a lot of time on obtaining a good image?</td>
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<tr>
<td>Do you need people to show their affection for you all the time?</td>
<td></td>
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<tr>
<td>When you are in a group, do you try to make your opinions the most intelligent or funniest?</td>
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</tr>
<tr>
<td>Do you often take the opportunity to pick up people you find attractive?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As a child, did you do a lot of things to get people's approval?</td>
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<tr>
<td>Does the possibility of social advancement move you to action, even if this involves not playing fair?</td>
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<tr>
<td>Do you generally give preference to those activities that imply an immediate gain?</td>
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<tr>
<td>Do you often have trouble resisting the temptation of doing forbidden things?</td>
<td></td>
<td></td>
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<tr>
<td>Do you like to compete and do everything you can to win?</td>
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<td></td>
</tr>
<tr>
<td>Is it easy for you to associate tastes and smells to very pleasant events?</td>
<td></td>
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<tr>
<td>Are there a large number of objects or sensations that remind you of pleasant events?</td>
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<tr>
<td>When you start to play with a slot machine, is it often difficult for you to stop?</td>
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<tr>
<td>Do you sometimes do things for quick gains?</td>
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<tr>
<td>Does your attention easily stray from your work in the presence of an attractive stranger?</td>
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<tr>
<td>Are you interested in money to the point of being able to do risky jobs?</td>
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<tr>
<td>Do you like to be competitive in all of your activities?</td>
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<tr>
<td>Would you like to be a socially powerful person?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you like displaying your physical abilities even though this may involve danger?</td>
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<td></td>
</tr>
</tbody>
</table>
150 Please indicate how often the following 36 statements apply to you by selecting the appropriate number from the scale (1 – 5). *

Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am clear about my feelings</td>
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<tr>
<td>I pay attention to how I feel</td>
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<tr>
<td>I experience my emotions as overwhelming and out of control</td>
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<tr>
<td>I have no idea how I am feeling</td>
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<tr>
<td>I have difficulty making sense out of my feelings</td>
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<tr>
<td>I am attentive to my feelings</td>
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<tr>
<td>I know exactly how I am feeling</td>
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<tr>
<td>I care about what I am feeling</td>
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<tr>
<td>I am confused about how I feel</td>
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<tr>
<td>When I’m upset, I acknowledge my emotions</td>
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<tr>
<td>When I’m upset, I become angry with myself for feeling that way</td>
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<tr>
<td>When I’m upset, I become embarrassed for feeling that way</td>
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<tr>
<td>When I’m upset, I have difficulty getting work done</td>
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<tr>
<td>When I’m upset, I become out of control</td>
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<tr>
<td>When I’m upset, I believe that I will remain that way for a long time</td>
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<tr>
<td>When I’m upset, I believe that I’ll end up feeling very depressed</td>
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<tr>
<td>When I’m upset, I believe that my feelings are valid and important</td>
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<tr>
<td>When I’m upset, I have difficulty focusing on other things</td>
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<tr>
<td>When I’m upset, I feel out of control</td>
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<tr>
<td>When I’m upset, I can still get things done</td>
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<tr>
<td>When I’m upset, I feel ashamed with myself for feeling that way</td>
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<tr>
<td></td>
<td>1</td>
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<tr>
<td>When I'm upset, I know that I can find a way to eventually feel better</td>
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<tr>
<td>When I'm upset, I feel like I am weak</td>
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<tr>
<td>When I'm upset, I feel like I can remain in control of my behaviours</td>
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<tr>
<td>When I'm upset, I feel guilty for feeling that way</td>
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<tr>
<td>When I'm upset, I have difficulty concentrating</td>
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<tr>
<td>When I'm upset, I have difficulty controlling my behaviours</td>
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<tr>
<td>When I'm upset, I believe that there is nothing I can do to make myself feel better</td>
<td></td>
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</tr>
<tr>
<td>When I'm upset, I become irritated with myself for feeling that way</td>
<td></td>
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<tr>
<td>When I'm upset, I start to feel very sad about myself</td>
<td></td>
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<tr>
<td>When I'm upset, I believe that wallowing in it is all I can do</td>
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</tr>
<tr>
<td>When I'm upset, I lose control over my behaviours</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>When I'm upset, I have difficulty thinking about anything else</td>
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<td></td>
</tr>
<tr>
<td>When I'm upset, I take time to figure out what I'm really feeling</td>
<td></td>
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</tr>
<tr>
<td>When I'm upset, it takes me a long time to feel better</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>When I'm upset, my emotions feel overwhelming</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Thank you for completing this survey. Please return this questionnaire to Deakin University in the reply paid envelope. If you have any questions please contact Jessica Newhouse at jessica.newhouse@deakin.edu.au