Weapons of mass consumption: The psychological mechanisms driving over indulgence**.**

by

Belinda C Goodwin

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Certificate of authorship and originality of thesis

The work contained in this thesis has not been previously submitted either in whole or in part for a degree at CQUniversity or any other tertiary institution. To the best of my knowledge and belief, the material presented in this thesis is original except where due reference is made in text.

As listed in Published Papers and Conference Proceedings, the thesis document includes several published manuscripts. Ms. Belinda Goodwin was primarily responsible for the design, data collection, analysis of results and complete drafting of each manuscript (with the exception of data collected for the study detailed in Chapter 3 whereby archived data was used). Co –authors Dr Matthew Browne, Professor Matthew Rockloff, Dr Natalie Loxton and Dr Phillip Donaldson contributed to manuscripts with guidance on content and editing. Dr Matthew Browne also assisted in the running data analysis where the use of specialist software was required. Vijay Rawat was employed to assist with formatting the final thesis document.

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Dedication:

To Mum, on your birthday

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Published papers and conference proceedings

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Goodwin, B. C, Browne, M., Loxton, N. & Rockloff, M. Rash impulsivity predicts lower anticipated pleasure response and a preference for the supernormal. *Personality and Individual Differences. In Press* doi: 10.1016/j.paid.2-016.01.030

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Abbreviations

BAS	Behavioural approach system
IAT	Implicit attitudes task
RD	Reward drive
RDS	Reward deficiency syndrome
RI	Rash impulsivity
RST	Reward sensitivity theory
SNPS	Supernormal and natural pleasure scale
SNP	Supernormal pleasure
NP	Natural Pleasure
TDRL	Temporal difference reinforcement learning

Abstract

Excess-consumption in the general population, whether economic, dietary, or substance-oriented, presents numerous health and social challenges. Psychoactive substances, energy dense food, and certain media and retail products tend to provide immediate and exaggerated reinforcement, in turn promoting excessive consumption that contributes to individual and societal harms. These stimuli may be understood to be 'supernormal' in that they activate reward pathways and approach behaviour more so than naturally occurring stimuli for which these pathways were intended. This thesis investigated the issue of unhealthy excess-consumption in the Australian general population, with a key focus to define, measure, and predict individual differences and preferences contributing to excessive consumption. These objectives were addressed through six studies involving a face to face interview study, a series of cross-sectional online surveys, and a reaction time task. Key findings were: 1) Shared variance amongst several types of rewarding stimuli; including fast food, salt, caffeine, television, gambling products, and illicit drugs; can be explained by an underlying individual difference factor; 2) People tend to systematically vary in their preference toward reward from artificial modern day consumer products (i.e., supernormal stimuli) over natural forms of reward, which I have termed "supernormal preference"; 3) Reward drive (RD) and rash impulsivity (RI) uniquely and differentially predict the above-average consumption of a variety of consumer products and activities as well as a preference towards supernormal over natural reward; and lastly, 4) supernormal preference, RD, and RI are positively related to the latent factor reflecting the consumption of several types of hedonic, modern day consumer products. These finding are discussed in terms of the neurological and evolutionary underpinnings of reinforcement processes and the impact that a preference for supernormal reward, and/or a rash impulsive disposition, might have on individuals, health interventions, and future research.

Chapter 1: An introduction to the issue of excess-consumption

1.1 Background

Excess-consumption, whether economic, dietary, or substance-oriented, presents numerous health and social challenges. Research into addiction and health-oriented behaviour, such as over-eating and alcohol abuse, has revealed a number of positive associations between qualitatively different types of consumption (Claes et al., 2012; Greenberg, Lewis, & Dodd, 1999; Holderness, Brooks-Gunn, & Warren, 1994; Penolazzi, Natale, Leone, & Russo, 2012; Petry, 2001; Sansone, Chang, Jewell, & Sellbom, 2012). Furthermore, evolutionary-psychology theory provides a coherent and plausible explanation of why a behavioural heuristic to "consume more" in order to promote the impression of fitness should exist in humans and other animals (Barrett, 2007; Hantula, 2003; Roberts, Van Vugt, & Dunbar, 2012). Also, neurological research on the dopaminergic system has yielded important insights regarding the mechanism by which an orientation towards consumption and resource acquisition might be rewarded and reinforced (Blum, Cull, Braverman, & Comings, 1996a; Franken, 2003; Re & Dp, 2012; Schultz, 1998). These considerations would lead us to expect individual differences in an orientation towards increased consumption over multiple domains. An important question for the study of health behaviour and the key enquiry of this research is: Are some people more susceptible to excess consumption of hedonic stimuli and why might this be? The review of the literature that follows summarizes addiction, evolution, neurobiological, and personality research concerned with excess-consumption. From this, we propose and define a behavioural trait that reflects elevated level of consumption of a broad range of hedonic products.

1.2 Comorbidity and addiction

Excess-consumption is a common element of maladaptive health behaviours. Pathological levels of excess-consumption play a key role in addictions to alcohol, substances (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998), gambling (Rockloff, 2011), food (Moreno, Rodriguez, Fernandez, Tamez, & Cepeda-Benito, 2008), shopping (Faber, Christenson, deZwaan, & Mitchell, 1995), sex (Hook, Hook, Davis, Worthington, & Penberthy, 2010), video gaming (Pentz, Spruijt-Metz, Chou, & Riggs, 2011), mobile phone use (Bianchi & Phillips, 2005), and social networking (Kuss & Griffiths, 2011). Comorbidities between various forms of excess-consumption and specific addictions are reported consistently in the literature (see Table 1.1 for a summary of findings). Greenburg et al., 1999 report moderate positive co-variance amongst alcohol, television viewing, gambling, Internet use, smoking, caffeine, and chocolate intake. In this study, college students (n = 129) responded to Rozin and Stoess's (1993) four-factor addiction scale measuring cravings, withdrawal symptoms, tolerance, and most importantly, lack of control (leading to excess consumption). Greenburg et al., found that consumption of almost every product were correlated, suggesting that there was variance in individual vulnerability towards more than one addictive activity or substance. That is, individual who reported a higher degree of dependence to one product were likely to do so for one or more other products. In more recent research, positive relationships have been found between smoking, alcohol, and drug use (Bachman, Wadsworth, O'malley, Johnston & Schelenberg, 2013), smoking and caffeine (Penolazzi et al., 2012), drug use and gambling (Petry, 2001), television and snacking (Gore, Foster, DiLillo, Kirk, & Smith West, 2003), and tobacco addiction and compulsive shopping (Pavarin & Biolcati, 2015). These additional comorbidities provide further evidence of a trait that leads to increased consumption or susceptibility to harmful overconsumption.

Importantly, common characteristics are apparent amongst this group of products and behaviours. For example, they all involve the consumption of hedonic stimuli popular in modern society; they are activities that tend to be unhealthy, particularly when consumed in excess; they are amenable to excess-consumption, and are often addictive in nature or consumed compulsively, regardless of whether or not they are the symptom of an actual diagnosed addiction (Sussman, Lisha, & Griffiths, 2010).

Table 1.1 *A list of examples of positive associations amongst several forms of excess consumption found in previous research.*

Positive association between:	**Author**
Gambling and alcohol abuse	(Petry, 2001)
Problem gambling and binge eating	(Claes et al., 2012).
Cigarette smoking and caffeine intake	(Penolazzi et al., 2012)
Alcohol use and binge eating	(Holderness et al., 1994)
Internet addiction and alcohol abuse	(Ko et al., 2008)
Compulsive buying and substance abuse	(Sansone et al, 2012)
Compulsive buying and binge eating	(Faber et al., 1995)
TV and snacking, gambling, and alcohol	(Greenberg et al., 1999)
Smoking and compulsive shopping	(Pavarin et al., 2015

To date, associations amongst these behaviours have only been explored as pair-wise comorbidities rather than considered as indicators of a latent factor with multiple indicators. However, it has long been inferred in previous research that a propensity to consume hedonic stimuli is something by which individuals are likely to systematically vary (Faber et al., 1995; Villella et al., 2011; Weed, Butcher, McKenna, & Ben-Porath, 1992; Walther, Morgenstern, & Hanewinkel, 2012; Zeinali & Vahdat, 2011). In fact, measures have been designed to capture generalized addictive personality types and have been found to predict outcomes such as substance and alcohol abuse (Weed, et al., 1992), problematic mobile phone use, and gambling problems (Blaszczynski, Buhrich, & McConaghy, 1985). Similarly, some researchers have found that particular personality traits explain shared variance in comorbid

behaviour. For example, studies suggest that personality traits such as sensation seeking and impulsivity explain co-variance amongst heavy alcohol use and binge eating (Fischer, Settles, Collins, Gunn, & Smith, 2012; Kane, Loxton, Staiger, & Dawe, 2004). Faber et al., (1995) noted what is increasingly evident now; there is sufficient evidence to justify an investigation into hedonic or compulsive consumption as a broad category of related behaviours. As Faber et al., suggest, by merging findings regarding consumption behaviour we can produce more parsimonious theoretical models.

1.3 Neurobiology and reward

Findings from neurological research demonstrate the mechanisms by which an orientation towards consumption behaviours might be rewarded and reinforced; providing further credence to the notion that an underlying trait that explains comorbidity in consumption behaviour exist. Feelings of pleasure or reward occur when dopamine neurotransmitters are released into synapses stimulating dopamine receptors in these regions of the brain (Blum et al., 1996). Numerous imaging studies have demonstrated dopamine activation in areas within the limbic, mid-regions of the human brain such as the ventral striatum, insula, orbitofrontal cortex, amygdala, and the hypothalamus in response to reward-related function (Bechara, 2005; Olds & Fobes, 1981; Robinson & Berridge, 1993). Dopaminergic reward is responsible for conditioning approach toward resources that represent nutrients or reproduction (Schultz, 1998). Accordingly, studies show that dopamine activity increases during the consumption of hedonic stimuli such as alcohol (Boileau et al., 2003), psychoactive drugs (Blum et al., 1996), gambling products (Bergh, Eklund, Södersten, & Nordin, 1997), energy dense food (Volkow, Wang, Fowler, Tomasi, & Telang 2011; Volkow, Wang, Fowler, & Telang, 2008), chocolate (Small, Zatorre, Dagher, Evans, & Jones-Gotman, 2001), luxury cars (Erk et al., 2002), caffeine (Yamato et al., 2002), the

Internet (Han et al., 2007; Kim et al., 2011), video games (Koepp et al., 1998), and pornography (Bocher et al., 2001). For example, PET scans have revealed higher levels of dopamine release in the ventral striatum in subjects that had consumed alcohol and juice compared to those who had consumed juice only (Boileau et al., 2003). Similarly, Volkow, Wang, Fowler, Tomasi, and Baler (2012) reported that both food and drug cues increase striatal extracellular dopamine activation in the human brain. The excess consumption of hedonic stimuli has been partly attributed to the way in which these stimuli directly stimulate dopaminergic centres in the limbic system, located in the midbrain, bypassing regions in the associative cortices involved in inhibition and decision making. This might explain why both humans and animals (who have comparatively less developed frontal lobes) will often over-consume unhealthy products despite negative consequences (Nesse & Berridge, 1997; Volkow, et al., 2011; Wang, Volkow, Thanos, & Fowler., 2004).

1.3.1 Dopamine deficiency and sensitivity

According to the literature, there are two, somewhat opposing mechanisms by which dopamine levels affect approach toward hedonic stimuli (Franken & Muris, 2005); one based in Reward Sensitivity Theory (RST) and the other based on Reward Deficiency Syndrome (RDS). RDS refers to a condition in which individuals lack D_2 receptors (Blum et al., 1996). This can be both the cause and result of excess-consumption. That is, for some it is a genetic predisposition, while others experience down regulation of D_2 receptors due to excessively frequent release of dopamine that can occur in addiction (Wang et al., 2004). Studies show that drug and alcohol abuse (Blum et al., 1996), internet addiction (Kim et al., 2011), over-eating (Johnson & Kenny, 2010; Wang et al., 2004), and problem gambling (Bergh et al., 1997) are common outcomes for individuals with RDS, suggesting that in order to experience reward they may require higher levels of hedonic stimuli to activate dopamine release. On the

other hand, RST proposes that reward approach is motivated by sensitivity in dopamine pathways (i.e., a hyper-active dopamine system). Individuals who binge eat or abuse drugs tend to show increased activity in dopaminergic pathways in responses to cues of these products compared to control subjects (Schienle, Schäfer, Hermann, & Vaitl, 2009; Volkow et al., 2010). Therefore, according to RST, those high in reward sensitivity are likely to consume more hedonic stimuli due to a surplus of dopamine, suggesting they have a higher capacity to anticipate reward, whereas RDS theory proposes that, people who have lower levels of dopamine functioning consume more hedonic stimuli in an effort to combat a lack of capacity to experience reward (Blum et al., 1996; Blum et al., 2000). The two hypotheses are not mutually exclusive. It is possible that excess consumption of hedonic stimuli is driven by different mechanisms in different individuals. Understanding the psychological characteristics of those who consume to excess or have a preference for hedonic stimuli may provide further insight into the different motivational pathways.

1.3.2 Wanting versus liking, and dopamine

In 1996, Berridge proposed that two separate components, ‘wanting’ and ‘liking’, need to be considered when examining approach to reward. Wanting refers to the appetitive motivation to approach reward, whereas liking refers to the experience of pleasure during stimuli intake. In terms of food based reward, it has been found that wanting (or craving) which can be induced by exposure to food-related cues, relates to increased activity in mesocorticolimbic dopamine activity (Berridge, 2007). Liking, on the other hand, is triggered by the taste of palatable food and is associated with opioid (rather than dopamine) release in different regions of the limbic system including the forebrain (Berridge, 2009; Peciña, Smith, & Berridge, 2006; Small, et al.,, 2001). This theory regarding consumption of food has also

been extended to other forms of hedonic stimuli including drugs (Robinson & Berridge, 1993) and alcohol (Heinz et al., 2005).

In terms of understanding individual differences in an orientation toward or a preference for a certain class of reward, it is an enquiry into the 'wanting' aspect of reward that is most applicable here. That is, the focus of the current research is the *anticipation* or *expectation* of pleasure, rather than the intensity of actual reinforcement. Products such as psychoactive substances and energy dense foods are subject to cravings (i.e., wanting) as these stimuli are anticipated as highly rewarding. It is suggested that this wanting is largely facilitated by dopaminergic activity (Berridge, 2009; 2012; Berridge & Kringelbach, 2008; Peciña, Cagniard, Berridge, Aldridge, & Zhuang, 2003).

1.4 Personality and excess-consumption

Personality traits have long been associated with addictive behaviours. For example, addictive personalities, impulsivity, and sensation seeking are associated with problem gambling, alcohol abuse, compulsive buying, and binge-eating (Billieux, Rochat, Rebetez, & Van der Linden, 2008; Chen et al., 2007; Evans et al., 2006; Fischer et al., 2012; Johnson, 2003; Magid, MacLean, & Colder, 2007; McDaniel, 2003; Weed,et al., 1992). The review of personality traits, their measures, and associated behavioural outcomes below, provides insight into possible psychometric predictors of increased consumption behaviour.

Addictive Personality: The Addiction-Prone Personality Scale (APPS; Zeinali & Vahdat, 2011), the Addiction Potential Scale (APS; Weed, et al., 1992) and the Addiction Scale of the Eysenck Personality Questionnaire (EPQ-R; Eysenck & Eysenck, 1975) are measures derived from personality scales that are designed to capture a general addictive personality trait. Addictive personality is associated with several addictive behaviours such as substance abuse (Weed et al., 1992; Zeinali & Vahdat, 2011), gaming addiction and problematic mobile

phone use (Bianchi & Phillips, 2005). However, including items derived from psychoticism or extraversion subscales on personality inventories, their measures lack face validity. (e.g., *"Do you prefer loud music over quiet music (APPS)"* and *"While on trains and buses, I often talk to strangers"(APS)*). Although they provide a useful example of the way in which an underlying personality traits can predict behaviour, these scales are not likely to capture an orientation toward consummatory rewards as attempted here.

Sensation seeking: Individuals that seek novel experiences, risk, and sensation report higher levels of substance abuse (Donohew et al., 1999; Pedersen, 1991), television viewing (McIlwraith, 1998), problem gambling (Benson, Norman, & Griffiths, 2011; Breen & Zuckerman, 1999) binge eating, and video game play (Pentz et al., 2011). Sensation seeking behaviour has been linked to reduced dopamine functioning (Derringer et al., 2010; Zuckerman, 1984) and therefore, according to RDS theory, may play a role in motivation approach to hedonic stimuli. One popular measure of sensation seeking is Zuckerman, Eysenck, and Eysenck's (1978) Sensation Seeking Scale (SSS). However, items such as *"I prefer friends who are excitingly unpredictable"* and *"I would like to try bungee jumping"* reflect novelty and risk components of sensation seeking that are not consistent with many of the every day hedonic activities considered in the current research such as watching television, eating, shopping, and social networking.

Impulsivity: Impulsivity is broadly defined as a tendency to engage in behaviour in a rash manner that lacks foresight, reflection or long term planning. Impulsivity has consistently been associated with various specific hedonic stimuli, such as: high calorie food (Kane et al., 2004; Moreno-López, Soriano-Mas, Delgado-Rico, Rio-Valle, & Verdejo-García, 2012), alcohol and other substances (Petry, 2001), gambling products (Benson, Norman, & Griffiths, 2011; MacLaren, Fugelsang, Harrigan, & Dixon, 2012; Petry, 2001) and media devices (Billieux, Van der Linden, & Rochat, 2008; Dong, Huang, & Du, 2011). However, varied

definitions and measures of impulsivity, derived from different theoretical backgrounds, have been applied across previous studies of personality (Dawe & Loxton, 2004). Definitions of impulsivity include rash, unplanned behaviour, risk taking, and novelty seeking (Cloninger, 1987; Eysenck & Eysenck, 1991; Zuckerman et al., 1978) and some are multi-faceted. For example, one popular multi-faceted impulsivity measure developed by Whiteside and Lynam (2001) describes factors of impulsivity including urgency, lack of premeditation, lack of perseverance and sensation seeking (Whiteside & Lynam, 2001). The scale's four factors are largely based a factor analysis of self-report questionnaire data (N=437). A more recent conceptualization, which is arguably more relevant to the current research, focuses on two distinct dimensions of impulsivity based on separate neural processes (Dawe & Loxton, 2004; Gullo, Loxton, & Dawe, 2014), which be described in the next section. While both the four and the two factor conceptualizations share similarities, empirical work suggests that the two-factor model is the more parsimonious approach for understanding addictive behaviours (Gullo et al., 2014).

The two-factor model of impulsivity

The two-factor model of impulsivity consists of two correlated factors: 1) rash impulsivity (RI): difficulty inhibiting one's behaviour following the activation of an approach response, despite potential negative consequences; and 2) reward drive (RD): the tendency for one to initiate goal-directed approach behaviour in response to signals of reward. RD reflects Gray's (1970) conceptualization of impulsivity involving individual differences in sensitivity and approach to reward. Those high in behavioural approach to reward are more likely to engage in approach and to experience greater positive affect during reinforcement. According to Reward Sensitivity Theory (RST; see section 1.3), this approach to reward is linked to increased activity in the mesolimbic dopaminergic pathways (Childress et al., 1999;

Schienle et al., 2009; Volkow et al., 2010). RI, on the other hand, is thought reflect decreased activity in the orbitofrontal cortex and the ventromedial prefrontal cortex; areas associated with impulse control and decision-making (Dawe, Gullo, & Loxton, 2004), suggesting that a rash impulsive approach to reward is likely to be the result of poor executive functioning and lack of self-control rather than responsive dopaminergic pathways.

RD and RI are understood to be two distinct but correlated dimensions of impulsivity, and both have been associated with consumption and addictive behaviours (Dawe, et al., 2004; Dawe & Loxton, 2004; Gullo, et al., 2014). Studies have demonstrated an association between RD and binge eating, alcohol abuse, video-gaming, and gambling (see Gullo, et al.,, 2014 for a review). Similarly, RI has been associated with chronic alcohol and poly-drug use (Chen et al., 2007; Dawe, et al., 2004; Gullo, Ward, Dawe, Powell, & Jackson, 2011; Johnson, 2003), pathological gambling (Benson et al., 2011; Fuentes, Tavares, Artes, & Gorenstein, 2006; Loxton, Nguyen, Casey, & Dawe, 2008), and compulsive shopping (Black, Shaw, McCormick, Bayless, & Allen, 2012; Mueller et al., 2011). Although RI and RD share common outcomes, most notably a positive relationship to the consumption of addictive or hedonic behaviours, conceptually they describe complementary aspects of impulsivity; relating to heightened approach (RD), and decreased inhibition (RI). Therefore, when entered simultaneously in regression models, RI and RD tend to explain unique variance in gambling, alcohol and drug use; although, RI appears to be the stronger predictor of the two (Gullo et al., 2011; Loxton et al., 2008; MacLaren et al., 2012). Interestingly, RD is also associated with some positive outcomes. For example, highly reward driven individuals report greater psychological well-being and hope, experiencing greater sociability and less loneliness (Carver, 1994; Clark, Loxton, & Tobin, 2015; Harnett, Loxton, & Jackson, 2013a).

Only a few studies thus far have taken the two-factor approach to measuring impulsivity. These studies have mainly aimed to predict clinical levels of only one or two

specific behaviours, and these have focused on addictive substances and problematic behaviours. For example, Dissabandra et al., (2014) compared levels of RD and RI between heroin dependant subjects (n= 293) and non-users (n=232) and Guerrieri, Nederkoorn and Jansen (2008) assessed reward sensitivity, response inhibition, and food intake in normal versus obese children. To date, little research has focussed on sub-clinical levels of consumption in the general population. Thus whilst RD and RI have been shown to play unique roles in the susceptibility to clinical levels of addictive behaviour, it remains an open question as to whether these results apply to sub-clinical levels of excess-consumption in the general population. In addition, although theoretical conceptualisations of RD and RI imply differing relationships to qualitatively different types of behaviour (e.g. social engagement versus risk taking), these predictions have hitherto not been specifically tested. More generally, little is known regarding the role of RD and RI in determining (mal)adaptive or (un)healthy patterns of consumption in the general population. Based on our current understanding of the neurobiological, psychological, and behavioural associations with RD and RI, it is reasonable to expect that both constructs will have unique effects on a broad range of hedonic consumption behaviours above and beyond those covered in the research to date.

It is important to acknowledge that demographics, mood, and environmental factors can also predict one's propensity for excess consumption. For example, younger males have been found to be at higher risk of gambling problems (Mok & Hraba, 1991; Stinchfield, 2000), alcoholism (Welte, Barnes, Wieczorek, Tidwell, & Parker, 2001), and drug abuse (Compton, Thomas, Stinson, & Grant, 2007), whereas females are more prone to compulsive shopping (Mueller et al., 2011) or binge-eating disorders (Halmi, Falk, & Schwartz, 1981). Mood disorders such as anxiety and depression are positively associated with excessive internet use (Yen, Ko, Yen, Wu, & Yang, 2007), drug and alcohol abuse (Robinson, Sareen,

Cox, & Bolton, 2009), and binge eating (Stice, Presnell, Shaw, & Rohde, 2005); suggesting one motive for excess consumption may be the desire to escape uncomfortable states. In addition to this, environmental factors such as country of residence (Bassett Jr, Pucher, Buehler, Thompson, & Crouter, 2008) socio-economic status (Van Oers, Bongers, Van de Goor, & Garretsen, 1999) and marital status (Power, Rodgers, & Hope, 1999) can also predict elevated consumption behaviour. For this reason it is important to control for, or at least be aware of, these other indicators when conducting and discussing research regarding health behaviours involving excess-consumption.

1.5 An evolutionary perspective on consumption

Reinforcement mechanisms in the brain evolved to motivate approach behaviours specifically towards the key tasks of acquiring and consuming scarce resources necessary for survival in natural environments. A large proportion of organism behaviours are, in the view of evolutionary psychology, thought to be primarily motivated by a desire to seek resources in the environment to increase fitness and reproduction; meaning humans have evolved to approach stimuli that are *perceived* as beneficial for survival (Nesse & Berridge, 1997; Volkow & Wise, 2005). Several forms of synthetic stimuli such as drugs, alcohol, and energy dense food, convey benefit via neural reward mechanisms designed to facilitate approach to ingestible nutrients. In addition to this, social standing and connectedness convey survival benefit in terms of increased chances of reproduction and species survival through sexual selection and group inclusion (Buss & Schmitt, 1993; Erk, Spitzer, Wunderlich, Galley, & Walter, 2002; Saad, 2006). This entails that opportunities for communication, information acquisition, and acquiring material assets that increase social status are highly valued. Today, this might be reflected in increased media use, such as digital networking, and economic consumption, such as the purchasing of luxury cars,

beauty products and clothes. These products do not represent ingestible nutrients, but rather ‘assets’ that may be collected to increase one’s social standing and attractiveness to the opposite sex.

Some previous research has explored evolutionary explanations for economic consumption. For example, one fMRI study revealed increased activation of reward centres in male brains in response to images of sports cars versus basic models (Erk et al., 2002). Also, qualities such as attractiveness, competence and likeability are more often associated with images of females wearing cosmetics and high heels, when compared to images of females who were not (Etcoff, Stock, Haley, Vickery, & House, 2011; Morris, White, Morrison, & Fisher, 2013). These findings have prompted the suggestion that, to increase social standing, males may procure items that increase their perceived status and wealth, while females may benefit socially from investing in products that foster a fertile and healthy appearance (Buss & Schmitt, 1993; Etcoff et al., 2011; Morris et al., 2013; Saad, 2006).

In moderation, most of the modern products that convey fitness are either harmless or sometimes beneficial to health and well-being. For example, a small glass of wine each evening has little to no detriment to health (Ferriera & Weems, 2008) and spending money on the occasional luxury item provides enjoyment and does not ‘break the bank’ for most people. However, some humans tend to consume in excess regardless of negative consequences such as health problems and debt. This tendency is convincingly explained, in part, by evolutionary psychology. Human motivational systems evolved in a time when resources were scarce; therefore limiting consumption was not an adaptive behaviour. One example is the tendency of higher mammals to invest great energies to locate and consume salt (a scarce resource in natural environments). Although salt is not a scarce resource for modern humans, we retain a motivational heuristic towards somewhat uncontrolled consumption of this substance. In the context of modern day resource selection, humans often

apply this ‘get all you can’ behavioural heuristic. Whilst this is an adaptive strategy in natural environments where resources are scarce or unreliable, it can often be detrimental to health in modern environments where resource availability is consistently high.

This incompatibility between evolved reward mechanisms and the current environment is exacerbated by an adapted tendency for organisms to conserve resources when seeking nutrition and reproduction (Chakravarthy & Booth, 2004; Hull, 1943). According to the ‘the law of less’ (Hull, 1943), when faced with a choice between two actions that will result in equally reinforcing outcomes, an organism will tend to choose the least laborious action. Furthermore, humans are known to be ‘cognitive misers’. That is, when negotiating the complex social world, we use heuristics or shortcuts in decision making to conserve cognitive effort (Fiske & Taylor, 1991). In terms of human’s action selection, both physical *and* cognitive effort are considered (Kool McGuire, Rosen, & Botvinick, 2010). The combination of physical and cognitive energy conservation and resource seeking behavioural heuristics in humans means that activities involving the acquisition of a fitness conveying resource through little effort (see Table 1.2) are highly susceptible to over consumption.

Supernormal stimuli and asymmetric selection

Early twentieth century ornithology researchers coined the term ‘supernormal stimuli’ when they found that the newly hatched herring gull prefers to peck at a fabricated thin red rod with white bands at its tip, rather than its mother’s naturally red spotted thin beak (Tinbergen and Perdeck, 1951). When presented with a range of stimuli along the same sensory dimension, organisms tend to respond most strongly to the most positive stimulus; a phenomenon known as peak shift theory (Lynn, Cnaani, & Papaj, 2005; Hogan et al., 1975 as cited in Moreno, Lobato, Merino, & Martínez-de la Puente, 2008). Consider colour;

according to peak shift theory, an organism whose reward system has evolved to respond to particular colour will be drawn the brightest and deepest version of this colour. This preference is demonstrated by the pied flycatcher who, when given the option, chooses to nurture large, painted bright blue eggs rather than the typically pale blue versions that house their young (Tinbergen & Perdeck, 1951). The implication is that, for at least some forms of stimuli, animals and humans tend to be drawn toward stimuli that exhibit the most exaggerated reward characteristics rather than those that most closely match a given sensory template. In a natural environment, stimuli with fabricated and exaggerated reward characteristics did not exist and subsequently neither did the need for neural mechanisms to recognize and censor approach to such stimuli: a phenomenon labelled as 'selection asymmetry' (Staddon, 1975; Ward, 2013). Thus, animals retain a tendency towards uncontrolled consumption of stimuli that are interpreted as conferring fitness. Evolutionary reasoning suggests that humans too have inherited this asymmetric response to reward, making them susceptible to unhealthy consumption (Barrett, 2010).

Today, many highly consumptive experiences exist in the form of artificial consumer products that are designed to be supernormal-stimuli; that is, stimuli that elicit a reward response that is more intense than the one for which reward system was originally were evolved (Barrett, 2010). Table 1.2 outlines some examples of modern stimuli with supernormal properties. Examples include, psychoactive drugs mimic adaptive rewards by giving off a false and exaggerated sense of fitness (Nesse & Berridge, 1997) and commercial fast food products are marketed on enhanced appearance, smell, and taste characteristics that hijack reward pathways away from more natural forms of nutrients (Barrett, 2007). Consider the example of choosing between dining on a plate of fresh fruit or a rich and decadent fruit flavoured dessert. Regardless of the choice made, which might be based on health considerations, most people would find the exaggerated sweetness, texture, and high caloric

density of the dessert more appealing than the plate of fruit.

Substances and foods are the most obvious examples of modern day supernormal stimuli. However, gambling products (Rockloff, 2014), television shows (Barrett, 2010; Derrick, Gabriel, & Hugenberg, 2009), digital social networking and the Internet (Rocci, 2013; Ward, 2013), and various retail products, such expensive cars (Erk et al.,), high heeled shoes (Morris et al., 2013), cosmetics (Etcoff et al., 2011), and children's toys (Morris, Reddy, & Bunting, 1995) have also been discussed as forms of modern day supernormal stimuli. To illustrate, purchasing retail products such as high heel shoes, cosmetics, and luxurious cars may not only improve one's physical attractiveness, but also increase the perception of social status, increasing reproductive chances (Erk et al., 2002; Etcoff et al., 2011; Morris et al., 2013). The overconsumption of retail products is a serious problem for many individuals (Faber et al., 1995) often resulting in debt and relationship breakdown (O'Guinn & Faber, 1989). It is possible that this compulsive shopping is propelled, not only by an evolved appetitive disposition and an innate desire to attain social standing, but also by the appealing, super-normal characteristics of synthetic products. Similarly, the acquisition of information through observation of others has benefits to social status and survival and is therefore inherently adaptive (Kendal, Coolen, Van Bergen, & Laland, 2005; Laland, 2004). Media products such as social networking sites, the Internet, and television are all examples of supernormal versions of this information. For example, social networking sites provide exaggerated reward characteristics in terms of visual aesthetics, interesting content and immediacy, providing optimal appeal to the asymmetric responder. In addition, the consumption of large quantities of social information of perceived relevance and import, may be obtained for low effort. Activities such as watching television and browsing the Internet, offer attractive, effortless, and often more exciting alternatives to face-to-face social interaction. For example, watching television requires very little energy and presents, for the

most part, entertaining and intriguing social observations and interactions – arguably hijacking an innate disposition to gather social information in one's own social group.

Evolution and individual differences

Evolutionary theory typically described species wide behaviours and for this reason combining theories of individual differences and evolution is exposed to criticism (De Jong & Van der Steen, 1998). However, even highly species-typical behaviour varies amongst individuals (Buss, 2009). For example, much of human behaviour is driven by a species wide motivation to seek a mate to reproduce with (Buss, Haselton, Shackelford, Bleske, & Wakefield, 1998), yet 'sex drive' varies according to gender, culture, health status, and environment (Corona et al., 2013; Lippa, 2007; Petherick, 2005). As Lewis (2015) notes, certain traits can be associated with both adaptive and non-adaptive behaviour in different context. A recent movement to integrate individual differences and evolutionary psychology research provides several plausible accounts of how species wide adaptations are expressed differently within individuals (Marsh, Boag, & Hicks, 2010). Buss and Greiling (1999) present several arguments for this, including the effect of heritable genetic predispositions combined with differing environmental and developmental contexts. For example, if one is born into a culture that values modesty and reserve, obvious sexual advances are not likely to be an adaptive strategy for finding a mate. In this environment, an innate drive to reproduce might be expressed in more refined or subtle courting behaviours.

Table 1.2 *Types of consumption with examples of stimuli, and the suggested adaptive purpose they confer.*

Type of consumption	Suggested adaptive purpose conferred
Substance Alcohol Caffeine Nicotine Psychoactive drugs	nutrients and social status/sexual selection
Food Energy dense food Salty or sweet snacks Soft drinks	Nutrients
Economic Gambling General retail products Clothing & beauty products Collectables Luxury items	social status /sexual selection
Media (information) Social networking devices Television Internet Magazines Communication devices	social status/sexual selection and group inclusion
Pornography	Reproduction

1.6 The current study

In summary, numerous studies from various psychological perspectives support the idea that individuals vary in their propensity to seek reinforcement from hedonic stimuli. However, the studies reviewed have focused on specific behavioural outcomes rather than considering the common hedonic characteristics of these which could point to a broad trait reflecting a tendency for excess-consumption. Drawing on the addiction, personality, biological, and evolutionary perspectives presented here, the current research aims are to define, measure, and predict a latent construct reflecting preference and orientation towards consumption of hedonic stimuli.

Chapter 2: A framework for the research

2.1 Purpose and aims

A substantial amount of literature focusing on clinical levels of addiction exists, however, pathological disorders are experienced by only a small percentage of the population. For example, in Australia it is estimated that only 1.4 % of the population meet the criteria for problem gambling (Jackson, Wynne, Dowling, Tomnay, & Thomas, 2009) and 6.8% are considered to be alcohol dependent (Teesson, Baillie, Lynskey, Manor, & Degenhardt, 2006). The substantial proportion of the population who show milder signs of addiction or consume unhealthy products at sub-clinical levels are largely ignored in the literature. Prevalence studies conducted in several Westernized nations suggest that a sizeable proportion of this population tend to over-consume some form of unhealthy product. For example, Sussman et al., (2012) reported that at least 47% of the general population in the US experience at least some signs of an addictive disorder involving tobacco, alcohol, illicit drugs, food, gambling, the Internet, and retail products. More recently, a 2015 study on a group of healthy female subjects (N=333) reported that minor dependencies were common. Thirteen percent of participants reported smoking up to ten cigarettes per day and 20% drank alcohol on a daily basis, with 22% consuming to a risky level at some point in their lives. Almost 10% gambled approximately 44 times per year and 44.6% reported at least one symptom of a compulsive shopping disorder. Other studies suggest that excess calorie consumption and over spending are highly prevalent in general population samples. It is reported that over 35% of the population of the US is now reported to be obese (Flegal, 2012) - a key cause of which is excess calorie consumption- with only slightly lower figures reported for the Australian population (WHO, 2011). In 2007, 46% of families in the US carried credit card debt averaging at $7,300 (Bucks, 2009) and the second largest type of household credit, the credit card, accounts for a total of $49.2 billion of combined debt over

almost 15 million Australian individual card holders (Ali, McRae, & Ramsay, 2012) suggesting that many individuals spend in excess of what they can afford. Excess use of alcohol is also common in modern western society. It is estimated that 51.6% of Australia's adult population consumes over the maximum recommended daily intake of alcohol (Loxley, Catalano, & Gilmore, 2012). These statistics point to high prevalence of excess-consumption in the general population suggesting that this behaviour is not unique to pathological addiction, but rather wide-spread.

A multitude of public health issues arise from general excess-consumption; including those which are not linked to pathological disorders. For example, over eating results in obesity and preventable diseases, violence and other physical damages are associated with substance use, and mental health issues often accompany debt from over spending (Ackerman & Osborne, 2012; Bean, 2001; Browne, et al., 2015; Flegal, 2012; Jayne, Holloway, & Valentine, 2006; Poirier et al., 2006). These harmful outcomes are not restricted to the minority of individuals who have a diagnosed addiction disorder, but also affect those that have the tendency to over-indulge at sub-clinical levels. For example, it has been shown that 84% of the total harm caused by gambling has been attributed to low to moderate risk as opposed to pathological gamblers (Browne et al., 2015) and moderately overweight individuals have an elevated risk of health problems such as gallstones, hypertension, high cholesterol level, and heart disease (Field et al., 2001). The World Health Organization (WHO; 2014) suggests that low alcohol consumption carries elevated risk of death and disease. In fact, one study on a Mexican, all male, sample, found that 15% of liver cancers were caused by low risk alcohol intake. This was compared to 13% attributed to moderate risk and 12% to high risk (WHO, 2014).

In sum, a substantial proportion of the general population is likely to partake in some form of unhealthy excess-consumption that can result in harm. Research aimed at better

understanding sub-clinical levels of excess-consumption is needed. The purpose of the current program of research is to better understand the psychology behind maladaptive health behaviours that involve excess-consumption. This includes identifying the activities and products that are amenable to excess consumption as well as providing several potential explanations for consumption behaviour. As discussed in Chapter 1, insights from neurobiological research, evolutionary theory, personality trait research and addiction studies may inform these explanations and, accordingly, this research investigates excess consumption behaviour from these perspectives. Findings will not only inform future research in these fields, but may contribute to efforts to prevent and treat major public health issues, such as obesity, preventable disease, and stress related disorders resulting from excess-consumption.

The following aims are proposed to extensively investigate the issue of excess-consumption in the Australian general population, with a focus to define, measure, and predict individual differences and preferences in consumption behaviour. The following key research questions are addressed:

1) What are the types of products/stimuli that people in the general population tend to consume at excess levels?
2) Can the shared variance amongst a broad range of consumption behaviour be explained by an underlying factor?
3) Do individual differences in trait impulsivity indicate a propensity to excessively consume certain types of products?
4) How can a preference for unhealthy forms of consumption be operationalized and measured?

These objectives are addressed through a series of six studies involving cross-sectional surveys, n reaction time task, and face-to-face interviews as detailed below.

2.2 Objectives

Objective 1: Identify the types of activities and products that the general population tend to over-consume (Study 1, Chapter 3).

In this preliminary study, face-to-face interviews with undergraduate university students (N=26) were conducted to gather information about the types of stimuli that people were prone to over indulge in and identify the outcomes people associated with excess-consumption. This qualitative interview method allowed for a purely inductive preliminary exploration into the research topic without any being guided by prior assumptions. As DeVellis, 2012 suggests, this is an appropriate way to identify if a theorized construct corresponds with the actual experiences of our population of interest. The interview data yielded a list of products prone to overconsumption and their associated negative outcomes, which not only provided insight into general excess-consumption, but confirmed assumptions for which the remainder of the research was based upon.

Objective 2: Establish the existence of a latent trait explaining shared covariance in consumption behaviour (Chapter 4)

Based on the data collected in the Study 1 and a review of the addiction literature, the current study proceeded under the assumption that stimuli such as alcohol, food, retail products, gambling, and media tend to be the targets of excess-consumption in the general population both at clinical and sub-clinical levels. Archived data collected via a computer assisted telephone survey of N=2323 Australian households containing measures of these items were then analysed using confirmatory factor analytic techniques to test for the existence of a latent trait of ‘consumptiveness’ (i.e., the tendency to excessively consume multiple hedonic products).

This study provides a valuable contribution to the health behaviour literature by offering a valid way to group hedonic stimuli, promoting parsimony and providing scope for using an underlying factor to represent overall 'consumptiveness' in future research.

Objective 3: Understand how trait impulsivity is associated with the excess-consumption of various consumer products (Chapter 5).

Reward drive (RD) and rash impulsivity (RI) are uniquely associated with many of the behaviours reflected in the latent trait considered in Study 2 (Dawe, et al., 2004; Dawe & Loxton, 2004; Gullo, et al., 2014; Benson et al., 2011; Fuentes, et al., 2006; Loxton, et al., 2008). It was therefore expected that the two aspects of impulsivity would uniquely predict an even broader range of consumption behaviours. To test this prediction, a wider range of 23 consumption behaviours (covering gambling, substance use, foods, entertainment, shopping, internet, and various other media use) were measured in a large general population online panel (N= 5392) via an online survey. RD and RI were then included in a series of regression models to assess their differential and unique associations with each behaviour. This study contributes to the growing body of research regarding the two-factor model of impulsivity by providing further examples of the types of behaviours it predicts as well as further defining the unique aspects of RD and RI. Furthermore, considering the neural underpinnings of the two- factor model of impulsivity, findings from this study can also provide insight into the areas of the brain that are likely to be most affected or stimulated by the consumption of different products.

Objective 4: Develop a scale to measure orientation towards supernormal stimuli (Chapter 6)

Thus far, the current research has applied a personality perspective in explaining consumption behaviour. Considering that many of the modern consumer products - that have been the focus of the study thus far - exhibit characteristics of supernormal stimuli, it was deemed that an evolutionary perspective might also be useful in understanding excess-consumption. Omenn (2010) highlights the importance of considering practical applications of evolutionary based behaviour in modern public health studies due their effects on preventable disease. By considering this point of view we adopt a gene-environment interactionist's perspective on health behaviour whereby both the interaction of nature (i.e., disposition inherited through genetic endowment) and nurture (i.e., the environment in which we live) are considered as potential causes of excess consumption.

This study uses exploratory factor analytic techniques to validate and measure a construct of supernormal preference, using the same online panel described in objective 3 For this, an existing anticipated pleasure scale is modified to include items reflecting pleasure derived from natural experiences as well as pleasure derived from supernormal products, using interview data from Chapter 3. This allows derivation of a *preference* for supernormal pleasure as the difference between these two subscale scores. Although commonly discussed, to date little research has assessed consumption behaviour from an evolutionary perspective or empirically investigated the construct of supernormal stimuli. This study provides some of the first empirical evidence demonstrating the role of evolutionary adaption in modern day consumption behaviour. This advances our understanding of consumer and health psychology by application of ideas from evolutionary psychology.

Objective 5: Use implicit measures to validate the construct and measure of supernormal preference (Chapter 7)

Self-report measures, although common in psychology literature, are often confounded by a social bias where individuals attempt to respond all statements in a socially desirable manner (Johnson, Fendich, & Mackesy-Amiti, 2012; Van de Mortel, 2008). Unfortunately, health behaviour measurements are particularly subject to this as people often feel that unhealthy habits are socially disapproved of (Adams et al., 2005; Hebert, Clemow, Pbert, Ockene, & Ockene, 1995; Klesges et al., 2004). In order to provide further validation for the construct (and the associated measure) of supernormal preference it was important to assess whether it reflected implicit as well as explicit attitudes.

The Implicit Association Task (IAT) is a widely used picture and word sorting task that measures implicit preferences and associations that may be otherwise socially undesirable to report (Greenwald, McGhee, & Schwartz, 1998). The IAT provides a measure relative strength of associations between concepts; in some cases, pictures of one category of stimuli and positive adjectives (e.g., joyful, lovely, superb), and pictures of another category of stimuli and negative adjectives (e.g., painful, awful, nasty). The IAT has recently been successfully applied in various studies regarding attitudes toward health behaviours and statuses such as obesity (Schwartz, Chambliss, Brownell, Blair, & Billington, 2003; Teachman & Brownell, 2001), smoking, and dietary choices.(Swanson, Swanson, & Greenwald, 2001)

In this study an Implicit Attitudes Task (IAT) was conducted online to a new panel (N=1024) to measure implicit positive or negative associations with both natural and supernormal stimuli. This component to the research provides validation for the construct of supernormal preference, thereby further supporting an evolutionary perspective on reward choice. Furthermore, it demonstrates the effectiveness of the IAT application in measuring

individual's implicit attitudes various rewards types and consumer products. This is a useful methodological demonstration for future for consumer, health, and psychology research.

Objective 6: Understand how trait impulsivity is associated with supernormal preference and the consumption of hedonic consumer products (Chapter 8)

The two-factor model of impulsivity has been linked to excess consumption of a range of rewarding products or activities that exhibit supernormal characteristics, both here in the research and in previous studies (Dawe, et al., 2004; Dawe & Loxton, 2004; Gullo et al., 2014). RD and RI have not, however, been assessed in terms of predicting a general preference for certain types of reward. This final study investigates whether RD and RI uniquely predict preference towards supernormal stimuli, using data collected form the online panel described in objective 3 and 4.

This investigation contributes to an emerging stream of research whereby individual personality traits are considered in terms of their evolutionary adaptiveness (Marsh et al., 2010). The results from this study provide insightful explanations for individual differences in what is typically discussed as 'species wide'. Also, considering the neural underpinnings of the two-factor model of impulsivity, findings from this study support our understanding of the brain activity that is likely to be involved in the wanting or craving of a particular class of reward.

Conclusion

In sum, this research addresses a common behavioural problem that is somewhat neglected in research to date. Many people consume an excess amount of unhealthy stimuli despite negative and sometimes harmful consequences. The majority of research into health

behaviours and addiction tends to consider environmental and mood/mental states that contribute to maladaptive behaviour. This thesis explores excess consumption primarily from an evolutionary/neurobiological perspective. This standpoint is a less commonly taken, but equally valid approach to empirically investigating consumption behaviour (Saad, 2013). This work provides valuable insight into health behaviour, informing several disciplines including psychology and behavioural science as well as evolutionary and consumer research. The following seven chapters are comprised of one unpublished report describing a preliminary study, and five manuscripts (4 published, 1 under review) that describe each of the research objective in order. These are followed by a post hoc SEM analysis that summarizes and models key results, while testing the direct effects of RD, RI, and supernormal preference on a latent behavioural trait of excess consumption

Chapter 3: What products tend to be over-consumed? A preliminary interview study

3.1 Background and aims

Various hedonic products are amenable to pathological levels of use including alcohol and other substances (Bush, et al.,, 1998), gambling products (Rockloff, 2012), food (Moreno, et al., 2008), retail products (Faber, et al., 1995), video games (Pentz, et al., 2011), mobile phone applications (Bianchi & Phillips, 2005), and social networking sites (Kuss & Griffiths, 2011). From this, and through general observation, one might assume that these stimuli are also those which tend to be over-consumed at non-pathological levels in the general population, however, to date this has not been investigated in a systematic manner. This preliminary study aims to ratify this assumption using a structured interview technique to compile a comprehensive list of products and/or activities that people feel they *have* or *do* too much of, despite negative consequences. Findings inform subsequent stages of the research program that aim to empirically investigate comorbidity amongst various forms of excess-consumption. In addition to this, a deeper understanding of the emotional and lifestyle impacts of excess-consumption provides rationale for the importance of research that investigates non-pathological levels of excess consumption in the general population.

3.2 Method[1]

3.2.1 Participants

A convenience sample of 26 healthy first-year psychology students (M_{age} = 23.96, *SD* = 8.67) were recruited from the Griffith University Subject Pool. Only participants in good physical and mental health were invited to take part in the study, precluding those with

[1] Parts of this study are briefly described in Chapter 6 as findings were used to justify the selection of scale items for the SNPS.

diagnosed addiction disorders. The majority of the participants were female (n= 22), likely due the higher proportion of female students enrolled in undergraduate psychology courses (Mulhern & Wylie, 2004; Nerdrum, Rustoen, & Ronnestad, 2006). Students received course credit for participation.

3.2.2 Script and procedure

Each participant was interviewed individually in a private area for approximately 30 minutes. An anonymous list of age and gender demographics was collected to summarize sample characteristics. A structured interview script was developed for the study. Using a variety of different phrasings, participants were asked to list products or activities that they felt that had or did too much of. Questions were framed to encourage participants to only list items that they enjoyed or that uplifted them in some way, but where excess-consumption was deemed to have negative outcomes. This steered the focus away from activities such as work, exercise, or household chores that, although many people would like to do less of, are essential to living and generally do not involve consumption. For a full script see Appendix 1. Key questions included the following and a series of prompt questions were administered to assist the participant in coming up with more items:

"So, let's talk about things you enjoy in your life. What sort of things do you enjoy? Would you say you sometimes had too much / did that too much?"

or

"What kinds of things make you feel relaxed? What activities do you find satisfying? Do you find it hard to cut-down on X? / Is it something you'd prefer to do less of?"

Participants were then asked to list products or activities that they felt their friends and family did or had too much of. The purpose of this question was two-fold; 1) It enabled us to capture

items that some participants might have been reluctant to expose regarding themselves, and 2) It provided examples of excess consumption in a larger demographic than that of young female psychology students.

Participants were then asked to describe the emotions they experienced after they had or did too much of each item on their list; e.g., *"What emotions did you experience after having/doing too much of (insert item)?"* As a guide, participants were given a list of 20 positive and negative emotions associated with consumer experiences (Richins, 1997). Note that participants were informed that they did not have to choose from the list and to provide up to three responses for each item. To assess negative impacts, participants were asked, *"What are some of the consequences of having/doing too much of (insert item). For example, does it impact your health, money, or time"?* Although the question was intended to elicit an open ended response, participants tended to just mention impacts provided as examples in the question.

The interviewer listed each item as it was mentioned during the interview using a pen and paper and later transferred data to a spreadsheet in Windows excel, securely disposing of written notes. The data collection period spanned 14 days and ceased when data saturation had been reached (i.e., approximately five interviews yielded no new data). At this point, there was enough information to replicate the study, and the inability to obtain additional new information was reached (Fusch & Ness, 2015).

3.2.3 Analysis

Interview data consisted of a list of items (activities and products) and associated emotions and impacts reported by each participant, as well as a list of items that each participant mentioned regarding a friend or family member. A list of 187 behavioural item responses were collapsed into 34 categories using a structural coding system whereby codes

are associated with general analytic themes in the data (Namey, Guest, Thairu, & Johnson, 2008). For example, watching DVD, movies, and TV series were categorized as 'TV' and make up, nail polish and hair conditioners were categorized 'beauty products'. Descriptive statistics are presented to identify the most commonly reported items. All coding was performed by the author and reviewed by the primary and first co-supervisor. Discrepancies were discussed until agreement was reached.

3.3 Results

Each participant listed between 3 and 16 items[2] that they had or did too much of (*M*=7.65, *SD*=3.61). As shown in Table 3.1, the most commonly self-reported items were beauty products and clothing (n = 14, 54%), alcohol (n=12, 46%), take away meals (n=11, 42%), caffeinated drinks, social networking, television, and sweet snacks (all n=10, 38%). The most commonly items reported regarding other people's consumption included drugs and alcohol (both n=14, 54%), beauty products and clothing, and cigarettes (both n=6, 23%). Table 3.2 lists all of the emotional reactions and negative impacts that participants associated with the most commonly mentioned items. From this, it can be seen that regret, guilt, shame, and annoyance were among the most commonly reported emotional reactions. Negative impacts of loss of time and money were reported by at least one person for 8 of 115 items and decrement to health was reported for 11 items. Several unexpected activities, although less common, were listed by some participants, such as relaxing and exercise (both n=4, 15%). Negative impacts from excess of these activities were all related to loss of time which tended to elicit emotional reactions similar to those listed for other items (e.g., regret, annoyance, shame, and unfulfilment)

[2] Calculated before categorisation

Table 3.1 *Number of participants mentioning each category (n=34) product or activity (self-report and report of others).*

Item	Self (n=26)	Other^
Beauty products and clothing	14	6
Alcohol	12	14
Take away meals	11	3
Caffeinated drinks	10	1
Social networking	10	2
TV	10	5
Sweet snacks	10	2
Social Outings	9	4
Savoury Snacks	7	4
General social activity	7	2
Drugs	6	14
Entertainment products	6	3
General food	6	1
Internet	6	3
Technology use	6	2
Dating & sex	5	5
Exercise	4	7
General spending of money	4	3
Relaxing	4	2
Beauty procedures	3	0
Home wares	3	1
Planning	3	0
Restaurant food	3	0
Cigarettes	2	6
Healthy food	2	1
Listening to music	2	1
Reading	2	0
Video Gaming	2	5
Gambling	1	2
Petrol	1	0
Buying technology products	1	3
Cleaning	0	1
Collecting pets	0	1
Pornography	0	1

^ Participant mentioned this item in regards to one or more other people in their lives.

Table 3.2 *Self-reported emotional reactions and negative impacts associated with the most commonly reported products and activities.*

Item[^]	**Emotional Reactions**	**Impacts**
Alcohol	regret, guilt, shame, embarrassment, neutrality, worry, misery, annoyance	time, health, money, relationships, study
Beauty products and clothing	regret, guilt, shame, annoyance, disappointment, contentment, happiness	money, health
Caffeinated Drinks	regret, shame, neutrality, tension, high-energy, fear, satisfaction	sleep, health, money
Drugs	regret, guilt, neutrality, frustration, annoyance, anger	health, time
Entertainment Products	regret, fulfilment, frustration, guilt, annoyance, happiness	money, space, intelligence
General Food	shame, fulfilment, unfulfilment, annoyance, guilt	health, time, money, body image
Internet	fulfilment, regret, irritation, guilt, contentment	Time
Social outings	anger, unfulfilment, frustration, embarrassment, guilt, neutrality, misery, shame, regret, humiliation	health, money, time, study
Savory snacks	guilt, annoyance, irritation, regret, unhappiness, shame, disgust, disappointment	health, work
Social Networking	loneliness, misery, homesickness, fulfilment, guilt, annoyance, panic	time, health, relationships, study
General social activity	homesickness, frustration, irritation, guilt, confusion, jealousy, contentment, nervousness, discontentment, stress, anxiety	time, health, study
Sweet snacks	regret, shame, depression, neutrality, guilt, worry, loneliness, homesickness, irritation, unfulfilment, annoyance	health, weight, money, mood
Take away food	embarrassment, regret, guilt, worry, shame, neutrality, anger	health, money
Technology use	loneliness, homesickness, fulfilment, happiness	money, space, time
TV	anger, unfulfilment, anxiety, guilt, worry, nervousness, tension, fulfilment, annoyance, regret	time, study, sleep

[^]Only behavioural items mentioned by more than 5 participants listed in this table

3.4 Discussion

The aim of the current study was to identify a range of products and activities that people commonly feel they tend to have or do too much of in the face of negative consequences. Findings from this structured interview study suggest that commonly over

consumed items include retail products, drugs, alcohol, take away meals, caffeinated drinks, social networking, television, and savoury sweet snacks. As expected, many of these items tend to be those which are amenable to pathological levels of addiction or disorder (e.g., drugs, alcohol, shopping, media use, and foods). This result is consistent with neurological research and a behaviourist perspective on reinforcement in that such products (i.e., those with hedonic properties) tend to elicit stimulation in dopaminergic pathways in the brain, thereby reinforcing and encouraging continued consumption (Bergh, et al., 1997; Blum et al., 1996; Boileau et al., 2003; Bocher et al., 2001; Erk et al., 2002; Han et al., 2007; Kim et al., 2011; Koepp et al., 1998; Small, et al., 2001; Yamato et al., 2002). Several activities without the same immediately rewarding characteristics were also mentioned; such as cleaning, relaxing, and exercise; however, they were reported far less and tended to be associated more with a loss of time than negative impacts on health or finances. Cases of disordered (i.e., excess) exercise and sleep are reported in the literature (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Peluso & de Andrade, 2005); the causes of which tend to be attributed to low mood states (Thase, 1998) or distorted body image (Peluso & de Andrade, 2005) rather than dopaminergic reward.

Each participant mentioned at least 3 products or activities that they felt they personally did or had too much of, confirming the commonly held belief that excess-consumption is an issue, to some extent, for most people. Negative emotional reactions to excess-consumption as well as negative impacts on time, health and money were also reported by almost every person interviewed. It is acknowledged that this finding is directly affected by the fact that doing or having *too much* of something has intrinsic negative connotations. Nonetheless, responses provide insight into the types of harms experienced, for example most experiences of excess-consumption were associated with feelings of guilt, shame or regret and anger or annoyance at one’s self. These responses reflect a strong theme

of repentance surrounding excess consumption experiences, whereby people tend to internally berate themselves for over indulging in ‘guilty pleasures.’ Furthermore, every product or experience listed was associated with at least one form of negative impact on a participant’s life, be it their time, health, or finances.

Limitations

Study findings were clearly biased by the narrow demographic characteristics of the sample. For example, the frequency of beauty products and clothes shopping is likely to be reflecting societal norms relating to typically female favoured products. However, one could interpret or relabel this class of items as general retail consumption which might apply more broadly across genders. This limitation was also somewhat overcome by asking participants about the excess consumption of family and friends; which would likely include a range of people of varying genders and ages. It must, however, be cautioned that excess consumption in this study is largely defined based on the perspective of young (largely) female undergraduate students and although the list of items identified (for which this study was primarily conducted) can generalized to the wider community, the amount frequency of mentions are less generalizable The study was also somewhat limited by the provision of emotional reactions to participants. This process was intended to provide examples, but tended to prime participants to exclusive rely on these responses. Nonetheless, we were able to attain, without bias, the valence of the emotional response (i.e., negative versus positive emotion). The sample and procedure was sufficient for the purposes of the current study – which was to simply identify a list of items amenable to excess consumption causing negative consequence However, future research might endeavour to conduct a similar study with a more representative sample and less prompting in order to attain generalizable statistics.

Current study findings support the notions that 1) excess consumption of hedonic stimuli is frequent amongst healthy individuals, and 2) harm can be accrued from lower sub-clinical levels of consumption. This provides strong rationale for the importance of investigation into excess consumption in the general population for the current and future research.

Chapter 4: Do gamblers eat more salt? Testing a latent trait model of covariance in consumption. [published manuscript]

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4.1 Abstract

A diverse class of stimuli; including certain foods, substances, media, and economic behaviours; may be described as 'reward-oriented' in that they provide immediate reinforcement with little initial investment. Neurophysiological and personality concepts, including dopaminergic dysfunction, reward sensitivity and rash impulsivity, each predict the existence of a latent behavioural trait that leads to increased consumption of all stimuli in this class. Whilst bivariate relationships (comorbidities) are often reported in the literature, to our knowledge, a multivariate investigation of this possible trait has not been done. We surveyed 1,194 participants (550 Male) on their typical weekly consumption of 11 types of reward-oriented stimuli; including fast food, salt, caffeine, television, gambling products, and illicit drugs. Confirmatory factor analysis was used to compare models in a 3x3 structure; based on the definition of a single latent factor (none, fixed loadings, or estimated loadings), and assumed residual covariance structure (none, a-priori / literature based, or post-hoc / data-driven). The inclusion of a single latent behavioural 'consumption' factor significantly improved model fit in all cases. Also confirming theoretical predictions, estimated factor loadings on reward-oriented indicators were uniformly positive, regardless of assumptions regarding residual co-variances. Additionally, the latent trait was found to be negatively correlated with the non-reward-oriented indicators of fruit and vegetable consumption. The findings support the notion of a single behavioural trait leading to increased consumption of reward-oriented stimuli across multiple modalities. We discuss implications regarding the concentration of negative lifestyle-related health behaviours.

4.2 Introduction

Overconsumption, whether economic, dietary, or substance-oriented, is a pressing issue in modern societies, presenting numerous health and social challenges. Psychoactive

substances, energy dense food, and certain media products, tend to provide immediate reward and reinforcement making them amenable to excess use in some individuals. Comorbidities amongst various forms of over-consumption are reported consistently in the literature. Greenburg et al., 1999 report moderate positive co-variance amongst alcohol, television viewing, gambling, Internet use, smoking, caffeine, and chocolate intake. In this study, college students (n = 129) responded to Rozin and Stoess's (1993) four-pronged addiction scale measuring cravings, withdrawal symptoms, lack of control and tolerance. Greenberg's et al., (1999) findings suggested variance in individual vulnerability towards more than one addictive activity or substance. More recently, positive relationships have been found between, smoking, alcohol and drug use (Bachman, et al., 2013), smoking and caffeine (Penolazzi et al., 2012), drug use and gambling (Petry, 2001), and television and snacking (Gore, et al., 2003). These comorbidity studies are primarily based on addiction scales rather than measures of frequency of consumption. The latter of which may detect mild to moderate forms of excess consumption which are more common in the general population, yet still harmful to health (Sussman et al., 2010). To date, bivariate relationships have been the main focus of these studies; however, it has been suggested that comorbidities amongst this broad class of hedonic experiences may reflect an underlying compulsive consumption or addictive personality trait (Faber et al.,, 1995; Villella et al., 2011; Weed, et al.,, 1992; Zeinali & Vahdat, 2011). Based on this view, it is reasonable to suggest that a latent behavioural trait does exist, whereby some individuals exhibit tendencies towards high levels of consumption of reward-oriented stimuli across multiple modalities.

One plausible argument for this notion is grounded in neurophysiological evidence. Over-consumed resources tend to be artificial products (e.g. confectionary) designed to stimulate reward pathways originally intended for natural stimuli (e.g., a piece of fruit) (Barrett, 2010). Alcohol, psychoactive drugs, gambling products, energy dense food (Bergh

et al., 1997; Blum et al., 1996; Small et al., 2001) caffeine (Yamato et al., 2002) and Internet use (Han et al., 2007; Kim et al., 2011) directly stimulate dopaminergic centres in the limbic system that have evolved to reinforce behaviour towards obtaining and ingesting high value environmental resources (Hantula, 2003). Reward Deficiency Syndrome (RDS) refers to a genetic condition in which individuals develop abnormally low numbers of dopamine receptors. Individuals with RDS tend to need more hedonic stimuli to activate dopamine release in order to experience reward (Blum, Cull, Braverman, & Comings, 1996a). Drug and alcohol abuse (Blum et al., 1996), Internet addiction (Kim et al., 2011), over-eating (Johnson & Kenny, 2010; Wang et al., 2004), and problem gambling (Bergh et al., 1997) are more likely to be exhibited by individuals with RDS. A general disposition towards excess consumption of all forms of reward-oriented stimuli would be consistent with the predictions of the RDS literature.

Personality theory, although operating on a different level of description than neurophysiological research, would also predict the existence of a latent behavioural trait that is reflected in positive co-variance amongst a broad range of hedonic consumption experiences. Traits such as impulsivity, and sensation seeking are associated with drug and alcohol abuse (Chen et al., 2007; Dawe et al., 2004; Donohew et al., 1999; Gullo et al., 2011), excess television viewing (McIlwraith, 1998), problem gambling (Benson et al., 2011; Breen & Zuckeman, 1999; Fuentes et al., 2006), and over-eating, (Kane et al., 2004; Pentz et al.,, 2011). Some findings suggest that personality traits may predict co-variation in consumption behaviour. For example, rash impulsivity has been found to explain a significant amount of covariance observed between binge eating and alcohol abuse (Kane et al., 2004) and sensation seeking was found to explained some of the covariance observed between alcohol use, caffeine intake, and smoking (Evans et al., 2006). Interestingly, the latter study was

conducted on a dopamine deficient sample, highlighting the way in which neurological and personality factors may combine to predict consumption behaviour.

Somewhat surprisingly, although it is predicted by several theoretical perspectives, the existence of a behavioural trait marked by greater consumption of reward-oriented stimuli has not yet been tested, using a latent factor approach. If a reward-oriented trait is found to exist in a naturalistic (i.e. 'everyday') behavioural sense, this would have practical health implications for the identification and treatment of individuals who may possess a pattern of consumption behaviour that is detrimental to health.

4.3 Aims and hypotheses

The current investigation aimed to test a prediction common to major theories of individual differences in reward-oriented behaviours, namely, whether or not behavioural self-report data supports the existence of a single dimensional trait characterised by increased levels of consumption of a broad class of stimuli. Importantly, we included hedonic stimuli spanning several modalities of consumption: substances, foods, and entertainment. Neurological and personality theories imply three common, and hitherto untested, hypotheses:

H1: Models of the covariance in reward-oriented consumption incorporating a one-dimensional latent (trait) factor would fit significantly better than models without a latent factor.

H2: For latent factor models with freely estimated factor loadings, all loadings of behavioural indicators on the latent factor would be positive.

H3: Consumption of *non*-reward-oriented substances should be neutrally or negatively correlated with the latent factor.

Testing these predictions requires some care, as covariance between particular indicator pairs (e.g. smoking and alcohol) may be expected to exhibit extra bivariate covariance over and above that inferred by the trait. Furthermore, it is not clear whether or not behaviours classified as reward-oriented might vary in terms of indicating the trait; a distinction that may be captured by comparing models in which factor loadings were either fixed or freely estimated. We therefore take a cautious approach, evaluating the hypotheses repeatedly in the context of three bivariate covariance assumption scenarios – detailed below, and with respect to either fixed or freely estimated factor loadings.

4.4 Methods

4.4.1 Participants

Two thousand, three hundred and twenty three households were contacted via a computer-assisted phone survey technique, and the final sample comprised 1,194 adult respondents who completed the whole survey. This represents a response rate of 52%, which is considered high for this form of participant contact (Curtin, Presser & Singer, 2005). The mean age of respondents was 45 years (*SD* = 11.2), and a slightly higher proportion of females (54%) than males were interviewed. The majority of participants were born in Australia (90%), were married or in a de facto relationship (77%), and in some form of full-time paid employment (70%). Approximately half (49%) lived in a household comprising of a couple with children living in the home.

4.4.2 Measures

Gambling: Respondents completed the *Consumption Screen for Problem Gambling (CSPG)*, which is designed to measure the consumption of gambling products in a manner analogous to the AUDIT-C. Three items measure frequency and duration of gambling activities, with one item measuring time spent gambling during a typical day. The CSPG has been shown to

have high predictive validity (100% sensitivity, 92.7% specificity) when compared with the established *Problem Gambling Severity Index* (Rockloff, 2011). The CSPG often yields highly skewed results when measured among general population samples due to a relatively small percentage of the population who use casino-style gambling products frequently. Therefore, the aggregated variable was categorised as (0 = No Gambling Activity, 1-3 = Some Gambling Activity, & 4+ = High Gambling Activity).

Media Consumption: Television and Internet use were both measured via four questions directly assessing time spent per both working and non-working day on each activity, e.g., "*On a typical work day/non-work day, how much time do you spend watching television (hrs/mins)?"* Social networking was measured using a single item, *"During the past 12 months how often have you used online (Internet) based social networking sites such as Facebook, MySpace, Flickr, Twitter"*, scored on a Likert scale ranging from 0 = *Never* to 5 = *Everyday*. Internet use and social networking were moderately correlated ($r = .33$, $p < .001$). Since Internet use reflects emailing and web-surfing activities and social networking also represents time spent online, the variables were standardised and summed for subsequent analyses. All five media items were negatively skewed, therefore each variable was log transformed and standardized prior to aggregation.

Dietary and substance consumption

Caffeine: A short measure of caffeine consumption from all sources (including coffee, tea, and energy drinks) was developed, as a suitable existing scale could not be identified. The items followed the protocol described previously: (a) "*In an average week, how many days in*

a week would you drink tea or coffee?" (b) "*How much would you drink on a typical day?*" Answers were standardised and summed to create a total *caffeine* variable.

Salt: A two-item scale was also developed to measure salt intake. The questions were, "*How often do you add salt to your food before or during cooking or preparation?*", and "*How often do you add salt to your food after it is cooked or prepared?*" Both items were scored on a four-point scale with responses: Never, Rarely, Sometimes, and Usually, and were summed to create a total *salt* variable.

Smoking. Participants were asked "*Approximately how many cigarettes do you smoke per day?*". The variable was highly skewed and therefore converted to an ordinal variable (0 = Non-Smoker, 1-10 = Low, 11-20 = Moderate, 21+ = High)

Drugs. Illicit drug use was measured by asking, "*Have you used any illicit drugs in the past 12 months? This includes drugs such as cannabis, ecstasy, amphetamines, etc.*", which had the responses: No, Once a month or less, or more than once a month.

Snacks. Participants were asked *"On average, how many times a week do you eat chocolate, lollies or other sweets*" and "*On average, how many times a week do you eat snacks such as chips, crackers or nuts?"* Responses were coded (0 = never, 1=less than once, 2= once, 3 = twice, 4 = three to six times, 5 =over seven times) and both items summed.

Fast Food: Participants were asked *"In an average week, how many times do you purchase foods for a meal or snack from fast food outlets such as KFC, MacDonald's, Hungry Jacks, Red Rooster?"* and *"In an average week, how many times do you purchase foods for a meal or snack from other food outlets such as Subway, pizza, bakery, service station, food or pie van, noodle bar, Chinese food, etc?"* Responses were coded (0 = never, 1 = less than once, 2 = once, 3 = twice, 4 = over three times) and both items summed.

Meat products: Participants were asked *"On average, how many times per week do you eat red meat?"* and *"On average, how many times per week do you eat meat products (such as such as sausages, frankfurter, Devon, fritz, salami, meat pies, bacon or ham)?"* (0 = never, 1=less than once, 2= once, 3 = twice, 4 = thrice, 5 = four times, 6 = over five times) and both items summed.

Fruit and Vegetables. Participants were asked *"How many serves of vegetables do you eat on a usual day?"* and *"How many serves of fruit do you eat on a usual day?"*

Alcohol: The present survey incorporated the *Alcohol Use Disorders Identification Test – Consumption subscale* (AUDIT-C; Bush et al., 1998), a shortened three-item version of the AUDIT that only includes consumption-oriented questions. Two of the three items of the AUDIT-C measure frequency of drinking behaviour, and one item assesses quantity consumed during a typical day when drinking. The AUDIT-C is a widely employed tool for research and diagnostic purposes (Dawson, Smith, Saha, Rubinsky, & Grant, 2012).

Ethics

The study received Human Research Ethics Committee approval and participants provided verbal informed consent preceding the phone survey.

4.4.3 Statistical analysis

We used model comparison methods within a confirmatory factor analysis (CFA) framework to test each of the hypotheses. The primary aim was to test whether or not the introduction of a single latent factor is justified by the multivariate consumption data. CFA is commonly used to test the validity of a single factor model, and compare the ability of two

different models to account for the same set of data (Wegener & Fabrigar, 2008). It provides a framework for testing our hypotheses by comparing models with and without the latent factor. Our analysis was based on recommended practice for employing CFA, that is, to compare a set of alternative models (determined prior to analysis) to decide on which model should be preferred (Schreiber, Nora, Stage, Barlow, & King, 2006). We describe below a 3x3 structured set of models for comparison. However, it should be borne in mind that our key comparison is simply that of a model with and without a latent factor, done with different assumptions for additional direct correlations between measures. Chi square difference tests were employed to compare models, along with RMSEA, AIC and BIC statistics. Models were adjusted independently in two respects: (1) the pattern of bivariate correlations (3 levels), and (2) the inclusion of a latent factor (3 levels), leading to a structured comparison of 9 models in total. The rationale for specifying this structured set of 9 models is described in detail below.

The models corresponding to the null hypothesis included no latent factor. In these three models, any correlations between measures were allowed only using direct correlations, either derived from the literature, or determined post-hoc from the data. The first alternate model form considered was one in which all behavioural indicators were fixed to have an equal loading on the latent factor (tau equivalence). In this case, all behaviours assumed to be equally reliable indicators of the hypothesised trait. The second alternative model allowed the loadings of each indicator to be freely estimated from the data, as per exploratory factor analysis. Thus, in these three models, measures were assumed to vary to the degree to which they were related to the hypothesised latent trait. In all, three forms of latent factor specification were considered: *none*, *fixed*, and *free*.

The specification of additional bivariate correlations between indicators affects the fitting of the latent factor. A somewhat naïve approach is to compare each of the latent factor models in the context of no additional correlations between indicators. This would assume that all covariance between indicators is due to the latent trait. However, it is more realistic to assume that there is extra correlation between certain indicators above and beyond that explained by a reward-oriented trait. One approach to allowing additional correlations between variables is *a-priori*, by a systematic scan of reported correlations in the literature. For example, based on previous research, alcohol, gambling, and nicotine would be expected to display additional positive covariance due to reports of their common social and environment associations (e.g., having a cigarette whilst drinking or gambling; Bobo & Husten, 2000; Lal & Siahpush, 2008). A final alternative is to specify extra bivariate correlations in a *post-hoc* manner based on statistical modification criteria on the data at hand. The bivariate correlations included as a result of the literature search and via modification criteria are provided in Appendix 2 (see Appendix Table 2.2). Thus, the latent factor hypothesis was considered in the context of three patterns of direct bivariate correlations: *none*, *a-priori*, and *post-hoc*.

All analyses were conducted in the statistical programming environment R (R Development Core Team, 2010). Distributions were inspected for outliers, missing data, normality, and spread. No outliers were identified and missing data was replaced using a single imputation method. Continuous variables, were approximately normally distributed. The recoded and transformed measures comprised a mixture of continuous, ordinal, and binary variables. Accordingly, a heterogeneous correlation matrix was computed using the *polycor* package, consisting of Pearson product-moment correlations between numeric variables, polyserial correlations between numeric and ordinal variables, and polychoric correlations between ordinal variables (Drasgow, 1986). The resulting correlation matrix was

positive-definite, and initial screening supported further analysis: the KMO measure of sampling adequacy was .645 and Bartlett's Test of Sphericity was significant, χ^2 (78) = 807.*6*, $p < .001$.

4.5 Results

4.5.1 Descriptives

Table 4.1 displays descriptive statistics using untransformed data. Results of a series of non-parametric gender and age comparisons indicated that males reported significantly higher levels of alcohol, salt, fast food and meat intake, and television viewing when compared to females. Female respondents reported higher levels of snacking and social networking. Participants under 46 years of age reported higher fast food, meat, snack, and alcohol intake along with more Internet, social network and television use, while those 46 and above reported higher caffeine intake. Smokers made up 18.5% of the sample and 4.9% of participants reported using illicit drugs in the past 12 months. Smoking did not vary by age (χ^2 (1) = .132, p = .136) or gender (χ^2 (1) = .335, p = .551). Males (χ^2 (1) = .12.772, $p < .001$) and younger participants (χ^2 (1) = 22.858, $p < .001$) reported higher levels of drug use.

4.5.2 Main analysis

Table 4.2 compares fit statistics for the three models tested (None, A-priori and Post Hoc). In all three cases chi-square difference tests show that models including a latent factor were a significantly better fit to the data when compared to models specifying correlations alone. All additional fit statistics presented in Table 4.2, including; BIC, AIC, GFI, RMSEA, and SRMR, confirm this finding. Item loadings on the latent factor (when free to vary) were

all positive[3] (see Table 4.3), indicating that the latent factor positively predicts alcohol, drug, cigarette, fast food, snack, television, Internet, gambling product, caffeine, salt and meat consumption. In addition, Pearson Product-moment correlations show that fruit and vegetable intake is negatively associated with the latent factor in each case.

Chi-square difference tests revealed that models in which the loadings were free to vary were a significantly better fit to the data when compared to models where loadings were fixed (see Table 4.2). Improvements were relatively minimal in each case considering the reduction in degrees of freedom between fixed and free models (None $\chi^2(10) = 120.10$, $p < .001$; A-Priori $\chi^2(10) = 61.97$, $p < .001$; and Post Hoc $\chi^2(10) = 80.70$, $p < .001$). *Figure 4.1* provides visual representation to further illustrate this. RMSEA values reflect the degree of misfit in the proposed model with values less than .05 considered a close fit (Browne & Cudeck, 1992). Confidence intervals suggest that in the None and A-Priori scenarios, allowing loadings to vary on the latent factor did not significantly improve model fit, and in the Post hoc scenario the improvement was marginal.

4.5.3 Gender and age differences

Parameter estimates for the first model were assessed separately by gender and age (see in the Appendix Table 2.1). In all cases, factor loadings were uniformly positive and of similar magnitude, with only some exceptions. Drugs contributed more weight in the young sample ($b = .416$) when compared to the older sample ($b = .062$) and for males, drugs ($b = .317$) and meat ($b = .291$) contributed substantially more to the latent factor and Internet ($b = .151$), and TV ($b = .055$), considerably less when compared to females ($b = .180$, $b = .097$, $b = .328$, $b = .249$), respectively.

[3] Smoking alone did not load significantly on the latent factor in the A-priori model.

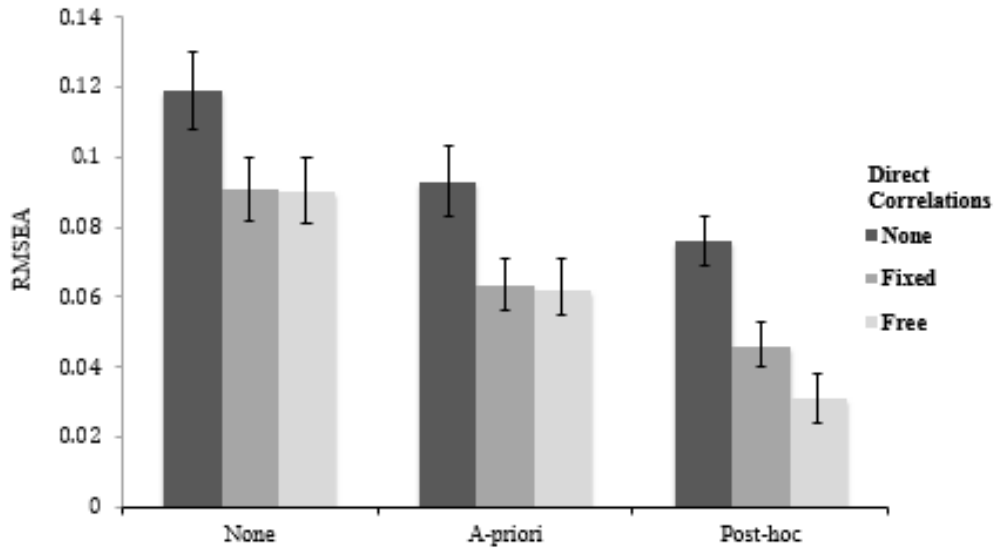

Figure 4.1 RMSEA (and 95% CIs) plotted for visual demonstration of differences in model fit.

Table 4.1 *Range, mean and standard deviation values for each numeric behavioural variable: Total and by gender and age (with non-parametric median comparisons).*

		Total		Male (1)		Female (2)				Under 46		46 & over			
	Range	Mean	SD	Mean	SD	Mean	SD	*Z*		Mean	SD	Mean	SD	Z	
Salt	0 - 8	2.51	1.96	2.69	2.01	2.36	1.91	-2.79	**	2.47	1.95	2.56	1.97	-0.81	
Fast Food	0 - 8	2.44	1.68	2.70	1.81	2.22	1.53	-4.39	***	2.92	1.72	2.02	1.51	-9.68	***
Meat Products	0 - 11	5.84	2.44	6.48	2.36	5.28	2.37	-8.25	***	6.07	2.40	5.63	2.45	-3.22	**
Caffeine	0 - 16	5.47	3.35	5.43	3.48	5.50	3.24	-0.64		4.60	3.41	6.25	3.10	-8.68	***
Snacks	0 - 10	4.92	2.36	4.72	2.40	5.09	2.31	-2.54	*	5.11	2.29	4.75	2.40	-2.77	**
^Social Networking	0 - 5	1.94	2.05	1.52	1.93	2.30	2.08	-6.58	***	2.35	2.01	1.41	1.88	-9.34	***
Alcohol (AUDITC)	0 - 12	3.75	2.94	4.70	3.18	2.93	2.45	-9.73	***	4.00	3.10	3.53	2.78	-2.40	*
Gambling (CSPG)	0 - 11	1.01	1.86	1.19	2.07	0.86	1.64	-1.91		1.00	1.79	1.02	1.92	-.083	
^TV Hours (work day)	0 - 21	2.33	2.91	2.50	3.17	2.18	2.66	-2.02	*	2.07	2.72	2.56	3.05	-4.59	***
^TV Hours (non-work day)	0 - 24	2.92	2.93	3.16	3.17	2.72	2.68	-3.12	**	2.85	2.95	2.99	2.91	-1.72	
^Internet Hours (work day)	0 - 20	1.04	1.90	.98	1.82	1.09	1.97	-1.41		1.13	1.86	0.96	1.93	-2.98	**
^Internet Hours (non-work day)	0 - 21	1.41	2.10	1.45	2.23	1.38	1.97	-0.09		1.47	1.74	1.36	2.28	-2.69	**

* = p <.05, **= p <.01, *** = p <.001, ^Untransformed, singular items are displayed in this table. Age categories based on median split

Table 4.2 *Comparison of fit-statistics for each of the models tested and correlations between fruit and vegetable intake and latent factors.*

Direct Correlations	None			A-priori			Post-hoc		
Common Factor Loadings	None	Fixed	Free	None	Fixed	Free	None	Fixed	Free
Fruit intake	--	$r_=$ -0.164	$r_=$ -0.194	--	$r_=$ -0.144	$r_=$ -0.104	--	$r_=$ -0.160	$r_=$ -0.179
Vegetable intake	--	$r_=$ -0.152	$r_=$ -0.154	--	$r_=$ -0.143	$r_=$ -0.177	--	$r_=$ -0.145	$r_=$ -0.172
χ^2	991.087*	587.82*	467.81*	351.361*	173.469*	111.501*	340.12*	149.739*	69.044*
df	55	54	44	31	30	20	43	42	32
BIC	37339.60	36943.4	36894.26	36869.92	36699.11	36708.00	36773.66	36590.36	36580.52
	9	3	2	4	8	0	2	7	2
AIC	37283.67	36882.4	36782.39	36691.94	36516.05	36474.08	36656.70	36468.32	36407.63
	3	1	1	7	5	7	6	5	0
GFI	0.856	0.924	0.937	0.947	0.975	0.984	0.945	0.978	0.990
RMSEA	0.119	0.091	0.090	0.093	0.063	0.062	0.076	0.046	0.031
RMSEA (CI^)	0.113	0.084	0.083	0.084	0.054	0.051	0.069	0.039	0.021
RMSEA (CIˇ)	0.126	0.098	0.097	0.102	0.073	0.073	0.084	0.055	0.041
SRMR	0.119	0.082	0.066	0.078	0.046	0.040	0.083	0.049	0.027
$\chi^2(df)_{difference\ test}$	403.27 (1)*	120.02 (10)*		177.89 (1)*	61.97 (10)*		190.38 (1)*	80.70 (10)*	

* $= p < .001$; r = Pearson Product Moment Correlation with the latent factor.

Table 4.3 *Unstandardized and Standardised estimates for the models where loadings were free to vary on the latent factor.*

Direct Correlations	None				A-priori				Post-hoc			
	B	*β*	SE	*z*	*B*	*β*	SE	*z*	*B*	*β*	SE	*z*
Drugs	1.000	0.558	0.04	15.04*	0.461	0.294	0.04	7.26*	1.000	0.480	0.05	9.60*
Fast Food	0.568	0.317	0.04	8.62*	1.000	0.639	0.06	11.72*	0.776	0.356	0.04	8.49*
Gambling	0.796	0.444	0.04	12.12*	0.435	0.278	0.05	6.17*	0.895	0.410	0.04	10.05*
Smoking	0.836	0.466	0.04	12.71*	0.105	0.067	0.04	1.56	0.992	0.455	0.06	8.27*
Salt	0.529	0.295	0.04	8.01*	0.268	0.171	0.04	4.37*	0.728	0.334	0.04	8.47*
Caffeine	0.454	0.253	0.04	6.87*	0.316	0.202	0.04	4.70*	0.753	0.345	0.05	7.23*
Alcohol	0.704	0.392	0.04	10.71*	0.251	0.160	0.04	3.68*	0.526	0.241	0.04	5.70*
Meat	0.358	0.200	0.04	5.40*	0.412	0.263	0.04	6.68**	0.240	0.193	0.04	4.81*
Snacks	0.244	0.136	0.04	3.67*	0.497	0.317	0.04	5.73*	0.352	0.161	0.04	3.86*
Internet	0.283	0.158	0.04	4.25*	0.410	0.262	0.04	6.05*	0.220	0.101	0.04	2.50*
TV	0.224	0.125	0.04	3.36*	0.253	0.161	0.04	3.78*	0.449	0.206	0.04	5.07*

* = p <.001

4.6 Discussion

The current study aimed to investigate the existence of a single dimensional trait characterised by higher levels of consumption of a range of rewarding stimuli. Our first two predictions were supported in that 1) the inclusion of a latent factor significantly improved model fit over the null model in all three covariance contexts, and 2) when free to vary, all reward-oriented indicators loaded positively on the latent factor. This demonstrates that a proportion of positive co-variance amongst the consumption of alcohol, drugs, cigarettes, fast food, snacks, TV, Internet, gambling products, caffeine, salt, and meat may be attributed to a latent trait. Negative associations between fruit and vegetable intake and the latent factor suggest that the trait is specific to certain type of stimuli (e.g., reward-oriented), and is furthermore unlikely to reflect acquiescence bias – whereby individuals tend to respond positively to all statements.

With reference to *Figure 4.1*, it may be seen that allowing factor loadings to vary produced a relatively small improvement in model fit over a model in which loadings were constrained to be homogenous, as compared to the improvement over the null model. This implies that the indicators were somewhat homogenous in terms of indicating the trait. Whilst all indicators may be construed as being hedonic, sensation-rich, appetitive, or rewarding; only some indicators can be thought of as being clearly addictive. Given the relative fit of the homogenous models, this lends credence to interpreting the latent trait in terms of an attraction to reward-oriented stimuli, rather in terms of possessing an orientation towards illicit substances. Given only a minor subset of the indicators (e.g. drugs) are not socially normative, the trait does not appear to reflect a willingness to disregard social structures.

Previous research has noted associations amongst addiction to stimuli such as television, caffeine, alcohol and chocolate (Greenberg et al., 1999), as well as gambling and

energy dense food (Claes et al., 2012), which are difficult to explain without reference to a general trait-orientation towards rewarding stimuli. The findings of the present study are in line with these previous observations regarding addiction, in which the common factor among the over-consumed stimuli appears to be in delivering immediate and relatively un-effortful, dopamine-driven rewards. From a neurophysiological perspective, variation between individuals could be the result of dopamine malfunction which has been found to cause various forms of excess consumption including alcohol abuse, binge eating, problem gambling and Internet addiction; (Bergh et al., 1997; Blum et al., 1996; Johnson & Kenny, 2010; Kim et al., 2011). It is thought that dopamine pathways originally evolved to reinforce resource acquisition and ingestion behaviours that promote survival in a resource-scarce environment. Psychoactive substances, energy dense food, and other modern day consumer products exhibit exaggerated reward properties that activate dopamine release more so than natural stimuli (Barrett, 2010; Nesse & Berridge, 1997; Wang et al., 2001), leading them to be termed ‘supernormal stimuli’ by some authors (Barrett, 2010, Tinbergen & Perdeck, 1951). This reasoning applies to addiction at a pathological level as well as more common instances of mild to moderate over-consumption in the general population. It is unclear as to the degree to which reward deficiency syndrome (RDS) may be applied to understand normal individual variation in susceptibility to overconsumption of supernormal stimuli. Nevertheless, the results of this study are consistent with an interpretation in terms of individual variability in the functioning of dopaminergic pathways. This is supported particularly with respect to the latent factor being associated with a variety of stimuli with exaggerated reward properties, but being negatively associated with the intake of natural stimuli (i.e., fruit and vegetables). A logical next step may be to develop a measure of trait reward-oriented behaviour and examine its associations with dopamine functioning.

Current findings also support predictions made by personality theory. Reward sensitivity theory suggests that some individuals demonstrate heightened approach toward appetitive stimuli (Gray, 1981). Empirical research supports this, with Behavioural Approach Scale (BAS; Carver & White, 1994) scores associated with increased approach toward alcohol (Franken, 2002), food (Passamonti et al., 2009), and risky gambling behaviour (Kim & Lee, 2011). In line with the present findings, a general tendency toward over-consumption could be a direct behavioural outcome for highly reward sensitive individuals. Similar predictions are made regarding highly impulsive or sensation seeking individuals (Benson et al., 2011; Chen et al., 2007; Dawe et al., 2004; Kane et al., 2004; Pentz et al., 2011). It has been suggested that impulsivity leads to a general vulnerability toward various forms overconsumption and addictive behaviours (Balogh, Mayes, & Potenza, 2013; Gay, Rochat, Billieux, d'Acremont, & Van der Linden, 2008). Furthermore, research demonstrates a mediating effect of impulsivity on the relationship between addictive behaviours (Evans et al., 2006; Kane et al., 2004). It may be the latent factor revealed in the current study, is explained by impulsivity. Reward sensitivity, impulsivity and sensation seeking are somewhat distinct, but tend to be moderately associated (Dawe et al., 2004). A clear delineation of the unique contributions of differing personality traits as well as a latent underlying consumptive trait remains to be explored.

Limitations

In models where parameters were free to vary, some items exhibited only minimal loadings on the latent factor. Residual covariance reflects the way in which many of the behaviours are likely to be associated for a variety of different reasons. For example, a licensed gaming bar encourages drinking alongside gambling in the same way that watching

television at home is a favourable environment for snacking (Francis, Lee, & Birch, 2003; Gore et al., 2003). In addition, parameter estimates for the None and Post hoc models are similar, whereas items exhibit different loadings on the latent factor in model based on addiction research (i.e., A Priori). This could reflect the way in which variables measured using addiction scales yield varying results when compared to variables using general consumption measures, an important consideration in future research.

Appropriate existing scales were not available for many of the behavioural items measured (e.g., salt, meat and caffeine intake). Many of the variables were measured using just one or two novel items, making reliability and validity difficult to assess. We also acknowledge that much other behaviour, not measured, may prove to be reliable indicators of the latent trait (e.g., shopping, viewing pornography, and video-gaming).

It is important to acknowledge that the latent factor describes only a small amount of variance in many of the behavioural variables. Furthermore, our interpretation of the latent factor is speculative. It is recognised that many explanations for shared co-variance amongst our measures exist above and beyond the personality and neuropsychological theories mentioned. Other personality traits, environmental factors, mental health, and perceptions and motivations surrounding healthfulness are some examples of plausible reasons for individual variance in consumption behaviour. Although we refer to the factor as a latent ‘trait’, which by definition is stable and long lasting, this cross-sectional study lacks the ability to assess the stability of behaviour. Aims for future research should be to replicate results using an extended range of reward-oriented behaviours as indicators, investigating alternative explanations for shared co-variance, longitudinal studies, the inclusion of established addiction scales and/or the development of reliable measures of consumption.

Conclusion

The current research was motivated by personality and neurophysiological theories that predict the existence of a latent trait indicated by increased consumption of a variety of reward-oriented stimuli in daily life. The results support the existence of such a trait, and further that the common stimulus characteristics are that of delivering an immediate and unmediated reward directly via dopaminergic pathways. The behavioural trait towards reward-oriented stimuli appears to be manifested across multiple modalities (i.e., psychoactive substances, media, foodstuffs). This represents the first study to investigate shared co-variance amongst the consumption of a broad range of products in everyday life in terms of a latent behavioural trait, and also one of few to measure frequency of general consumption behaviour in an adult, non-clinical sample. Increased consumption of the stimuli considered here can result in negative health outcomes. Individuals who tend towards excessive consumption of one form of stimulus will be more likely to consume a variety of other reward-oriented stimuli. This has important practical implications for population health. An overabundance of consumption opportunities, and artificial, highly attractive 'supernormal' products in the developed world has contributed to a variety of avoidable diseases. Understanding the factors behind individuals' vulnerability to overconsumption may play a useful role in future public health initiatives.

Chapter 5: Differential effects of reward drive and rash impulsivity on the consumption of a range of hedonic stimuli. [published manuscript]

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5.1 Abstract

Impulsivity has consistently been associated with over-consumption and addiction. Recent research has reconceptualised impulsivity as a two- dimensional construct (Dawe et al., 2004). The present study explores the relationship of the two components of impulsivity, reward drive (RD) and rash impulsivity (RI), on a broad group of 23 hedonic consumption behaviours (e.g., gambling, substance use, eating, media use). We tentatively grouped the behaviours into three descriptive classes: entertainment, foodstuffs, and illicit activities and substances. RD and RI positively predicted elevated levels of consumption in a community sample (N = 5391; 51% female) for the vast majority of the behaviours considered. However, the effect sizes for RD and RI varied depending on the behaviour; a pattern that appeared to be at least partially attributable to the class of consumption. Results support the view that RD is related more strongly to the consumption of products that provide social engagement or a sense of increased status; whereas RI better reflects an approach toward illicit or restricted products that are intensely rewarding with clear negative consequences. Results support the utility of the two-factor model of impulsivity in explaining individual differences in patterns of hedonic consumption in the general population. We discuss findings in terms of strengthening current conceptualisations of RI and RD as having distinct implications with respect to health-related behaviours.

5.2 Introduction

Research into health behaviour and addiction has explored a broad range of hedonic products that tend to elicit excessive consumption that can lead to harm. These typically in include products such as foods (Davis & Carter 2009), illicit substances (Darke et al., 2008; McGlothlin & West, 1968; Rehm, 2011), and retail goods (Sansone et al., 2012). More

recently, the use of certain entertainment and media products have been considered as forms of consumption behaviour (Noor, Roser, & Erickson, 2014; Rockloff, 2011; Ward & Carlson, 2013), with much research now focusing on excessive or problematic use of digital media and gambling products (Morahan-Martin, 2005; Pentz et al., 2011; Rockloff, 2011; Takao, Takahashi, & Kitamura, 2009). Impulsivity is consistently associated with excessive and unhealthy levels of various forms of consumption. Examples include food (Kane et al., 2004; Moreno-López et al., 2012), substances (Petry, 2001), gambling products (Benson et al., 2011; MacLaren, Fugelsang, Harrigan, & Dixon, 2012; Petry, 2001), retail goods (Billieux, Rochat, & Rebetez 2008) and digital media (Billieux, Van der Linden, et al., 2008; Dong, et al., 2011).

Impulsivity, broadly defined, reflects a tendency to engage in behaviour in a rash manner that lacks foresight, reflection, or long term planning. However, varied measures of impulsivity (derived from different theoretical backgrounds) have been applied across previous studies of personality (Dawe, et al., 2004). For example, Gray (1981; 1970) defined the construct in terms of individual differences in sensitivity and approach to reward, whereas other definitions of impulsivity describe rash unplanned behaviour, risk taking, and novelty seeking (Cloninger, 1987; Eysenck & Eysenck, 1991; Zuckerman et al., 1978). Whiteside and Lynam, (2001) described a multi-factor model of impulsivity based on the factor analysis of self-report questionnaire data. Factors include urgency, lack of premeditation, lack of perseverance, and sensation seeking (UPPS; Whiteside & Lyam, 2001). More recently, conceptualizations of impulsivity, particularly as related to addictive behaviours, have focused on two distinct dimensions based on separate neural processes (Dawe & Loxton, 2004; Gullo, et al., 2014) and recent factor analytic studies suggest that impulsivity is likely to be a multi-dimensional construct, consisting of at least two correlated factors (Dawe, et al., 2004). While both conceptualizations share similarities, it has been demonstrated that the

two-factor model is the more parsimonious approach for understanding addictive behaviours (see Gullo et al., 2014).

In the two factor model, the first factor is termed rash impulsivity (RI); involving difficulty inhibiting one's behaviour following the activation of an approach response, despite potential negative consequences. The second is reward drive (RD); the tendency for one to initiate goal-directed approach behaviour in response to signals of reward. RD is thought to involve the mesolimbic dopaminergic pathways; a brain region associated with natural reinforcement responses to nutrients and reproduction. It is thought that RI reflects activity in the orbitofrontal cortex and the ventromedial prefrontal cortex; areas associated with self-control and decision-making (Dawe, et al., 2004).

RI and RD share many common features, including a positive relationship with addictive and hedonic behaviours (Dawe, et al., 2004; Dawe & Loxton, 2004; Dissabandara et al., (2014); Gullo, et al., 2014). Nevertheless, conceptually they describe complementary aspects of impulsivity relating to heightened approach (RD), and decreased inhibition (RI). RD is distinguished from RI in that high RD individuals report greater psychological well-being and hope, experiencing greater sociability and less loneliness – with RI being associated with less positive outcomes (Carver & White 1994; Clark et al., 2015; Harnett et al., 2013).

Only a few studies have taken the two-factor approach to measuring impulsivity; justifying the need for assessment of the unique roles of RD and RI in potentially determining consumption behaviour of both addictive and non-addictive products. When entered simultaneously in regression models, RI and RD both explain unique variance in gambling, alcohol use, and drug use, although RI appears to be the stronger predictor of the two (Gullo et al., 2011; Loxton et al., 2008; MacLaren et al., 2012). Studies linking impulsivity to addictive behaviour have mainly aimed to predict clinical levels of only one or two specific

behaviours, focusing on addictive substances and problematic behaviours. For example, Dissabandra et al., (2014) compared levels of RD and RI between heroin dependant subjects (n= 293) and non-users (n=232), and Guerrieri et al., (2008) assessed reward sensitivity, response inhibition, and food intake in normal versus obese children. To date, little research has focussed on sub-clinical levels of consumption in the general population. Thus whilst RD and RI have been shown to play unique roles in the susceptibility to clinical levels of addictive behaviour, it remains an open question as to whether these results apply to sub-clinical levels of over-consumption in the general population. In addressing this question, we are able to better understand the effect of impulsivity on minor levels of over-consumption that affect a substantial proportion of the general population (Sussman et al., 2011). In addition, although theoretical conceptualisations of RD and RI imply differing relationships to qualitatively different types of behaviour (e.g. social engagement versus risk taking), these predictions have hitherto not been specifically tested. More generally, little is known regarding the role of RD and RI in determining (mal)adaptive or (un)healthy patterns of consumption in the general population.

5.3 Current study

This paper considers RD and RI with respect to the day-to-day consumption of a wide range of hedonic products in a community sample. We focus on elevated usage levels in the general population, rather than discriminating clinical versus non-clinical levels. In order to concisely describe our predictions and findings regarding this wide range of variables, we group products into three tentative classes: foodstuffs, ‘illicit’ activities including stigmatized or restricted / risky behaviours, as well as ‘entertainment’ – a product category of modern media and economic consumption. Table 5.1 summarises the measured items. Although products were categorised in this way for descriptive purposes only, a confirmatory factor

analysis showed that item loadings were positive and, for the most part, homogenous on their allocated factors. An RMSEA of .065 [95% CI = .063, .066] suggested that this model fitted the data well.

Table 5.1 *Product classifications based on reward characteristics.*

Entertainment	**Foods**	**Illicit**
o SMS	♦ Desserts	Δ Pornography
o Browsing online	♦ Sweets	Δ Alcohol
o Magazines	♦ Snacks	Δ Gambling
o Brochures	♦ Caffeine	Δ Smoking
o Social networking	♦ Soft drink	Δ Drugs
o Shopping	♦ Take away	
o Internet	♦ Packaged food	
o TV	♦ Salt	
o Video gaming	♦ Meat products	

Since general impulsivity is associated with various forms of hedonic consumption (Benson et al., 2011; Billieux, Van der Linden et al., 2008; Dong et al., 2011; Kane et al., 2004; MacLaren et al., 2012; Moreno-López et al., 2012; Petry, 2001), we expect that RD and RI should be associated with above average consumption of all behaviours listed in Table 5.1. According to current the conceptualization of the two-factor model, trait RD reflects goal-directed approach behaviour (Dawe et al., 2004) and is associated with higher sociability and psychological well-being (Clark et al., 2015; Harnett et al., 2013). On the other hand, RI more likely reflects a lack of control (Dawe et al., 2004) and is associated with higher consumption of products providing intense reward with clear negative consequences (Gullo et al., 2011; Loxton et al., 2008; MacLaren et al., 2012). Therefore, we expect that RD will have a stronger association with the consumption of products classed as entertainment, which includes a range of activities that provide reward through experiences of social interaction; or increased social status via acquisition of wealth or assets. Notably, the behaviours in the

entertainment category tend to involve some level of social or economic engagement, and are either socially accepted or even encouraged. RI, on the other hand, should show stronger associations with the more intensely rewarding and potentially more dangerous products in the 'Illicit' category. These are products that are widely recognized to provide short-term rewards at the expense of potential long-term harms, and should therefore be related to a lack of control and planning. It is less clear whether RD or RI is more important in explaining variability in food consumption. Although many experience a lack of control and long-term harms from excessive eating, foods tend to provide only moderately intense short-term rewards. Also, food consumption tends to have a strong social component (e.g. dining with family or having coffee with friends) and tends not to be socially proscribed. Therefore, we expect that both RD and RI may play a relatively equal role in predicting above average food consumption.

5.4 Methods

5.4.1 Survey participants and procedure

Data for the current study was collected as part of a large research project, results involving the consumption items and the RD and RI variables have been published previously in separate manuscripts (Goodwin, Brown, & Rockloff, 2015, Goodwin, Browne, Rockloff, & Loxton, 2016, respectively). Participants consisted of 5391 (51% female) members of an online survey panel maintained by an agency specializing in the recruitment of survey participants (myopinions.com.au). Participation was remunerated with credit points that could be accumulated and exchanged with the agency for cash. The survey took approximately 20 minutes to complete. Ages ranged from 18 to 87 years old (M=49.01, SD=16.50). Participants were born in Australia (74%), the United Kingdom (8.4%), New Zealand (2.7%) and other countries (14.9%).

5.4.2 Measures

Behavioural Items: Behavioural items represented the consumption of a range of hedonic stimuli including energy dense foods and beverages, illicit and/or restricted substances, and various retail and/or media. The brief AUDIT C (Bush et al., 1998) and the Consumption Scale for Problem Gambling (CSPG; (Rockloff, 2011) were utilized as validated measures of alcohol and gambling consumption. A further 21 variables were aggregated from a set of 31 additional novel items. Appendix 3 details each of the items that were summed to create each variable. Items were recorded on Likert scales (see Appendix 3), whereby the middle category represented an approximate average based on, where available, population norms (Goodwin, Browne, & Rockloff, 2015). The behavioural variables were converted into binary indicators of 'above typical consumption' based on a median split. Whilst this transform results in some loss of information and power, it provided for an identical scale across all responses and enabled the use of a consistent analysis (logistic regression) in all cases, facilitating comparisons of effects across behaviours.

Rash Impulsivity: Rash impulsivity was measured using a short version of the Barratt Impulsivity Scale (BIS-11; Spinella, 2007). This measure consists of 15 statements, whereby the participant must rate the extent to which the statement applies to them. Responses are recorded on a 4-point Likert scale (1, Rarely/never; 2, Occasionally; 3, Often; 4, Almost always/always). The measure includes three subscales; Attentional (e.g., *"I don't pay attention"),* Motor (e.g., *"I act on the spur of the moment"*), and Non-planning (e.g., *"I am a careful thinker. [inverted]").* The total BIS-11 score was utilized in the current study Cronbach's alpha in the present sample was .83

Reward Drive: The Behavioural Approach Scale (BAS) from the Behavioural Inhibition and Approach Scale (BIS/BAS; Carver & White, 1994) was used to measure RD. This 13 item

measure involves three subscales 1) Drive, assessing a persistence in pursuing desired goals (e.g., *"When I want something, I usually go all out to get it"*), 2) Reward Responsiveness scale, focused on the response to occurrence or anticipation of reward (e.g., *"When I'm doing well at something, I love to keep at it"*), and 3) Fun seeking (e.g, *"I crave excitement and new sensations"*). Responses were recorded on a 4-point Likert scale (1, Rarely/never; 2, Occasionally; 3, Often; 4, Almost always/always). The total BAS score was utilized in the current study. Cronbach's alpha coefficient in the current study was .88.

Ethics

The study received Human Research Ethics Committee approval from the university's review board and participants provided informed consent preceding the online survey.

5.4.3 Statistical analysis

A series of multiple logistic regressions were performed with reward drive and rash impulsivity predicting above median consumption on each of the measured products. Each model controlled for gender, age, income, and the shared variance between RD and RI (r = .27, p <.001). A false discovery rate (FDR) adjustment was applied to significance values to reduce the probability of a Type I error when running multiple analyses (Benjamini & Hochberg, 1995). The authors also ran another series of regressions whereby each model included the interaction term, RD by RI. No significant interaction effects were found, therefore only main effects are presented in the results section.

5.5 Results

5.5.1 Gender, age, and income effects

Table 5.2 compares gender, age and income group means for each of the measured behaviours. Women were significantly higher consumers of many entertainment products; including watching television, reading advertising brochures, retail products, magazines, social networking, SMS, and online shopping products. Men consumed more of the illicit products along with some of the food items (e.g., pornography, cigarettes, alcohol, gambling products, drugs, caffeine, soft drink, meat products, take away food, and packaged food). Using a median split, those 51 years of age and under reported higher consumption of most products, as did participants who earned over $65K per year. However, those earning $65K or under reported more television viewing, smoking of cigarettes, and reading of advertising brochures.

5.5.2 Regression of consumption behaviours on RD and RI

As shown in Table 5.3, RD positively predicted 19 of the 23 consumption behaviours, with the exception of smoking, packaged food, television and meat products (marginal). The strongest of these associations were between RD and frequency of: browsing online (standardized β =.238, p <.001), SMS (β =.223, p <.001), using social networking (β =.213, p <.001), viewing pornography (β =.174, p <.001), and consumption of caffeine (β =.178, p <.001). RI positively predicted 18 of the consumption behaviours, with exception of reading junk mail, eating dessert, shopping (marginal), reading magazines, and browsing online. The strongest of these associations were between RI and using drugs β =.512, p <.001), gambling (β =.283, p <.001), alcohol (β =.235, p <.001), buying packaged food (β =.206, p <.001), and eating take away food (β =.190, p <.001). Finally, the binarized behavioural responses were aggregated using a simple count; yielding a variable that described the number of

behaviours (out of 23) that individuals undertook at above-median levels. Using OLS regression this 'total consumption' variable was predicted positively by both RD β= .645, $p < .001$ and RI β= .604, $p < .001$.

Figure 5.1 plots the standardized beta weight for rash impulsivity and reward drive for each behavioural item. Items are coded according to Table 5.1 as Entertainment, Foods, or Illicit, representing the three classes of stimuli measured. Items with asterisks above the broken diagonal line (i.e., browsing online, brochures, magazines, snacks, dessert, shopping, SMS, and social networking) share significantly stronger associations with RD when compared to RI according to Fishers exact test for comparing parameter estimates, and those below the line (i.e., Internet, soft drink, TV, packaged foods, alcohol, gambling, smoking and drugs) share significantly stronger association with RI.

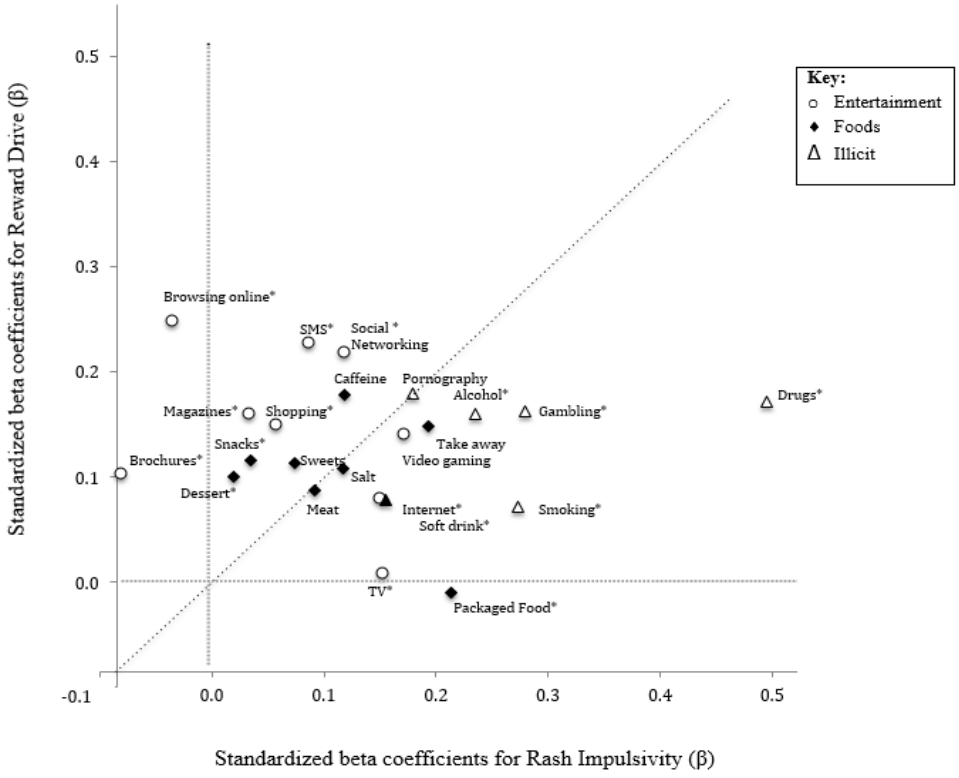

Figure 5.1 Scatterplot of rash impulsivity and reward drive standardized beta weights from regression analyses for each behavioural item, *difference between RD and RI beta weight significant at $p < .05$.

Table 5.2 *Means, standard deviations and t –tests for comparing gender, age, and income groups.*

	Gender						**Age**						**Income**					
	F Mean	*(SD)*	*M Mean*	*(SD)*	*t*		*<51 Mean*	*(SD)*	*51+ Mean*	*(SD)*	*T*		*<$65K Mean*	*(SD)*	*$65K + Mean*	*(SD)*	*t*	
Packaged Food	1.87	(1.04)	2.02	(1.17)	-4.86	***	2.16	(1.15)	1.74	(1.02)	14.28	***	1.90	(1.13)	1.99	(1.08)	-2.99	**
TV	10.47	(2.47)	10.31	(2.60)	2.20	*	9.81	(2.74)	10.95	(2.19)	-16.73	***	10.57	(2.65)	10.15	(2.35)	6.05	***
Smoking	1.59	(1.53)	1.74	(1.72)	-3.54	***	1.68	(1.59)	1.65	(1.66)	0.75		1.73	(1.70)	1.57	(1.51)	3.77	***
Soft Drink	3.88	(1.76)	4.29	(1.83)	-8.37	***	4.47	(1.76)	3.71	(1.77)	15.62	***	3.93	(1.82)	4.29	(1.77)	-7.22	***
Internet	9.57	(2.53)	9.91	(2.48)	-4.88	***	10.25	(2.42)	9.24	(2.49)	14.99	***	9.68	(2.65)	9.81	(2.30)	-1.94	
Meat Products	2.54	(0.97)	2.82	(0.98)	-10.48	***	2.81	(1.06)	2.55	(0.88)	9.91	***	2.63	(0.99)	2.74	(0.98)	-3.79	***
Desserts	2.66	(1.07)	2.61	(1.02)	1.79		2.61	(1.00)	2.67	(1.08)	-2.10	*	2.63	(1.08)	2.64	(0.99)	-0.17	
Brochures	3.34	(1.41)	3.02	(1.44)	8.14	***	3.03	(1.42)	3.32	(1.43)	-7.49	***	3.25	(1.44)	3.09	(1.42)	3.97	***
Salt	4.86	(1.70)	4.93	(1.74)	-1.57		4.92	(1.66)	4.87	(1.78)	1.00		4.87	(1.76)	4.94	(1.66)	-1.52	
Sweets	3.00	(1.21)	2.82	(1.14)	5.69	***	3.00	(1.17)	2.83	(1.19)	5.17	***	2.85	(1.19)	2.99	(1.15)	-4.34	***
Snacks	2.67	(1.05)	2.67	(1.03)	-0.23		2.76	(1.03)	2.58	(1.05)	6.31	***	2.60	(1.06)	2.77	(1.01)	-6.20	***
Video Gaming	4.30	(3.21)	4.85	(3.52)	-5.94	***	5.60	(3.56)	3.58	(2.86)	22.76	***	4.43	(3.42)	4.75	(3.29)	-3.41	**
Take away	4.08	(1.20)	4.30	(1.25)	-6.37	***	4.51	(1.27)	3.89	(1.11)	19.00	***	4.05	(1.21)	4.38	(1.22)	-9.80	***
Shopping	4.58	(1.38)	4.37	(1.28)	5.61	***	4.68	(1.43)	4.29	(1.21)	10.72	***	4.33	(1.25)	4.68	(1.42)	-9.28	***
Alcohol	2.71	(2.58)	3.74	(2.98)	-13.40	***	3.28	(2.90)	3.14	(2.74)	1.80		2.90	(2.81)	3.63	(2.78)	-9.39	***
Magazines	1.83	(1.09)	1.53	(0.87)	11.55	***	1.62	(0.92)	1.75	(1.06)	-4.48	***	1.69	(1.02)	1.68	(0.97)	0.40	
Gambling	1.20	(1.91)	1.78	(2.47)	-9.47	***	1.31	(2.07)	1.64	(2.34)	-5.40	***	1.47	(2.26)	1.49	(2.16)	-0.40	
Drugs	1.08	(0.46)	1.12	(0.58)	-3.14	***	1.16	(0.66)	1.04	(0.35)	8.41	***	1.11	(0.58)	1.08	(0.42)	1.56	
Caffeine	19.34	(4.54)	20.19	(4.56)	-6.73	***	19.64	(5.18)	19.85	(3.89)	-1.70	*	19.55	(4.47)	20.02	(4.69)	-3.67	***
Pornography	2.44	(1.45)	3.38	(2.22)	-18.11	***	3.27	(2.20)	2.53	(1.53)	14.06	***	2.79	(1.88)	3.03	(1.97)	-4.38	***
Social Network	10.99	(5.99)	9.12	(5.63)	11.66	***	12.38	(5.84)	7.95	(5.08)	29.38	***	9.66	(5.92)	10.69	(5.81)	-6.25	***
SMS	3.32	(1.16)	3.02	(1.13)	9.45	***	3.65	(1.08)	2.73	(1.04)	31.82	***	2.95	(1.18)	3.48	(1.04)	-17.28	***
Browse Online	3.02	(1.42)	2.85	(1.35)	4.48	***	3.20	(1.40)	2.68	(1.34)	13.82	***	2.79	(1.39)	3.14	(1.37)	-9.11	***

*** = p <.001, ** = p <.01, * = p <.05. Age and Income categories based on a median split.

Table 5.3 *Logistic regression results predicting above median consumption of a variety of products from Reward Drive and Rash Impulsivity, controlling for gender, age, and income.*

	Range (Median)		**n>med**	**Reward Drive**							**Rash Impulsivity**						
				B	*(SE)*	*Wald*		*Lower CI*	*OR*	*Upper CI*	*B*	*(SE)*	*Wald*		*Lower CI*	*OR*	*Upper CI*
Packaged food	2 -14	(2)	1682	-0.004	0.033	0.110		0.971	1.004	1.038	0.206	0.033	6.326	***	1.189	1.229	1.270
TV	2 - 16	(10)	2542	0.004	0.030	0.143		0.974	1.004	1.035	0.154	0.030	5.213	***	1.133	1.167	1.202
Soft Drink	1-9	(1)	899	0.065	0.032	2.138	*	1.034	1.067	1.101	0.159	0.031	5.170	***	1.137	1.172	1.209
Meat Product	2 -12	(4)	2271	0.077	0.039	1.945	^	1.038	1.080	1.123	0.095	0.038	2.469	*	1.058	1.099	1.143
Internet	2 -16	(10)	1632	0.082	0.033	2.477	*	1.050	1.086	1.123	0.153	0.033	4.687	***	1.128	1.165	1.203
Smoking	1 - 7	(3)	943	0.090	0.040	2.252		1.051	1.094	1.138	0.265	0.039	6.757	***	1.253	1.304	1.356
Dessert	1-7	(2)	2494	0.100	0.030	3.363	**	1.073	1.106	1.139	0.013	0.029	0.449		0.984	1.013	1.043
Junk Mail	1 - 6	(3)	2615	0.106	0.030	3.495	***	1.078	1.111	1.145	-0.080	0.029	-2.723	**	0.897	0.924	0.951
Salt	2 - 8	(5)	2115	0.114	0.030	3.738	***	1.088	1.121	1.155	0.108	0.030	3.671	***	1.082	1.115	1.148
Snacks	1 -7	(3)	1451	0.116	0.030	3.837	***	1.089	1.123	1.157	0.035	0.029	1.188		1.005	1.035	1.066
Sweets	1 -7	(2)	2618	0.123	0.034	3.664	***	1.093	1.131	1.169	0.071	0.033	2.168	*	1.039	1.073	1.109
Video Gaming	2 - 16	(2)	2466	0.133	0.032	4.097	***	1.106	1.142	1.179	0.017	0.031	5.540	***	0.986	1.018	1.050
Magazines	2 -14	(4)	1576	0.152	0.031	4.979	***	1.129	1.164	1.201	0.030	0.030	1.016		1.000	1.030	1.061
Take Away	2 - 14	(4)	2088	0.152	0.034	4.498	***	1.126	1.165	1.205	0.190	0.033	5.750	***	1.170	1.209	1.250
Shopping	0 - 12	(3)	2385	0.155	0.031	4.991	***	1.132	1.168	1.205	0.061	0.030	2.036	^	1.032	1.063	1.096
Alcohol	1 - 7	(1)	2288	0.168	0.031	5.388	***	1.146	1.183	1.220	0.235	0.030	7.709	***	1.227	1.265	1.304
Pornography	0 - 13	(1)	1681	0.174	0.038	4.592	***	1.146	1.191	1.237	0.176	0.037	4.760	***	1.149	1.192	1.237
Gambling	1 - 6	(1)	348	0.175	0.067	4.833	***	1.114	1.191	1.274	0.283	0.032	8.732	***	1.285	1.327	1.371
Drugs	8 - 47	(20)	2450	0.175	0.067	2.613	**	1.114	1.191	1.274	0.512	0.067	7.604	***	1.560	1.669	1.786
Caffeine	2 - 16	(2)	1371	0.178	0.031	5.768	***	1.158	1.194	1.232	0.118	0.030	3.958	***	1.093	1.126	1.160
Social Networking	3 – 25	(10)	2548	0.213	0.033	6.364	***	1.197	1.237	1.279	0.124	0.032	3.863	***	1.097	1.133	1.170
SMS	1 - 7	(3)	2335	0.223	0.033	6.663	***	1.208	1.249	1.292	0.095	0.032	2.964	**	1.065	1.100	1.136
Browse Online	1 - 6	(3)	1676	0.238	0.033	7.274	***	1.228	1.269	1.311	-0.029	0.032	-0.934		0.941	0.971	1.002

*** = p <.001, ** = p <.01, * = p <.05, ^ = marginal. Variables sorted according to beta weight association with RD

5.6 Discussion

The key study aim was to understand the relationship between the dimensions of the two-factor model of impulsivity and hedonic product consumption. In particular, we were interested in the differential effects of RD and RI on the consumption of a wide range of qualitatively different products. RD and RI were both positively associated with above-average consumption of almost all of the measured behavioural items. As expected, RI shared its strongest associations with the intensely rewarding and potentially dangerous products classified as Illicit (e.g., alcohol, drugs, & gambling products). Both RD and RI tended to share small to moderate associations with food items whilst RD shared its strongest associations with the consumption of products classed by the current authors as entertainment.

In accordance with previous findings on clinical samples, people high in RI and RD reported higher levels of consumption. Thus, RD and RI appear to be not only useful in predicting addictive or disordered behaviours (Dissabandara et al., 2014; Kane, et al., 2004; Loxton et al., 2008), but also in explaining elevated consumption in the general population. Nevertheless, with the exception of illicit drugs, the effect sizes for RI and RD tended to small to moderate. This is not especially surprising, since like other high-level personality constructs, RD and RI can be understood to have a ‘diffuse’ effect on behaviour; i.e. they have a small but measurable influence across a broad domain of specific behaviours. Given that unhealthy lifestyle choices are known to co-occur (be co-morbid) in individuals, we have grounds to suspect that personality traits such as RD and RI are instrumental in explaining these multivariate comorbidities. Whilst impulsivity may be a relatively minor influence on any given behaviour, the aggregate impact of RD and RI on one’s total health and wellbeing may be significant.

As illustrated in *Figure 5.1*, beta coefficients for RD and RI vary markedly across the behaviours considered in this study. Our specific predictions regarding the relative strength of RD and RI with behaviours in the three different descriptive classes were largely supported. That is, above-average consumption of most items categorized as illicit, including cigarettes, gambling products, alcohol, and drugs, shared significantly stronger associations with RI than RD. Most food products measured (i.e., meat, salt, sweets, dessert, snacks, and caffeine) did not have different association with RD when compared to RI. Finally, entertainment items, including browsing online, sending SMS, social networking, reading magazines, and shopping), all shared significantly larger associations with RD.

These findings strengthen current conceptualizations of RD and RI. RD has been associated with socially driven behaviours (Clark et al., 2015) as well as more reflection and planning in approach to reward (Dawe et al., 2004). This is consistent with the pattern of effects seen here, in which RD predicted behaviours that tend to take relatively more cognitive effort, involve less immediate reward and more socially positive consequences. This may be seen in relatively stronger effects for the different forms of economic consumption, or communicating via digital media activities that generally take some planning and reflection, and lead to longer term rewards in terms of feelings of social interaction, affluence, or increased social standing. The relatively weaker effect observed for RI is understandable, given that it is conceptualized as a lack of control despite negative consequences (Dawe et al., 2004). This description is also consistent with the finding that RI was relatively more strongly associated with increased consumption of gambling, alcohol, smoking, and substance use; behaviours that provide immediate and intense reward for very little effort, and for which the negative consequences are serious and well known (e.g., addiction, over-dose, and bankruptcy). RD and RI appear to be both independently associated with increased consumption, which can potentially be maladaptive, regardless of the product.

However, our findings also support the notion that RI is most strongly associated with more unhealthy, risky forms of consumption.

There were some notable exceptions to these patterns, where items did not conform to expectations based on their allotted category. For example, TV, video–gaming and Internet were more strongly predicted by RI than RD. In part, this reflects previous study findings linking self-regulation and impulsivity to Internet use (e.g., Billieux & Van der Linden, 2012) and video-gaming (Billieux et al., 2011). It may be that, although these activities often mimic social interaction (in the case of games), or provide for hedonic social observation (in the case of TV), they often lack the features of active social engagement that other items in this category possess. In addition, being related to RI but not RD, packaged food consumption did not conform to the same pattern of results as other food items. This may be due to the fact that the appeal of this product lies more in the quick satisfaction of a craving (hunger), rather than being particularly hedonically rewarding.

Limitations

This cross-sectional survey had several specific limitations connected with the goal to simultaneously assess a wide range of hedonic consumption behaviours. Due to the need to keep the total survey time reasonable, many behavioural measures were measured using just one or two items, which can be expected to lead to diminished effect sizes due to measurement error. Furthermore, predicting specific behaviours from general personality traits is known to suffer from a mismatch in levels of description, which also contributed to lower effect sizes (Epstein, 1979). The large sample size employed was designed to partially compensate for these two issues. R^2 values from the current study, although small, in many cases were comparable to those from similar studies predicting actual behaviour from personality traits (Gullo et al., 2011; Dawe & Loxton, 2001; Stojek, Fischer, Murphy, &

MacKillop, 2014). In addition, with the exception of alcohol and gambling, behavioural variables were measured using novel, self-report items that did not belong to a previously validated scale. This was somewhat compensated by the fact that items directly measured frequency of product consumption, reducing uncertainty around construct validity.

It is important to note that in this study the BAS and BIS-11 were applied as broad measures of RD and RI. Each scale is made up of subscales that are likely to be differentially associated with the hedonic behaviours. RD as a construct continues to be refined and a new revised scale has been recently developed based on revised reinforcement sensitivity theory (rBAS; Jackson, 2009). This revised scale assesses the more functional aspects of reward drive (Clark et al., 2015; Harnett et al., 2013; Jackson, 2009; Jackson, Loxton, Harnett, Ciarrochi, & Gullo, 2014) and has less in common with rash impulsivity. The measure of the original BAS used in the current study tends to correlate more so with rash impulsivity due to the inclusion of a ‘fun seeking’ scale. Although the aim of the current study was to predict hedonic consumption based on the broader constructs of RI and RD, future research might benefit from applying the updated BAS scale and investigating sub scale effects as this may result in more pronounced unique effects of the two factors of impulsivity and a more detailed understanding of these effects. Furthermore, consumption of hedonic stimuli is often used as a form of ‘self-medication’ due the stimuli’s effect on reward centres in the brain (Markou, Kosten, & Koob, 1998; Tuomisto et al., 1999). The current research did not control for factors such as depression, anxiety, and positive and negative affect and further research is recommended to identify the impact these emotional and mood states/traits might have on the current findings.

Conclusion

To date, research into the effects of impulsivity on behaviour has focused on single pathological or disordered behavioural outcomes. Furthermore, the recently realised, two-factor model of impulsivity has been under-used in such research. Our results suggest that the two-factor model of impulsivity has relevance in explaining a wide range of consumption behaviours in the general population. Taken in the aggregate, across both behaviours and individuals, these traits may play a significant role in determining health outcomes. Our findings strengthen current conceptualisations of RI and RD. Results supported the interpretation that RD reflects reward approach in a reflective, socially driven manner, whereas RI reflects an approach to intense reward that lack controls and consideration for negative consequences. Excess consumption in the general population contributes to debt, emotional strain, and a variety of avoidable diseases. Understanding the psychological factors underlying an individual's vulnerability to excessive consumption should play a useful role in future public health initiatives and research.

Chapter 6: Measuring preference for supernormal stimuli: A two-dimensional anticipatory pleasure scale. [published manuscript]

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6.1 Abstract

Supernormal stimuli are artificial products that activate reward pathways and approach behaviour more so than naturally occurring stimuli for which these systems were intended. Many modern consumer products (e.g., snack foods, alcohol, pornography) appear to incorporate supernormal features, leading to excessive consumption, in preference to naturally-occurring alternatives. No measure currently exists for the self-report assessment of individual differences or changes in susceptibility to such stimuli. Therefore, an anticipatory pleasure scale was modified to include items that represented both supernormal and natural classes of rewarding stimuli. Exploratory factor analysis yielded a two-factor solution, and as predicted, natural (N) and supernormal (SN) items reliably loaded on separate dimensions. Internal reliability for the two scales was high, ρ =.93, ρ =.90, respectively. The two-dimensional measure was evaluated via regression using the N and SN scale means as predictors and self-reports of daily consumption of 21 products with supernormal features as outcomes. As expected, supernormal pleasure ratings were related to higher supernormal product consumption; whilst natural pleasure ratings had either negative or neutral associations to consumption of these products. We conclude that the resulting two-dimensional measure is a potentially reliable and valid self-report measure of differential preference for supernormal stimuli. Whilst further evaluation is needed (e.g. using experimental measures), the proposed scale may play a useful role in the study of both trait- and state-based variation in human susceptibility to supernormal stimuli.

6.2 Introduction

Processed foods, psychoactive substances, some retail goods, and various social media and gaming products, are readily over consumed, presenting numerous population health challenges (Roberts, et al., 2012). Evolutionary psychology provides a persuasive explanation of excessive consumption. Animals, including humans, tend to approach (i.e., gather, acquire and consume) stimuli that provide the highest relative reward for their efforts, thereby optimizing their utility (Chakravarthy and Booth, 2004; Kacelnik and Bateson, 1996). Neurological reward mechanisms evolved to promote adaptive behaviour by reinforcing stimuli that send signals of promoting fitness; such as providing nutrients or reproductive opportunities. Tinbergen (1951) coined the term 'Supernormal Stimulus' upon finding that animals tend to exhibit heightened responses to exaggerated versions of natural stimuli. This 'selection asymmetry' (Staddon, 1975; Ward, 2013) is not maladaptive in natural environments in which exaggerated versions of the stimulus are rare – but presents problems when artificial and exaggerated alternatives exist. For example, the newly hatched herring gull prefers to peck at a fabricated thin red rod with white bands at its tip, rather than its mother's naturally red spotted thin beak (Tinbergen & Perdeck, 1951). In the context of resource selection, the outcome is a behavioural heuristic of 'get all you can': an adaptive strategy in natural environments where resource supply is scarce or unreliable. In the modern human environment, many highly rewarding experiences exist in the form of artificial consumer products that have been designed or refined to be supernormal. That is, they stimulate an evolved reward system to a degree not found in natural stimuli (Barrett, 2010). For example, psychoactive substances (Nesse & Berridge, 1997), commercial fast food products (Barrett, 2007), gambling products (Rockloff, 2014), television shows (Derrick et al., 2009; Barrett, 2010), digital social networking and the Internet (Rocci, 2013; Ward, 2013), and various retail products, such expensive cars (Erk et al., 2002), high heeled shoes

(Morris et al., 2013), cosmetics (Etcoff et al., 2011) and children's toys (Morris et al., 1995) have all been discussed as forms of modern day supernormal stimuli. For some of these stimuli, neurological evidence has shown that they tend to activate dopamine pathways intensely, hijacking the reward response designed for natural rewards; thereby promoting excess consumption and in some cases, addiction (Barrett, 2010; Blumenthal & Gold, 2010; Wang et al., 2001).

To varying degrees, supernormal stimuli tend to be unhealthy. The ready availability of high calorie take away meals and snacks, the toxicity of alcohol, and other substances, the sedentary activity involved in watching television, using digital media and gaming products, and the expense of retail items or gambling, all serve to provide an environment that fosters unhealthy behavioural choices, leading to harms (Barrett, 2007, 2010; Birch, 1999; Hantula, 2003; Ward, 2013). This makes the study of susceptibility of modern humans to supernormal stimuli of practical significance. In the current report we use the term supernormal stimuli to refer to modern human products and experiences that are characterized by asymmetric selectivity (uncontrolled approach to more intense variants), and being made artificially abundant in the modern world. These products are often processed, refined, or synthesized consumer goods including snack foods or substances. Less obvious examples include, messages received via social media. Although at times less stimulating than a face-to-face conversation, this communication method provides prolonged enhanced visual, speed and delivery characteristics. Similarly most modern day clothing and other retail products exhibit similar enhanced signifiers of rarity or desirability, with attendant implications for sexual or social status. Consumption or acquisition of these products is theorized to provide immediate reward due to being interpreted as fitness-enhancing.

6.2.1 Individual differences in reward preferences

Evolved reward mechanisms are generally regarded as species wide (De Jong &Van der Steen, 1998). However, this does not entail that all humans are 'hard wired' to respond equally intensely to stimuli with exaggerated reward properties. That is, even highly species-typical behavioural phenotypes vary amongst individuals (Buss, 2009), and despite the general attractiveness of supernormal stimuli, not everybody regularly consumes to excess or succumbs to addiction (Sussman et al., 2010). Pleasure is experienced from a variety of sources that do not involve consumption of supernormal stimuli; including exploring scenic landscapes, enjoying the company of family and friends, and engaging in favored hobbies or pastimes (Gard, Gard, Kring, & John, 2006; Snaith et al., 1995). An important question for health research and the enquiry of this study is: Do some people experience more intense reward from supernormal stimuli than by natural forms of stimuli?

It has been suggested that people do vary in their tendency to over-consume rewarding stimuli and that underlying psychological traits may help explain this (Faber et al., 1995; Villella et al., 2011; Weed et al., 1992; Zeinali & Vahdat, 2011). Recent empirical findings using factor analysis support this assertion; demonstrating that a common underlying factor explains a meaningful proportion of co-variance amongst immediately gratifying, hedonic products including alcohol, drug, cigarette, fast food, snack, salt, meat, caffeine, gambling, Internet and television consumption (Goodwin, Browne, Rockloff, & Donaldson, 2015). Similarly, materialist economic behaviour has been related to individual differences in orientation toward acquisition, suggesting that some individuals are particular motivated towards rewards involving purchases, monetary gain, and consumption (Richins & Dawson, 1992). Both psychological and physiological literature (Davis et al., 2007; Dawe, et al., 2004; Moreno-López et al.,, 2012; Volkow, Fowler, & Wang, 2002) suggest that these findings may

reflect individual differences in orientation towards a general class of rewards with a common supernormal property.

6.2.2 The current study

To date, although scales measuring anticipated pleasure responses to rewarding experiences exist, no work has been done to distinguish responses to different types of reward. The Snaith-Hamilton Pleasure Scale (SHPS) was developed primarily to detect anhedonia in depressed patients (Snaith et al., 1995). Items for the scale were suggested by members of the general public (n=55), each providing a list of five situations which provided them with pleasure. Items that were unlikely to be applicable to most people (e.g., specific alcoholic drinks, or dietary preferences) were excluded. The majority of items in the final scale reflected examples of rewarding experiences that, by our definition, are natural (i.e., not supernormal) (e.g., "*I would enjoy other people's smiling faces*" or "*I would enjoy a warm bath or refreshing shower*").

Although little is known regarding preferences for natural and supernormal stimuli, personality and neurological theory predicts that individuals may vary in their orientation towards different types of reward. Ideas from the literature on supernormal stimuli provide a framework to organize rewards into a two-dimensional natural/supernormal scheme. Using the Snaith-Hamilton Pleasure Scale (SHPS) as a basis, the current study aims to create a measure of anticipated pleasure that included items clearly representing both supernormal and natural experiences. A scale that measures supernormal versus natural preference should predict above-average consumption of a broad class of modern artificial and enhanced products; and should help improve our understanding of trait and state based variation in unhealthy lifestyle choices.

We expected that modified SHPS would form a clear two-factor structure based on natural and supernormal items. Furthermore, we expected that higher anticipated pleasure ratings for supernormal experiences would predict higher frequency of actual consumption of a wide range of supernormal stimuli; this list including: alcohol, drugs, caffeine, digital media products, high calorie foods, and luxury or otherwise non-essential retail products.

6.3 Materials and methods

6.3.1 Supernormal scale development

A list of supernormal items was developed based on qualitative interviews with undergraduate university students, whereby participants (n = 26, 85% female, 18 – 46 years old) were asked to think about the things they enjoyed in life and list those things that they tended to do, or have, too much of. This technique was chosen in order to mirror the procedure used to develop the SHPS. Questions were administered using a semi-structured interview and were designed to tap into perceptions of excessive or uncontrolled approach behaviour reflecting the asymmetric selectivity property of supernormal items (for full script, see Appendix 1). Each unique response was allocated a node and frequencies of nodes were tabulated. Responses describing specific illicit or restricted substances were removed and nodes were combined in order to yield items that were as general as possible. For example, reference to general or specific savoury snack foods were combined into a single node labelled *"Eating a savoury snack, such as cheese, crackers, chips or nuts"*. From this, all nodes mentioned by 13 or more participants (>50% of the sample) were retained for the scale. These included; high calorie foods in the form of sweets and snacks, discretionary retail products, social media, and television.

6.3.2 Survey participants and procedure

Participants (n= 5391, 51% female) were members of on an online survey panel maintained by an agency specializing in the recruitment of survey participants (myopinions.com.au). Emails were sent to panel members inviting them to participate in the online survey for which they could earn points that could be accumulated and exchanged with the agency for cash. The full survey took approximately 20 minutes to complete. Ages ranged from 18 to 87 years old (M=49.01, SD=16.50). The majority of participants were born in Australia (74%), with the remainder born in either the United Kingdom (8.4%), New Zealand (2.7%) or other (14.9%).

6.3.3 Measures

Supernormal Pleasure Scale (SNPS): As described above, a set of five supernormal items were created for the purpose of this study (e.g., "*Purchasing a new item such as clothing or an appliance for your house*" or "*Receiving a personal message via email, SMS or social networking site*"). Respondents answered these items on a 5-point Likert scale ranging from (1= 'none at all or neutral') to (5= 'there is nothing I would enjoy more'). The Spearman-Brown split half reliability for these items was high (ρ =.90).

Natural Pleasure Scale (NPS): The Snaith-Hamilton Pleasure Scale (SHPS; Snaith et al., 1995) consists of 14 items measuring how much pleasure a participant would anticipate feeling in response to a variety of experiences. One item "*Watching my favourite television show*" was redundant as it was identical to an item from the supernormal pleasure scale and five items from the SHPS did not clearly describe either supernormal or natural experiences (e.g., "*My favourite meal*"). Only the eight remaining items that clearly described natural stimuli (e.g., "*Having a refreshing bath or shower*" and "*The scent of flowers or a sea*

breeze") were retained. Respondents answered on a 5-point Likert scale ranging from (1= 'none at all or neutral') to (5= 'there is nothing I would enjoy more'). The Spearman-Brown split half reliability for these items was high (ρ =.93).

Behavioural Items: Twenty-one variables representing the consumption of a range of foods, substances, entertainment and retail products were aggregated from a set of 58 questions asking participants to record typical time spent on or frequency of various types of consumption (e.g., "*On a typical weekday or working day how much time do you spend gaming on a desktop computer, game console, portable gaming system, mobile phone or tablet*" or "*On average how often do you drink caffeinated soft drinks such as Coke or Pepsi*"). Participants responded on a Likert scale between 7 - 9 categories for most items, whereby the middle category represented an approximate average based on, where available, population norms. For example, responses regarding various forms of entertainment consumed on a typical day included; "1 = none, 2 = less than 10, 3 = 10 minutes to 30 minutes, 4 = 30 minutes to 1 hour, 5 = 1 to 3 hours, 6= 3 to 5 hours, 7 = 5 to 7 hours, and 8 = over 7 hours". Items that represented the same activity or product were aggregated. For example, all items regarding caffeinated drinks were summed to create a caffeine variable. Where possible, established scales were utilized such as the brief AUDIT C (Bush et al., 1998) for alcohol consumption and the Consumption Scale for Problem Gambling (CSPG; Rockloff, 2011). See Appendix 3 for the full questionnaire. The continuous behavioural variables calculated from each scale or measure were characterized by a range of distributions, some markedly non-normal. They were converted into binary indicators of 'above typical consumption' based on a median split. This allowed a consistent analysis method (logistic regression) to be used on all behavioural responses, and aided interpretation and presentation of results.

6.3.4 Statistical analyses

The thirteen selected anticipatory pleasure items were entered into an exploratory factor analysis (EFA) using the Mplus statistical software package. After reliability checks on subscales in two-factor solution, mean pleasure ratings were calculated for supernormal (SNP) and natural (NP) item sets and normalized. Binary logistic regression models were run in R statistical software for each of the median split behavioural variables, simultaneously predicted by SNP and NP.

6.4 Results

The KMO measure of sampling adequacy approximated the proportion of variance caused by an underlying factor to be .897 and Bartlett's Test of Sphericity was $\chi^2(78) = 29895.431$, $p < .001$, warranting factor analysis. Table 6.1 shows the results of the factor analysis exploring one and two-factor models. As expected, items in the two-factor solution showed no cross loadings. All items loaded positively on their corresponding factor with no cross loading. Spearman-Brown reliabilities for the supernormal and natural scale were $\rho = .91$ and $\rho = .93$, respectively. SNP and NP were correlated $r = .497$, $p < .001$. This was expected as they are conceptualized sub-domains of a more general construct of overall anticipatory pleasure or inversely, as the SHPS scale was originally intended, anhedonia. Simultaneous entry of both SNP and NP in the regression analyses allowed each IV to act as the other's control, and increases the degree to which the beta coefficients reflected the unique contribution of SNP / NP, rather than general anticipatory pleasure. Table 6.2 displays the results of 21 binary logistic regression models predicting above-typical consumption of various products using normalized SNP and NP scale means. Where the dependent variable matched one of the items in the supernormal scale, this item was removed from the scale for this analysis. For example, when predicting TV consumption, the item *"Watching my favourite television*

program", was not included in the aggregated supernormal scale. All 21 supernormal behavioural variables were predicted by SNP. Many behaviours shared moderate to large associations (Cohen, 1988) with supernormal pleasure ratings. For example, eating snacks β=.460, SE =.050, $p < .001$, sweets β=.425, SE =.038, $p < .001$, dessert β=.375, SE =.051, $p < .001$, take away food β=.372, SE =.037, $p < .001$, social networking β=.424, SE =.034, $p < .001$, buying packaged food β=.366, SE =.037, $p < .001$, browsing online β=.332, SE =.036, $p < .001$, and playing video games β=.302, SE =.034, $p < .001$. The remainder of items shared small to medium associations with supernormal pleasure ratings. Furthermore, all but two behaviours (junk mail and magazines) were negatively predicted, or not predicted, by NP after controlling for SNP. Finally, the binarized behavioural variables were aggregated using a simple count; yielding a variable that described the number of behaviours (out of 21) that individuals undertook at above-median levels. The resulting count was approximately normally distributed, and we employed OLS to regress it on NP and SNP. It was negatively predicted by NP β= -.746, SE =.051, $p < .001$, and positively predicted by SNP β= 1.116, SE =.051 $p < .001$.

6.5 Discussion

The current study aimed to develop and validate a pleasure scale that could distinguish between preferences for supernormal and natural pleasure experiences. We used the following two-step process: 1) exploring the factor structure of a list of items designed to reflect either supernormal or natural reward properties, and 2) regressing a broad range of behavioural variables measuring relative quantity/frequency of supernormal product consumption onto the newly formed sub-scales. EFA results revealed a two-factor solution that fit the data well and clearly distinguished between two types of reward.

Table 6.1 *Comparing fit statistics and factor loadings for one and two factor models, with final set of items and Spearman-Brown statistics for items in each factor.*

	One Factor Model	Two Factor Model	
Natural	1	1	2
Being with close family or friends	.542*	.529*	
Engaging in hobbies or pastimes	.473*	.421*	
Having warm bath or refreshing shower	.642*	.523*	
The scent of flowers or a sea breeze^	.747*	.740*	
Seeing other peoples smiling faces	.787*	.808*	
Small things (e.g., a bright sunny day or a phone call from a friend)	.823*	.819*	
A beautiful landscape or view	.781*	.810*	
Helping others	.718*	.757*	
Supernormal			
Watching my favourite television programme^	.393*		.306*
Purchasing a new item such as clothing or and appliance for the house#	.492*		.426*
Receiving a personal message via email, SMS or social networking website#	.483*		.484*
Eating a dessert such as cake, ice-cream or cookies#	.448*		.856*
Eating a savoury snack, such as cheese, crackers, chips or nuts#	.483*		.785*
Spearman Brown ρ	.89	.93	.90
Correlation with factor 1	--		.497*
Chi-Square	6851.594		2818.408
df	65		53
RMSEA	.139		.098
SRMR	.082		.042
AIC	161741.659		157732.473
BIC	161998.766		158068.690
x^2 difference (2 factor vs. 1 factor)	--	4033.186*	

* = Significant at the p <.05, loadings < .25 suppressed. # = author additions, ^ = original item edited by author

That is, natural items loaded positively on the first factor (NP), and items designed to represent supernormal stimuli loaded positively on the second factor (SNP), and with no cross loadings. The two factors were positively correlated (r = .497) reflecting the fact that both SNP and NP are conceptually sub-factors of general anticipatory pleasure – contra-indicative of anhedonia, the construct that the original SHPS was intended to measure. However, concordance of item content with the sub-factor loadings, and the absence of cross loadings between sub-factors, supports the idea that SNP and NP are meaningful sub-constructs of general anticipated pleasure.

Table 6.2 *Logistic regression results predicting above/below median split for each supernormal behavioural variable from mean natural and supernormal pleasure ratings.*

	Range (Median)		**n>med**	**Natural**							**Super**					
				B	*(SE)*	*Wald*		*Lower CI*	*OR*	*Upper CI*	*B*	*(SE)*	*Wald*		*Lower CI*	*OR*	*Upper CI*
Snacks^	1 -7	(2)	2618	-0.200	(0.033)	-6.096	***	1.141	1.180	1.220	0.460	(0.050)	9.229	***	1.508	1.585	1.666
Sweets	1 -7	(3)	1451	-0.231	(0.038)	-6.125	***	0.950	0.982	1.014	0.425	(0.038)	11.123	***	1.473	1.530	1.590
Social Networking	3 – 25	(10)	2548	-0.176	(0.033)	-5.295	***	0.811	0.838	0.867	0.424	(0.034)	12.467	***	1.477	1.528	1.581
Dessert^	1-7	(2)	2494	-0.088	(0.033)	-2.646	**	0.886	0.916	0.947	0.375	(0.051)	7.343	***	1.383	1.455	1.531
Take Away	2 -14	(4)	1576	-0.309	(0.037)	-8.429	***	0.708	0.734	0.762	0.372	(0.037)	10.014	***	1.397	1.450	1.505
Trolley	2 -14	(2)	1682	-0.547	(0.037)	-14.739	***	0.557	0.578	0.600	0.366	(0.037)	9.863	***	1.389	1.442	1.496
Browse Online	1 - 6	(3)	1676	-0.087	(0.036)	-2.441	*	0.884	0.916	0.950	0.332	(0.036)	9.204	***	1.344	1.393	1.444
Video Gaming	2 - 16	(2)	2466	-0.350	(0.034)	-10.385	***	0.670	0.693	0.717	0.302	(0.034)	8.994	***	1.308	1.353	1.399
Soft Drink	2 -12	(4)	2271	-0.367	(0.034)	-10.790	***	0.670	0.693	0.717	0.284	(0.034)	8.380	***	1.284	1.328	1.374
Internet	2 -16	(10)	1632	-0.268	(0.036)	-7.459	***	0.738	0.765	0.793	0.280	(0.036)	7.724	***	1.276	1.323	1.371
Shopping^	2 - 14	(4)	2088	-0.016	(0.033)	-0.473		0.953	0.985	1.017	0.238	(0.048)	4.988	***	1.210	1.269	1.331
Meat Product	1 - 7	(3)	943	-0.302	(0.043)	-7.075	***	1.110	1.147	1.186	0.233	(0.044)	5.342	***	1.208	1.262	1.318
Junk Mail	1 - 6	(3)	2615	0.137	(0.033)	4.155	***	1.110	1.147	1.186	0.221	(0.033)	6.687	***	1.207	1.247	1.289
Pornography	2 - 16	(2)	1371	-0.424	(0.038)	-11.171	***	0.630	0.654	0.679	0.210	(0.038)	5.483	***	1.188	1.234	1.282
Drugs	1 - 6	(1)	348	-0.343	(0.064)	-5.325	***	0.665	0.709	0.757	0.207	(0.067)	3.098	**	1.151	1.230	1.315
TV^	2 - 16	(10)	2542	-0.009	(0.032)	-0.267	***	0.960	0.992	1.024	0.191	(0.044)	4.373	***	1.159	1.211	1.265
Magazines	1 - 7	(1)	2288	0.210	(0.034)	6.208	***	1.192	1.233	1.276	0.165	(0.033)	4.970	***	1.141	1.180	1.220
Salt	2 - 8	(5)	2115	-0.015	(0.033)	-0.454		0.953	0.985	1.018	0.158	(0.033)	4.740	***	1.133	1.172	1.211
Caffeine	8 - 47	(20)	2450	-0.018	(0.033)	-0.559	***	0.950	0.982	1.014	0.138	(0.033)	4.230	***	1.111	1.148	1.186
Gambling	0 - 13	(1)	1681	-0.068	(0.035)	-1.947		0.902	0.934	0.967	0.127	(0.035)	3.602	***	1.096	1.135	1.176
Alcohol	0 - 12	(3)	2385	-0.101	(0.033)	-3.085	**	0.875	0.904	0.934	0.078	(0.033)	2.387	*	1.046	1.081	1.117

*** = p <.001, ** = p <.01, * = p <.05. ^ Supernormal pleasure rating mean calculated without item regarding this specific behaviour.

Multiple regression results added criterion validity to our interpretation of the two-factor solution. SNP and NP display consistent and contrasting relationships with a broad range of supernormal stimuli. When controlling for NP, those scoring higher on SNP were more likely to consume above the median amount of supernormal products. This finding still applied when items describing the dependent variable were removed from the predictor variable. (e.g., When social networking was the dependent variable, the item "*Receiving a personal message via email, SMS or social networking website*" was removed from the SNPS). Effect sizes, although small to moderate for all items, were substantial, considering that it is recognized as generally difficult to directly predict specific behavioural outcomes based on general attitudes or personality traits (Ajzen & Timko, 1986). Anticipated pleasure responses to supernormal stimuli are not likely to predict a large proportion of variance in any one consumption behaviour, but rather a small to moderate amount of variance across a wide range of consumption behaviours.

The items 'junk mail' and 'magazines' did not conform to expectations. Both were predicted positively by supernormal and natural pleasure ratings, and in the case of magazines natural pleasure was a stronger predictor. This could be due to the fact that digital media has somewhat replaced print media in terms of supernormal status (delivering greater speed and accessibility) and that products in print media are an indirect form of supernormal stimuli in that they are only images. When SNP is taken into account, those scoring higher on NP were more likely to fall under the median amount of consumption of supernormal stimuli with the exception of 'shopping' and 'salt' intake, which were not affected by NP.

These results suggest that items measuring anticipated reward from natural and supernormal stimuli can be successfully classified into two correlated but distinct scales. Current findings demonstrate criterion validity, and internal reliability, supporting their use for measuring individual differences in susceptibility to supernormal reinforcement. It

appears that the supernormal and natural pleasure scales reflect the way in which individuals respond differently to experiences involving fabricated products with enhanced reward properties (e.g., sweet foods and retail products), when compared to more natural forms of reward (e.g., being close to friends and family or viewing an attractive landscape). The relationship of SNP and NP to actual behaviour is in line with theoretical expectations. These findings are also consistent with recent findings regarding a latent behavioural factor that explains positive covariance amongst the consumption of alcohol, drugs, cigarettes, fast food, snacks, TV, Internet, gambling products, caffeine, salt, and meat products (Goodwin, Browne, Rockloff, & Donaldson, 2015). SNP preference is a plausible trait-based description of individual differences in this tendency to over-consume.

It has been suggested a preference for supernormal reward could be the result of differences in dopamine functioning. Dopamine deficiency has been found to be related to various forms of excess consumption including alcohol abuse, binge eating, problem gambling and Internet addiction (Bergh et al., 1997; Blum et al., 1996; Johnson & Kenny, 2010; Kim et al., 2011).The concept of supernormal susceptibility is consistent with an interpretation in terms of individual variability in the dopamine functioning. Dopaminergic pathways evolved to prioritize resource acquisition and consumption in a resource-scarce environment are likely to be particularly sensitive to psychoactive substances, energy dense food, and other modern day consumer products exhibiting exaggerated reward properties (Barrett, 2010; Nesse & Berridge, 1997; Wang et al., 2001). If this is the case, then the two-dimensional NP / SNP scale described here would be expected to discriminate individuals with dopamine dysfunction. Future research might profitably employ neurophysiological techniques in conjunction with self-report measures, in order to confirm the correspondences between these two levels of description.

A self-report measure of NP/SNP may help inform the way in which evolved biological reward drives can vary amongst individuals. Although all mammals appear to share species wide adaptions for survival, strategies and preferences employed to achieve survival differ greatly between individuals (Lund, Tamnes, Moestue, Buss, & Vollrath, 2007; Marsh et al., 2010). A recent movement to integrate research into individual differences and evolutionary psychology provides several plausible accounts of how species wide adaptions are expressed differently within individuals (Marsh et al., 2010). Buss (1999) presents several arguments for this, including the effect of heritable genetic predispositions combined with differing environmental and developmental contexts. Therefore, future research might benefit from consideration of the influence of personality trait differences on expression of evolved reward mechanisms. For example, rash impulsivity is often associated with dysfunctional behaviours such as substance use, gambling, excessive retail shopping and binge-eating (Benson et al., 2011; Black, Shaw, McCormick, Bayless, & Allen, 2012; Dawe & Loxton, 2004; Kane et al., 2004; McDaniel & Zuckerman, 2003; Petry, 2001), whereas reward sensitivity tends to predict approach to all rewarding experiences (not just illicit or unhealthy substance such as drugs of abuse or highly appetitive foods; Carver & White 1994; Clark, et al., 2015; Gullo et al., 2011; Harnett et al., 2013; Loxton et al., 2008). It may be that these two personality constructs, amongst others, predict ones' preference toward supernormal stimuli. The current scale provides a tool for measuring this supernormal preference.

Supernormal experiences are inherently unhealthy and amenable to excess consumption due to their processed characteristics (e.g., snacks and take away foods) and encouraging prolonged sedentary behaviour (e.g., social networking and gaming). Therefore, the ability to identify individuals who prefer these types of reward provides a valuable contribution to those researching, treating and preventing population health problems caused by over-consumption.

Limitations

A desire to provide socially acceptable answers is inherent in self-report measures, particularly when items reflect health and lifestyle choices (Arnold & Feldman, 1981; Hebert et al., 1995). It is important to recognize that covariance between pleasure preferences and consumption behaviour may in part be due to individual differences in perceptions of health or the desire to appear healthy. Though less convenient, future research might utilize implicit measures of reward preference using experimental methods and/or objective third party measures of behaviour. This would further strengthen evidence for the construct validity of the scale. It is also acknowledged that some construct overlap may exist between supernormal pleasure ratings and materialism as measured, for instance, by the Values-Oriented Materialism Scale (Richin & Dawson, 1992); since items regarding purchases and acquisition appear in both measures. Inclusion of this scale in future research might provide discriminate validity of the SNPS. Finally, using cross sectional methods, we are unable to provide evidence of test re-test reliability in either the pleasure scale or behavioural measures. Future research should address the stability of such measures using longitudinal research designs.

Conclusion

The current study provides an initial step creating a method of distinguishing between supernormal and natural anticipated pleasure items. Findings inform the fields of evolutionary psychology and personality research, highlighting the way in which biological reward mechanisms may be expressed differently between individuals. Excess-consumption of artificial, highly attractive ‘supernormal’ products in the developed world contributes to a variety of avoidable diseases, debt, and poor socio-emotional well-being. Identifying individuals who are particularly attracted to unhealthy behaviours and vulnerable to over-consumption may play a useful role in the treatment and prevention of various behavioural health problems.

Chapter 7: Supernormal preference in humans: Evidence for construct validity. [manuscript under review for publication]

7.1 Abstract

Many products such as alcohol, energy-dense food, retail and gambling products are designed to appropriate the reward from natural stimuli. Described as 'supernormal', these products often convey a false sense of fitness, hijacking dopamine pathways that originally evolved for the purpose of reinforcing nutritional and reproductive activity in a natural environment. The ready availability of these unhealthy products in modern day western environments is thought to contribute to excess consumption, potentially leading to health problems and addiction. Recently, a self- report measure was developed to capture preference for supernormal over natural stimuli (Supernormal and Natural Pleasure Scale; SNPS). Initial results suggest validity and utility for the SNPS measure and the construct on which it is based (i.e., supernormal preference). The present study utilized an Australian Internet panel of 1024 participants (57% male). A novel version of the Implicit Association Test was used to show that explicit and implicit attitudes towards supernormal pleasures are largely congruous. Findings provide further validity to the construct of supernormal preference, but also show that most people tend to have more positive associations with natural stimuli than they do with artificial products and experiences. Results are discussed in terms of the evolutionary underpinnings of health choices.

7.2 Introduction

The excess consumption of psychoactive substances, energy dense food, and certain media products is a pressing issue in modern Western societies, presenting numerous health and social challenges (e.g., obesity, health decline, and debt). Many hedonic consumer products exhibit artificial and exaggerated reward properties and provide immediate

reinforcement making them amenable to excess use in some individuals. In order to identify those most at risk of excess consumption, it is useful to quantify individual preference toward and/or a propensity to excessively consume unhealthy products. Recently, a self-report scale was developed to measure a preference towards artificial over natural reward: the Supernormal and Natural Pleasure Scale (SNPS; Goodwin, Browne, & Rockloff, 2015). Initial results show promise that the SNPS is a valid and reliable measure with great utility in health, consumer, and individual differences research, however further application and validation of the scale are required. The primary aim of the current study is to further test reliability and validity of the scale, as well as the construct on which it is based.

7.2.1 Supernormal stimuli

Animals and humans tend to exhibit heightened reward responses to exaggerated versions of natural stimuli. This response has been described as ‘selection asymmetry’ whereby an organism’s response to reinforcing stimuli is not upper-bounded – resulting in uncontrolled approach behaviour toward stimuli with exaggerated reward characteristics (Staddon, 1975; Ward, 2013). Similarly, twentieth century ornithology researchers coined the term ‘supernormal stimuli’ when they found that the newly hatched herring gull prefers to peck at a fabricated thin red rod with white bands at its tip, rather than its mother’s naturally red spotted thin beak (Tinbergen and Perdeck, 1951). From this - alongside similar findings (see Barrett, 2010 for review) - it is proposed that stimuli with exaggerated or enhanced reward features will tend to elicit excessive consumption, and be preferred over the natural stimuli for which reward pathways in the brain originally evolved. In a modern human environment, many highly rewarding experiences exist in the form of artificial consumer products that have been designed or refined to be supernormal. These include processed foods, psychoactive substances including alcohol and nicotine, some retail goods, and various

social media and gambling products – all of which are known to be prone to excessive consumption. These products can convey a false sense of fitness, hijacking dopamine pathways that originally evolved for the purpose of reinforcing nutritional and reproductive activity in a natural environment. This is thought to contribute to the excess consumption of unhealthy products, potentially leading to health problems and addiction (Barrett, 2010; Blumenthal and Gold, 2010; Wang et al., 2001).

7.2.2 Individual differences in a preference towards supernormal stimuli

Based on an evolutionary perspective alone, one might expect that an orientation toward supernormal products over natural reward in the human species should take place without exception. However, this is unlikely considering that only some people persistently make unhealthy consumption choices. Several authors have postulated the existence of an underlying trait whereby individuals vary in their attraction towards, and propensity to consume, artificial hedonic stimuli (Faber et al.,, 1995; Villella et al., 2011; Weed et al., 1992; Zeinali & Vahdat, 2011). Recently, it was shown that individual differences in a general trait of ‘consumptiveness’ explained co-variation in a variety of artificial appetitive products (Goodwin, Browne, Rockloff, & Donaldson, 2015). To measure this general trait, Goodwin, Browne, and Rockloff (2015), developed the Supernormal and Natural Pleasure Scale (SNPS), a two-dimensional self-report instrument designed to measure anticipatory pleasure towards both natural stimuli (e.g., spending time with family and friends and viewing an attractive landscape) and supernormal stimuli (e.g., watching television and eating snack food). Self-reported supernormal anticipatory pleasure predicted increased consumption of a broad range of supernormal consumer products including, alcohol, salt, snacks, gambling, retail products, and digital media. Conversely, higher scores on the natural factor were either negatively related or not related to consumption of each of these products.

Goodwin, Browne, & Rockloff (2015) presented results to suggest the SNPS is a valid and reliable self-report measure of preference for supernormal stimuli. However, further validation of both the scale and the construct itself are required. For example, consumption of natural products (e.g., fruit and vegetable intake) were not measured in the previous study, meaning it was difficult to assess whether the trait represented a preference for consumable items in general or just those with supernormal properties (Goodwin, Browne, & Rockloff, 2015).

The Implicit Association Test (IAT) is a widely used picture and word sorting task that measures implicit preferences and attitudes that may be otherwise socially undesirable to report (Greenwald et al., 1998). The IAT provides a measure of relative strength of associations between concepts; in some cases, pictures of one category of stimuli and positive adjectives (e.g., joyful, lovely, superb), and pictures of another category of stimuli and negative adjectives (e.g., painful, awful, nasty). Participants are instructed to complete each trial as quickly as possible, whereby responses rely on automatic cognitive processes that do not allow time for controlled thought (Evans, 2008), including considerations of social acceptability or managing self –presentation. The IAT paradigm has been successfully applied in several studies measuring implicit health related attitudes and consumer preferences (Schwartz et al., 2003; Swanson et al., 2001; Teachman & Brownell, 2001). The IAT should therefore be a useful tool in assessing implicit preferences towards supernormal vs. natural forms of stimuli.

7.2.3 Study aims

In the current study, we measure both explicit and implicit attitudes towards a range of rewarding experiences. The key aim is to test whether self-reported supernormal preference (explicit attitudes measured by the SNPS) predicts implicit associations with

supernormal stimuli. In confirming this, we will not only strengthen the utility of the SNPS measure, but also the validity of the construct of 'supernormal preference' as an automatic positive consideration of such products. A secondary aim is to determine whether supernormal preference is negatively related to the consumption of natural products (i.e., fruit and vegetables).

7.3 Methods

7.3.1 Participants and procedure

Participants (n= 1024, 57% male) were members of on an online survey panel maintained by an agency specializing in the recruitment of survey participants (myopinions.com.au). Emails were sent to panel members inviting them to participate in the online survey and experiment for which they could earn points that could be accumulated and exchanged with the agency for cash. Participants completed the survey prior to the reaction time task component which was presented online after the survey. Together, participation in the study took approximately 25 minutes. Before the reaction time task, participants were advised that it was a timed activity and to find a quiet place to complete it free from distraction. Ages ranged from 18 to 84 years old (M=47.82, SD=16.33). The majority of participants were born in Australia (74.5%), with the remainder born in the United Kingdom (7.9%), Asia (6.9%), Europe (3.6%) or other countries (7.1%). Participants provided informed consent and the study was approved by the university's Human Research Ethics Committee.

7.3.2 Measures

Implicit Association Test: The IAT (Greenwald et al., 1998) is a computer based categorization task that indirectly assesses the relative strength of associations between

concepts. Participants sort stimuli into four categories, using two response keys on a computer's keyboard. Two categories are the *attributes* (typically, pleasant or unpleasant words), and the other two categories are the *targets* (e.g., artificial and natural pictures). Combinations of these categories appear at the top right and left corners of the screen (e.g., 'artificial' and 'unpleasant' on one side and 'natural' and 'pleasant' on the other). A series of words and images appear in the middle of the screen and respondents are asked to indicate which category a word or image belongs. For example they might be asked to use the 'I' key (with the right hand) to allocate stimuli to the categories on the right side of the screen and the 'E' key (with the left hand) to allocate stimuli to the categories on the left side of the screen (see *Figure 7.1*). After several rounds, categories will appear in a different combination (e.g., 'artificial' and 'pleasant' on one side and 'natural' and 'unpleasant' on the other), meaning that a different pair of categories will now share a response key. The IAT effect is the difference in reaction times for the two combinations of targets and attributes. In essence, one ought to take relatively longer to match (i.e., use the same response key for) supernormal stimuli and unpleasant words if they have an implicit preference towards supernormal stimuli.

In the current study, the IAT was developed using Inquisit © software, a flexible syntax based program for presenting visual computerised tasks and recording precise reaction times (Inquisit, 2015). Each participant in this study completed two counterbalanced IATs, for which the targets (N = 54 the pictorial stimuli) varied randomly. In one task they were asked to categorize pictures of various fresh foods (e.g., vegetables, fruit and raw nuts; N=12) and processed foods (e.g., deli meats, commercial 'junk food', and desserts; N=12) as well as natural scenes (e.g., beaches and landscapes; N=3) and retail scenes (e.g., clothing and home wares stores; N=3) as either *natural* or *artificial*. In the other task, participants categorized pictures of traditional activities and products (e.g., hiking, swimming, and playing chess;

N=12), and technological activities and products (e.g., pokie machines, playing video games, and smart phones; N=12) as either *technological* or *traditional* experiences. *Figure 7.1* provides four examples of single trials. Images on the top row (a) show two examples of trials in the Artificial versus Natural task in the supernormal congruent condition. The correct response in the first trial is to allocate the picture of grapes to the 'Natural' category using the 'I' key. In the second, the correct response is to allocate the word 'Humiliate' to the 'Unpleasant' category, also using the 'I' key. Images on the bottom row (b) show two examples of single trials in the Artificial versus Natural task in the natural congruent condition. The correct response in the first trial is to allocate the picture of the candy to the 'Artificial' category using the 'I' key. In the second, the correct response is to allocate the word 'Beautiful' to the 'Pleasant' category, using the 'E' key.

Supernormal Preference: Preference for supernormal pleasure was measured using the Supernormal and Natural Pleasure Scale (SNPS; Goodwin, Browne, & Rockloff, 2015). It contains two subscales that measure anticipatory pleasure in response to supernormal stimuli (e.g., "*Watching my favourite TV show*") and natural stimuli ("*Seeing other people's smiling faces"*). Participants are asked how much pleasure they anticipate in response to each experience by responding on a 5 point Likert scale (1 = "*none or neutral*" to 5 = "*There is nothing I would enjoy more*"). Items were averaged within each subscale to create aggregate scores. General anticipatory pleasure was calculated via the sum of the two means. Supernormal preference was calculated by the difference between the two means.

Fruit and vegetable consumption: Participants were asked, in two separate questions, "*On average how much/many fruit/vegetables do you eat?"*. Responses were recorded on an 8-point Likert scale, (i.e., "1 = none, 2 = one serve a week or less, 3 = two to four serves per

week, 4 = five to six serves per week, 5 = one serve per day, 6= two to three serves per day, 7 = four to five serves per day, and 8 = more than five serves per day").

Figure 7.1 Examples of single trials from the IAT measure.

7.3.3 Statistical analysis

Firstly, we confirmed the two-factor structure the SNSP in the Goodwin, Browne, & Rockloff (2015) study Zero –order correlations were used to test the relationship between supernormal preference and fruit and vegetable consumption. Before analysing the IAT data, all response times were checked for any occasions where any participant had taken over 10,000ms (10 secs) to make a response, reflecting potential disengagement in the task. No cases above his threshold were found. Secondly, a linear mixed model was specified to test the effect of self-reported supernormal preference on latencies in the supernormal-congruent and the natural-congruent conditions in the IAT. Table 7.1 labels and describes all of the analysis variables and provides the R code used to specify the model. It is shown here that the model takes into account the random effects of individual differences and stimuli differences

(each picture and word) on response times (Latency). The variance in latencies due to individual differences in response times for each task and each condition are also included in the model. Similarly, variance in latencies due to the effect of different stimuli on the supernormal congruent condition (i.e., random slopes) are included in the model. Additionally, the model includes fixed main effects of age, task, condition, general pleasure, and supernormal preference. To test the main hypothesis that self-reported supernormal preference predicts positive associations with supernormal stimuli, we tested the interaction effects of condition by supernormal preference.

Table 7.1 *Labels and descriptions of all study variables and the R code used to specify model.*

Variable label	Description
ID:	Participant unique ID code
Age:	Participant age
Artificial versus natural task:	Whether latency was recorded in the task asking participants to match Artificial and Natural stimuli (0) or the Technological versus Traditional Task (1)
Stimuli:	The stimuli for which the response latency was recorded
Supernormal congruent:	Whether latency was recorded in the natural preference condition (0; e.g., categorizing supernormal and pleasant with the same key) or the supernormal preference condition (1)
Latency:	Response time in milliseconds
General pleasure:	The sum on all items on the SNPS for each participant
Supernormal preference:	The difference between the mean of the natural subscale and the mean of the supernormal subscale of the SNPS.

R code

```
Latency ~ Age + Artificial versus natural task + Supernormal congruent * General pleasure +
Supernormal congruent * Supernormal preference + (Supernormal congruent + task | ID) +
(Supernormal congruent | Stimuli)
```

The model was applied to three versions of the dataset: 1) a dataset including only the latencies associated with the 16 pictorial stimuli that matched items in the SNPS, 2) a full dataset that included all 56 pictorial stimuli, and 3) a dataset that *excludes* the latencies associated with the 16 pictorial stimuli that matched items in the SNPS. This allowed us to make the inference that the construct of supernormal preference, both explicit and implicit,

reflected a general orientation to supernormal stimuli and is not target specific. Each dataset included latencies associated with the 16 word stimuli.

7.4 Results

Results confirmed the two-factor structure of the SNPS (see Table 7.2)., All items loaded positively on their corresponding factor and model fit statistics suggested a acceptable data fit. As predicted, correlations showed that supernormal preference was negatively related to both fruit (r = -.108, p < .001) and vegetable (r = -.199, p < .001) intake. General pleasure was positively related to both fruit (r = .108, p < .001) and vegetable (r = .139, p < .001) intake.

Table 7.3 outlines the results of the linear mixed effect model using three version of the dataset. Results from the full dataset (2) showed that when controlling for the random intercept effects, significant fixed main effects were found for age (β= 6.26, SE =0.35, p < .001), task (β= -56.57, SE = 4.60, p < .001) and condition (β= 201.12, SE =45.44, p < .001).

Significant fixed interaction effects for condition by general pleasure (β= 24.05, SE =6.11, p < .001) and condition by supernormal preference (β= -55.43, SE = 10.12, p < .001) were found. This pattern of results was similar across the three datasets tested. Using the most reduced dataset (1), fixed effects of task (β= 32.97, SE = 30.30, p, =.29) condition by general pleasure (β= 21.55, SE = 7.47, p < .01), and condition by supernormal preference (β= -52.24, SE = 12.32, p < .001) were somewhat weaker, but nonetheless remained significant suggesting that (as hypothesized) supernormal preference reflects a general orientation to supernormal stimuli that is not target specific.

Table 7.2 *Factor loadings and fit statistics for the two-factor SNPS.*

Natural	1	2

Being with close family or friends	.522*	
Engaging in hobbies or pastimes	.358*	
Having warm bath or refreshing shower	.567*	
The scent of flowers or a sea breeze	.672*	
Seeing other people's smiling faces	.815*	
Small things (e.g., a bright sunny day or a phone call from a friend)	.818*	
A beautiful landscape or view	.678*	
Helping others	.672*	
Supernormal		
Watching my favourite television programme		.562*
Purchasing a new item such as clothing or and appliance for the house		.576*
Receiving a personal message via email, SMS or social networking website		.647*
Eating a dessert such as cake, ice-cream or cookies		.650*
Eating a savory snack, such as cheese, crackers, chips or nuts		.603*
	Correlation with factor 1	.558*
	Chi-Square	565.855*
	df	64
	RMSEA	.088
	SRMR	.056
	AIC	31266.886
	BIC	31464.145

* = Significant at the $p < .05$

Bivariate correlations between implicit supernormal preference (i.e., the difference between response latencies in supernormal incongruent versus congruent conditions) revealed that supernormal preference was significantly negatively related to vegetable ($r = -.096$, $p < .01$), but not fruit ($r = -.032$, $p = .305$) intake.

7.5 Discussion

If the impact of supernormal stimuli on human consumption is to be investigated with vigor, then valid and reliable measures of supernormal susceptibility are required. The current study sought to validate the SNPS as a two-dimensional self-report measure of supernormal versus natural preference. Support for reliability and validity of the scale were achieved by 1) replicating the two-factor item structure of the SNPS from the 2015 study, 2) confirming that

supernormal preference was negatively associated with fruit and vegetable intake, and 3) demonstrating that implicit preferences towards supernormal products are related to self-reported preference scores on the SNPS. The main aim of the IAT was to demonstrate that supernormal preferences expressed explicitly in the SNSP are consistent with the automatic positive associations revealed in implicit attitudes.

7.5.1 The SNPS factor structure and healthy consumption

The two factor structure of scale items revealed in the current study was identical to that of the Goodwin, Browne, & Rockloff, (2015) study (many of the item loadings were notably higher), with the exception of the item *"Receiving a personal message via email, SMS or social networking website"* which weakly cross-loaded on the natural factor. This replication of results demonstrates cross sample invariance that helps validate the scale for use in future research. As expected, individuals with a high self-reported supernormal preference consumed less fruit and vegetables and individuals with high implicit supernormal preference consumed less vegetables. The effect for fruit was slightly weaker (and non-significant in the case of implicit supernormal preference), which is understandable considering that, in comparison to vegetables, fruit tends to exhibit more exaggerated reward features (e.g., sweeter taste and often brighter, more colourful appearance); particularly through modern agricultural practices. These findings in aggregate further highlight the utility of the SNPS for detecting a preference for artificial stimuli, strengthening the scales construct validity.

7.5.2 Response times in natural and supernormal congruent IAT conditions

A positive relationship between condition and response times demonstrated that overall participants showed a preference for natural stimuli (i.e., response times were

significantly faster in the natural congruent condition than in the supernormal congruent condition). Although the response times within each condition varied greatly, even after individual differences were control for, results showed that overall people have an implicit preference towards natural and traditional consumables, activities and experiences. Although the human reward system has evolved to be excited by exaggerated reward features, it may be that modern day supernormal stimuli does not 'hijack' this reward system in the same way that has been seen in animals; a somewhat encouraging notion. Alternatively, this finding may demonstrate the way in which humans have been conditioned over time, through education and/or experience, to associate unhealthy or unnatural products with negative outcomes (e.g., sedentary behaviour, pain, poor-health, and debt). This means that although the image of a decadent dessert is still likely to excite reward pathways, automatic cognitions immediately identify the stimuli as bad for wellbeing and subsequently implicitly 'unpleasant'. In real world contexts, synthetic products and experiences may be cheaper and easier to access, and thus a relative weakness for the supernormal still has important implications for human health.

7.5.3 Explicit and implicit supernormal preference

Controlling for age, individual differences, task, and stimuli differences, those higher in supernormal preference on the SNPS exhibited shorter response times in the supernormal congruent condition, suggesting that explicitly reported supernormal preference was reflected in implicit positive associations with supernormal images. Importantly, these results remained stable when pictorial items that represented SNPS scale items were removed from the dataset. Together these findings provide support, not only for the validity of the SNPS as a measure for supernormal preference, but also for the notion that an orientation towards the supernormal is not 'stimuli' specific. That is, an individual's general preference for

supernormal stimuli is reflected in implicit positive associations with a range other forms of supernormal stimuli, not only those which they explicit anticipate will be highly pleasurable.

Selection asymmetry provides an evolutionary based explanation for the development of a preference for supernormal consumer products. Although reward responses evolved to promote adaptive behaviour, certain behaviours can be associated with both adaptive and non-adaptive outcomes in different contexts (Lewis, 2015). For example, in our evolutionary past the ability to react swiftly to physical threats was adaptive to survival; but in a modern context, an over-active stress response often results in hyper-vigilance and anxiety. Selection asymmetry may follow a similar explanation. Intense or concentrated forms of reward in a natural environment tend to signify opportunities; whether for improvement in group-status, mating opportunities, or nutrition. However, the application of selection asymmetry in modern human environments can lead to excess consumption of products such as alcohol, gambling, luxury retail items, and energy dense food and can be highly detrimental to one's health and financial security. In efforts to reduce excess consumption of unhealthy products in the general population, it may be useful to apply an evolutionary perspective in describing maladaptive health behaviours in the same way that it is applied in psycho-education around anxiety disorders (Haslam-Hopwood, et al., 2006).

Limitations and future research

The effect size associated with the key finding regarding the interaction effect of condition by supernormal preference was small (r = .13). This may be partly due to the fact that automatic cognitive processes involved in IAT responses do not allow time for socially desirable responses common in self-report health measures (Johnson et al., 2012; Van de Mortel et al., 2008). Thus, much of the variance in SNPS responses may be due to individual differences in perceptions of health or the desire to appear healthy, rather than actual

attitudes. Accuracy in measuring true attitudes towards health behaviours may be improved in future research with the use of implicit measures. In addition, research into the SNPS thus far has been cross sectional only, therefore test re-test reliability cannot be assumed. It may be that supernormal preference is better describes as a state that varies across different time points, rather than a stable trait, and longitudinal research is required in the future to address this issue.

Conclusion

The current study provided support for construct of individuals preference toward supernormal over natural stimuli. Findings suggest that implicit positive associations with images of supernormal consumer products are positively related to self-reported preference for supernormal reward. This supports the theory that individuals may vary in their orientation to, and subsequent propensity to consume, unhealthy products. This contributes an evolutionary based understanding of harmful health behaviour, usefully informing future research and harm prevention initiatives

Table 7.3 *Multilevel model parameters for effect of subject, stimuli, task, condition, and supernormal preference on latencies for the three datasets.*

Fixed effects		**Data (1)**				**Data (2)**				**Data (3)**			
		B	**SE**	***t***		**B**	**SE**	***t***		**B**	**SE**	***t***	
	(Intercept)	542.82	49.59	10.95	***	657.11	41.05	16.01	***	644.90	41.17	16.27	***
	Age	7.40	0.39	18.93	***	6.26	0.35	17.85	***	6.11	0.35	17.43	***
	Natural versus artificial task	32.97	30.30	1.09		-56.57	4.60	-12.29	***	-56.77	4.60	-12.29	***
	Supernormal congruent	262.26	63.12	4.16	***	201.12	45.44	4.43	***	185.30	45.75	4.05	***
	General pleasure	2.17	6.05	0.36		-1.29	5.27	-.24		-1.90	5.26	-0.36	
	Supernormal preference	12.93	10.16	1.27		8.01	8.88	.90		7.74	8.87	0.87	
	Supernormal congruent x General pleasure	21.55	7.47	2.88	**	24.05	6.11	3.94	***	24.65	6.14	4.01	***
	Supernormal congruent x Supernormal preference	-52.24	12.32	-4.32	***	-55.43	10.12	-5.48	***	-55.37	10.18	-5.44	***
Random effects			**Variance**				**Variance**				**Variance**		
ID	(Intercept)		32185				34048				33879		
	Condition		43858				42870				42538		
	Task		18388				14227				14039		
Stimuli	(Intercept)		3545				2852				2872		
	Condition		18161				11419				9119		
	Residual		133591				143367				144305		

*** = $p < .001$. ** = $p < .01$, * = $p < .05$. Data (1): Dataset includes only pictorial stimuli that matches items on the SNPS, Data (2): All stimuli included, Data (3): Only pictorial stimuli that does not match items on the SNPS included

Chapter 8: Rash impulsivity predicts lower anticipated pleasure response and a preference for the supernormal. [published manuscript]

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8.1 Abstract

Alcohol, other psychoactive substances, high calorie foods, media entertainment, gaming, and retail products are all forms of modern supernormal stimuli. They exhibit exaggerated features that activate evolved reward systems more so than the natural stimuli for which these systems are adapted. Recent findings suggest that people may vary in the strength of their preference toward supernormal stimuli. The current study assessed whether the two-factor model of impulsivity (Dawe & Loxton, 2004) predicts a preference for supernormal stimuli. A cross-sectional survey design (n=5389) was used to measure anticipatory pleasure for both supernormal and natural-reward experiences; and their hypothesized antecedents: Rash impulsivity (RI) and reward drive (RD). As predicted, RI was positively associated with preference for supernormal stimuli and negatively associated with general anticipatory pleasure ratings. In contrast, RD was positively associated with general pleasure ratings, but explained little to no variance in supernormal preference when controlling for RI. The findings link trait rash impulsivity with increased sensitivity to supernormal stimuli, and provide new insights into both constructs.

8.2 Introduction

Alcohol, other psychoactive substances, high calorie foods, media entertainment, gaming, and retail products are often consumed in excess, contributing to poorer health outcomes for many people. Rash impulsivity (RI) and reward-drive (RD) are associated with excess consumption of such products (Gullo et al., 2014; Kane et al., 2004). This has lead to the suggestion that these traits may play a role in some people's general propensity for excessive and unhealthy consumption (Goodwin, Browne, Rockloff, & Donaldson, 2015;

Kane et al., 2004). Recently, factor analytic studies have uncovered a potential latent trait reflecting individual differences in general consumption of hedonic stimuli (Goodwin, Browne, Rockloff, & Donaldson, 2015) and preferences toward particular types of reward (Goodwin, Browne, & Rockloff, 2015). In this paper, we link these reward preferences to trait/personality measures of RI and RD.

Supernormal Stimuli

Human beings often consume unhealthy stimuli, despite an awareness of subsequent negative consequences (e.g., obesity, pain, financial debt, etc.). One explanation for this based in evolutionary theory, is that human reward systems evolved to suit an environment in which resources were scarce and self-limiting consumption was not adaptive. In non-natural environments, where resources are plentiful, humans (along with other species) retain a tendency towards uncontrolled consumption of stimuli that are interpreted as conferring fitness: a phenomenon labelled as 'selection asymmetry' (Staddon, 1975; Ward, 2013). In this model, "supernormal" stimuli - those that possess exaggerated versions of naturally rewarding features, ought to be particularly attractive. For example, processed foods that contain concentrated and refined sugars and carbohydrates are attractive because they exaggerate the features found in seeds and fruits – a valuable and fitness-conferring resource in natural environments. For modern humans, highly appetitive experiences exist in a variety of artificial consumer products that have been carefully designed to maximize desirability. This broad range of products can be understood as supernormal-stimuli due to one common property; they invoke an evolved pre-disposition to respond to a degree not found in natural stimuli (Barrett, 2010). For example, psychoactive drugs (e.g., cocaine) are thought to mimic adaptive rewards by giving off a false and exaggerated sense of fitness and vitality (Nesse & Berridge, 1997). Industrially manufactured foods are carefully designed to provide enhanced

appearance, smell, texture, and taste characteristics that can stimulate reward pathways more so than more natural food sources. More speculatively, television shows (Barrett, 2010), digital social networking (Rocci, 2013; Ward, 2013), and various retail products (Etcoff et al., 2011; Morris et al., 1995) have also been discussed as forms of modern supernormal stimuli due to properties that increase feelings of social status and belonging.

Supernormal experiences tend to be inherently unhealthy due to eliciting uncontrolled consumption, being synthetic nature, and often encouraging prolonged sedentary behaviour (e.g., media consumption and gambling). This poses an important question for behavioural-health: Are some people generally more sensitive to reward from supernormal stimuli and therefore more susceptible to excess consumption of unhealthy products?

Individual differences and supernormal stimuli

Evolutionary adaptions to environments are typically species wide, however, many specific traits are associated with both benefits and costs to adaptive fitness and therefore even highly species-typical behaviours vary between individuals and situations (Lewis, 2015). Likewise, whilst virtually all people are prone to the allure of supernormal stimuli, one would expect to observe individual differences in susceptibility. A recent confirmatory factor analytic study analysed covariance between the consumption of various artificial products: alcohol, drugs, cigarettes, fast food, snacks, TV, Internet, gambling products, caffeine, salt, and processed meat products; as well as several natural products (Goodwin, et al., 2015). A uni-dimensional latent factor with positive loadings for all artificial (but not natural) products fit the data well, suggesting that this behavioural trait may be interpreted as an orientation towards supernormal stimuli. However, pleasure is felt from a variety of experiences including those that are natural or not markedly artificial (e.g., viewing a landscape or helping others; Snaith et al., 1995). In a subsequent study, Goodwin, Browne, &

Rockloff (2015) developed a measure of anticipatory pleasure. Factor analysis revealed a clear two factor structure corresponding to two subdomains of anticipatory pleasure: one included items regarding supernormal stimuli (e.g., television and snack food) and the other included items regarding natural stimuli (e.g., smiling faces and attractive landscapes).

Neurological evidence supports the idea that some people are more susceptible to consummatory stimuli than others. For example, those who struggle with weight and eating problems show even greater activation of reward pathways to palatable food and food-related cues (e.g., knives, forks) than normal weight/non-eating disordered individuals (Stoeckel et al., 2008). Thus, individual differences in a general susceptibility to supernormal stimuli would be consistent with some individuals exhibiting sensitive dopamine pathways.

Reward drive and rash impulsivity

Impulsivity in general has been associated with specific risky behaviours such as substance abuse, problem gambling, and excessive video-gaming (Walther et al., 2012), yet varied models of impulsivity derived from different theoretical backgrounds have been applied across previous studies of personality and addiction. For example, Whiteside and Lynam (2001) describe multi-factor models of impulsivity largely based on the factor analysis of self-report questionnaire data. Factors include urgency, lack of premeditation, lack of perseverance and sensation seeking (Whiteside & Lynam, 2001). More recently, conceptualizations of impulsivity, particularly as related to addictive behaviours, have focused on two distinct dimensions based on separate neural processes (Dawe & Loxton, 2004; Gullo, et al., 2014). While both conceptualizations share similarities, it has been demonstrated that the two-factor model is the more parsimonious approach for understanding addictive behaviours (see Gullo et al., 2014). In this model, the first dimension, reward drive (RD) refers to the tendency of an organism to initiate goal-directed approach behaviour in

response to signals of reward. Reflecting Gray and McNaughton's, (2000) motivational Behavioural Approach System (BAS), RD involves the mesolimbic dopaminergic pathways; a brain region associated with natural reinforcement as found in response to food, sex, and drugs, and moreover, in the prediction of potential reward (Hernandez & Hoebel, 1988; Krüger, Hartmann, & Schedlowski, 2005). There has been a rapidly increasing body of evidence supporting the association between RD and a range of consumption behaviours (see Gullo, et al., 2014 for a review). For example, heightened RD has been consistently associated with binge-eating, having a preference for foods high in fat and sugar, a preference for colourful and varied food, hazardous drinking, and an early age of drug experimentation (Davis. et al., 2007; Dissabandara et al., 2014; Kane, et al., 2004).

The second dimension, rash impulsivity (RI) refers to difficulties in inhibiting one's behaviour following the activation of an approach response despite potential negative consequences. The second facet is proposed as involving dysfunction in the orbitofrontal cortex and the ventromedial prefrontal cortex; areas associated with impulse control and decision-making (Dawe & Loxton, 2004). RI has been associated with chronic alcohol and poly-drug use (Gullo, et al., 2011), pathological gambling (Walther, et al., 2012) and compulsive shopping (Black et al., 2012).

These findings have prompted research into the unique contributions of each of these dimensions to health and lifestyle choices. When both constructs are considered as predictors in the same model, RI and RD both explain unique variance in alcohol use and drug use. However, RI appears to be the stronger predictor of the two (Gullo et al., 2011; MacLaren, et. al., 2012). Highly reward driven individuals experience heightened positive affect in rewarding situations and have been found to report greater psychological well-being and hope, and to experience greater sociability and less loneliness (Clark et al.,, 2015; Harnett et al., 2013). This suggests that RD can be involved in both functional and less desirable reward

outcomes. High RD individuals might therefore be likely to experience high anticipatory pleasure for all rewarding experiences, whether or not those experiences could be construed as supernormal. RI, on the other hand, is primarily associated with more dysfunctional behaviours such as substance use, gambling, excessive retail shopping, and binge-eating (Black, et al., 2012; Dawe et al., 2004; Kane et al., 2004; Walther, et al., 2012). All of these dysfunctional behaviours would appear to fall into the supernormal category of stimuli. Thus, high RI individuals should anticipate more pleasure from supernormal stimuli, rather than reward stimuli in general.

8.3 The current study

Impulsive personality characteristics are consistently associated with unhealthy behaviours (Gullo et al., 2014); and more recently, research has focused on the unique effects of two separate dimensions of impulsivity on functional and clearly dysfunctional behaviours. The supernormal / natural distinction appears to be a useful organizing principle for understanding stimuli that particularly encourage excessive consumption. The aim of this study is to investigate the relationships between the two-factor model of impulsivity (RD and RI) on preferences for supernormal (versus natural) pleasurable stimuli. We tested the following predictions:

1. Reward drive is associated with general anticipatory pleasure, but not preference for supernormal over natural stimuli;

2. Rash impulsivity is associated with a differential preference for supernormal stimuli, but not general anticipatory pleasure.

8.4 Methods

8.4.1 Participants and procedure

Data for the current study was collected as part of a large research project. Factor analysis results involving the SNPS items have been published previously in a separate manuscript (Goodwin, Browne, & Rockloff, 2015). Participants (n = 5391, 51% female) were members of on an online panel set up by an agency specializing in the recruitment of survey participants in Australia (MyOpinions.com.au). Emails were sent to panel members inviting them to participate in the online survey for which they could earn points that could be accumulated and exchanged with the agency for cash. The full survey took approximately 20 minutes to complete. Ages ranged from 18 to 87 years old (M=49.01, SD=16.50). The majority of participants were born in Australia (74%), with the remainder born in either the United Kingdom (8.4%), New Zealand (2.7%) or elsewhere (14.9%).

8.4.2 Measures

Supernormal and Natural Pleasure: Preference for supernormal pleasure was measured using the Supernormal and Natural Pleasure Scale (SNPS; Goodwin, Browne, & Rockloff, 2015). It contains two subscales that measure anticipatory pleasure in response to supernormal stimuli (5 items; e.g., "*Watching my favourite TV show*") and natural stimuli (8 items; "*Seeing other people's smiling faces"*). Participants are asked how much pleasure they anticipate in response to each experience, responding on a 5 point Likert scale (1 = "*none or neutral*" to 5 = "*There is nothing I would enjoy more*"). Items were averaged within each subscale to create aggregate scores. General anticipatory pleasure was calculated via the sum of the two means. Differential preference for supernormal stimuli was calculated by the

difference between the two means. Cronbach's alphas for the natural subscale, the supernormal subscale and in total were .88, .78, and .89, respectively.

Rash Impulsivity: Rash impulsivity was measured using a short version of the Barratt Impulsivity Scale (BIS-15; Spinella, 2007) consisting of 15 statements in which participants must rate the extent to which they agree with each statement on a 4-point Likert scale (1, Strongly Disagree; 2, Disagree; 3, Agree; 4, Strongly Agree). The measure includes five questions from three subscales; Attentional (e.g., *"I don't pay attention"),* Motor (e.g., *"I act on the spur of the moment"*), and Non-planning (e.g., *"I am a careful thinker. [inverted]").* Cronbach's alpha in the present sample was .83

Reward Drive: The Behavioural Approach Scale (BAS) from the Behavioural Inhibition and Approach Scale (BIS/BAS) was used to measure RD. This includes three subscales 1) Drive, assessing a persistence in pursuing desired goals (e.g., *"When I want something, I usually go all out to get it"*) and 2) Reward Responsiveness scale, focused on the response to occurrence or anticipation of reward (e.g., *"When I'm doing well at something, I love to keep at it"*) and 3) Fun seeking (e.g, *"I crave excitement and new sensations"*). Items were measured on the 4-point Likert scale described above. Cronbach's alpha coefficients in the current study were all .80 and above (Reward Responsiveness, a = .81, Drive a = .88, Fun seeking, a = .80, Total BAS, a = .81). As reported previously (Dawe & Loxton, 2004), RI and RD were weakly to moderately correlated in the current study (r= .26). Missing data for single items were replaced using a single imputation method before aggregation.

8.5 Results

As shown in Table 8.1, females rated natural and general pleasure, and RD significantly higher than males, whereas males exhibited higher supernormal pleasure, supernormal preference, and RI. Younger participants reported lower natural pleasure ratings and higher supernormal ratings and preferences, as well as higher RD, and higher RI scores.

Several multiple regressions were conducted to test the effects of the two-factor model of impulsivity on both general anticipatory pleasure ratings and relative preference for supernormal stimuli. Multi-collinearity was not apparent amongst the variables in each regression analysis with tolerance values well above .2 (Menard, 1995). As shown in Table 8.2, gender and age alone explained 8% of the variance in general pleasure ratings. RD was a positive predictor of general pleasure ratings $\beta = .370$, $p < .001$, explaining an additional 13% of variance. RI negatively predicted general anticipatory pleasure ratings $\beta = -.071$, $p < .001$, but accounted for very little additional variance after controlling for age and gender. When entered simultaneously, RI $\beta = -.170$, $p < .001$ and RD $\beta = .414$, $p < .001$, accounted for 15% of unique variance in general anticipatory pleasure, with larger standardized beta coefficients compared to when entered singly. This suggests that the 'pure' constructs of RD and RI, corresponding to the covariance that is not shared with the other, have the strongest associations (in opposite directions) with general anticipatory pleasure.

Table 8.3 compares regression models for differential preference for supernormal stimuli. Gender and age alone explained 7% of the variance. Reward drive alone was a positive predictor of supernormal preference $\beta = .105$, $p < .001$, but explaining only an extra 1% of variance. Rash impulsivity alone positively predicted supernormal preference $\beta = .193$, $p < .001$, accounting for an extra 4% of variance. When entered simultaneously, they together accounted for 4% unique of variance in supernormal preference. Beta coefficients for RI and RD both decreased (RD decreasing more so, and changing sign from positive to negative),

when entered simultaneously. This implies that the variance unique to RD that is not shared with RI, has a neutral or negative association with supernormal preference. However, RI maintains a positive relationship with supernormal preference, regardless of whether or not RD is controlled for.

Table 8.1 *Descriptive statistics by age group, gender and total with t-tests.*

	Total	Male (n= 2592)	Female (n= 2799)			<50 yrs (n= 2611)	≥ 50 yrs^ (n= 2780)		
	M (SD)	M (SD)	M (SD)	*t*	*d*	M (SD)	M (SD)	*t*	*d*
Natural Pleasure	3.58 (0.68)	3.39 (0.68)	3.76 (0.63)	20.49***	.56	3.47 (0.68)	3.68 (0.67)	-11.69***	.31
Supernormal Pleasure	2.96 (0.66)	3.09 (0.64)	2.81 (0.66)	16.04***	.43	3.00 (0.67)	2.93 (0.66)	3.37***	.11
General Pleasure	3.27 (0.59)	3.10 (0.58)	3.42 (0.55)	21.00***	.56	3.23 (0.60)	3.31 (0.58)	-4.79***	.14
Supernormal Pref.	-0.31 (0.32)	-0.29 (0.32)	-0.33 (0.32)	-4.91***	.12	-0.24 (0.31)	-0.38 (0.31)	16.04***	.45
Reward Drive#	34.64 (5.86)	34.39 (5.69)	34.87 (6.00)	03.00**	.08	36.16 (5.81)	33.23 (5.54)	18.93***	.51
Rash Impulsivity#	32.05 (5.89)	32.23 (5.81)	31.87 (5.95)	2.20*	.06	32.61 (5.85)	31.52 (5.88)	6.82*	.19

^Age categories based on median split, # variables based on sum total, others based on mean, *** = p <.001,** = p <.0,1* = p <.05, d = Cohen's d effect size.

Table 8.2 *Standardized regression coefficients for RI and RD predicting general anticipatory pleasure (n = 5389).*

	β				Zero-order correlations (*r*)		
Model	(1)	(2)	(3)	(4)	Age	RD	RI
Gender	-.282	-.276	-.277	-.268	.08	-.04^	.03^
Age	.083	.181	.074	.181		-.29	-.11
RD		.371		.414			.27
RI			-.070	-.170			
R^2	.08	.21	.09	.23			
F	243.46	474.34	172.94	415.16			

DV = General anticipatory pleasure; Supernormal mean + Natural mean, All statistics reported in this table are significant at p <.001, except for those marked ^ which are significant at the p <.05 level.

Table 8.3 *Standardized regression coefficients for RI and RD predicting differential supernormal preference (n = 5389).*

Model	(1)	(2)	(3)	(4)
Gender	.087	.089	.080	.081
Age	-.256	-.226	-.233	-.218
Reward Drive		.105		-.059
Rash Impulsivity			.193	.179
R^2	.07	.08	.11	.11
F	200.78	154.92	212.95	164.73

DV = Differential Supernormal Preference; Supernormal mean - Natural mean, All statistics reported in this table are significant at $p < .001$.

8.6 Discussion

All humans desire pleasure, but the objects of our desire – and our manner of pursuing them - vary considerably. RD and RI describe two dimensions along which people vary in their approach to rewards. Our results show that RD and RI are associated with different patterns of anticipatory pleasure both in general, and specifically for supernormal stimuli. As predicted, RD was a positive indicator of general anticipated pleasure ratings. That is, people high in RD tend to anticipate high levels of pleasure from a general class of rewarding experiences and situations, whether or not they are supernormal. These experiences include those that are socially acceptable and adaptive in the modern environment, which accords with recent research investigating the functional outcomes associated with reward drive (e.g., Clark et al., 2015; Harnett et al., 2013). In contrast, RI was negatively associated with anticipated general pleasure ratings, especially after controlling for RD. Thus, although RD and RI are positively correlated with one another, their unique properties have contrasting associations with one's capacity to anticipate pleasure.

Increased anticipated pleasure associated with RD is consistent with a surplus model: people are more likely to engage in rewarding activities when they anticipate receiving greater pleasure from them. On the other hand, approach behaviour associated with RI may

derive from a deficit: that is, RI individuals are compensating for a lack of capacity to anticipate reward, therefore generally expecting less pleasure from all rewarding experiences. This is particularly apparent in heavy drug users. Often excess drug use will lead to diminished dopamine functioning, causing the user to reject other sources of reward, and require higher and more frequent doses of psychoactive substances in order to achieve pleasure (Volkow et al., 2014). Similar processes have been found to occur in the case of excess food (Volkow et al., 2008) and alcohol consumption (Heinz, et al., 2005). This is congruent with previous findings in which models predicting drug use, which include both RD and RI, are dominated by RI (Gullo et al., 2011; MacLaren et al., 2012). Both high RD and RI individuals have the propensity to readily approach and over-consume unhealthy products (Gullo et al., 2014). It may be that this propensity is driven by two opposing mechanisms. That is; high rash impulsivity may be associated with excess consumption because general anticipated pleasure levels are low, leading to an increased need to stimulate dopamine, whereas high reward drive may be associated with excess consumption due to an increased capacity to anticipate reward.

Findings regarding differential supernormal preference showed the opposite pattern of results: RI positively predicts supernormal preference whilst RD had a very small negative association. This finding is also consistent with the above compensatory model of RI. If individuals high in RI have difficulty in experiencing pleasure, then they ought to prefer more intense and immediate stimulation. Supernormal, as compared to natural stimuli, have exactly these properties. For example, rash impulsivity is associated with substance abuse due partly due to the overvaluing of synthetic reinforcers, and the undervaluing of more natural reinforcers (Dawe et al., 2004). That is, a lack of capacity to experience reward may increase the rash impulsive person’s attraction to highly exaggerated, synthetic, and immediately reinforcing products. On the other hand, individuals who are high in RD may be more likely

to anticipate enjoyment from reward from a variety of sources and therefore do not tend to exhibit a preference for the supernormal.

Our findings may also go towards demonstrating one way in which different personality phenotypes might have formed to facilitate adaptive behaviour. As Lewis (2015) notes, certain traits can be associated with both adaptive and non-adaptive behaviour in different context. For example, in our evolutionary past the ability to flee or fight in dangerous situations was adaptive to survival; but in modern times, this response often results in debilitating hyper-vigilance, anxiety or stress disorders. A similar case may be argued for rash impulsivity. In an environment where resources are scarce or competed for, a disposition to act impulsively towards immediate rewards would usually lead to better mating opportunities and nutrition, and thereby fitness. In today's developed-world environment where resources are abundant, this impulsivity may lead to obesity, debt, or ill-health. In the same way that evolutionary theory has increased our understanding of anxiety disorders, it may also be useful consider an evolutionary perspective in conceptualising maladaptive health-related behaviours.

Limitations & Future Research

Caution must be exercised in interpreting significance values due the extremely large sample size used. Although effect sizes associated with the key findings are small, they are substantial considering it can be difficult to directly predict specific behavioural outcomes based on general attitudes or personality traits (Ajzen & Timko, 1986).

The measurement of impulsivity and related traits continues to be refined and a new revised Behavioural Approach System Scale (rBAS) has been recently developed based on revised reinforcement sensitivity theory (Jackson, 2009). This scale appears to assess the more functional aspects of reward sensitivity/drive (Clark et al., 2015; Harnett et al., 2013;

Jackson, 2009). An overlap between the reward drive scale and the measure of impulsivity is expected, in part, due to neurologically shared reward circuitry. However, the total original BAS measure used in the current study includes a fun seeking subscale that is highly correlated with measures of rash impulsivity (Dawe & Loxton, 2004; Gullo et al., 2011). In replicating or extending on this research it is recommended that one use the updated BAS scale (Jackson 5; Jackson, 2009). This may result in more pronounced unique effects of the two factors of impulsivity. Further to this, the current findings highlight the importance of including measures of both RD and RI in future models. In doing this, the overlap between the two measures is accounted for allowing for a more pure interpretation of each trait.

Conclusions

Preference toward supernormal stimuli has received little empirical attention and studies thus far have not addressed personality factors. Predicting individual variance in preference toward products with exaggerated reward properties; such as desserts, snack foods, and various retail items; provides valuable information regarding those people that may be more prone to unhealthy consumption. The current findings suggest that the two-factor model of impulsivity is useful in predicting an orientation towards supernormal stimuli, and that RI, rather than RD appears to be instrumental in prompting unhealthy lifestyle choices.

Chapter 9: Over-indulgence: Food for thought

9.1 Introduction

The findings from the studies presented in this thesis have addressed the key research aims by demonstrating that 1) a latent variable can explain shared variance in consumption behaviour, 2) individuals differ in their preference towards pleasure derived from modern day consumer products and natural reward, and 3) the two-factor model of impulsivity is useful in predicting a variety of consumption behaviours as well as pleasure preferences. In Chapter 1, several theoretical viewpoints are presented that suggest an underlying factor may exist that explains comorbidity amongst addictive and/or consumption behaviour. A latent trait reflecting shared variance amongst a range of consumptive activities support this and the preceding studies provide insight into the psychometric predictors of reward preference (Chapter 6 & 8) and singular excess-consumption behaviours (Chapter 5). However, until this point, the utility of the supernormal preference measure, RD, and RI as predictors of a latent trait reflecting consumption behaviours has not yet been directly tested. *Figure 9.1* provides an overview of the relationships tested thus far, highlighting the key relationships not yet tested.

To address this gap, a new ad hoc research question was posed; does supernormal preference, RI, and RD explain unique variance in a latent factor reflecting consumption behaviour? In other words, is comorbidity amongst various consumption behaviours partly accounted for by individual differences in impulsivity and reward preference? Answering this provides a somewhat more complete picture of the data. A final, post hoc analysis using structural equation modelling was conducted to address this query. Based on the research findings thus far, it was expected that a supernormal preference, RD, and RI would all positively predict a latent factor reflecting covariance in consumption behaviour.

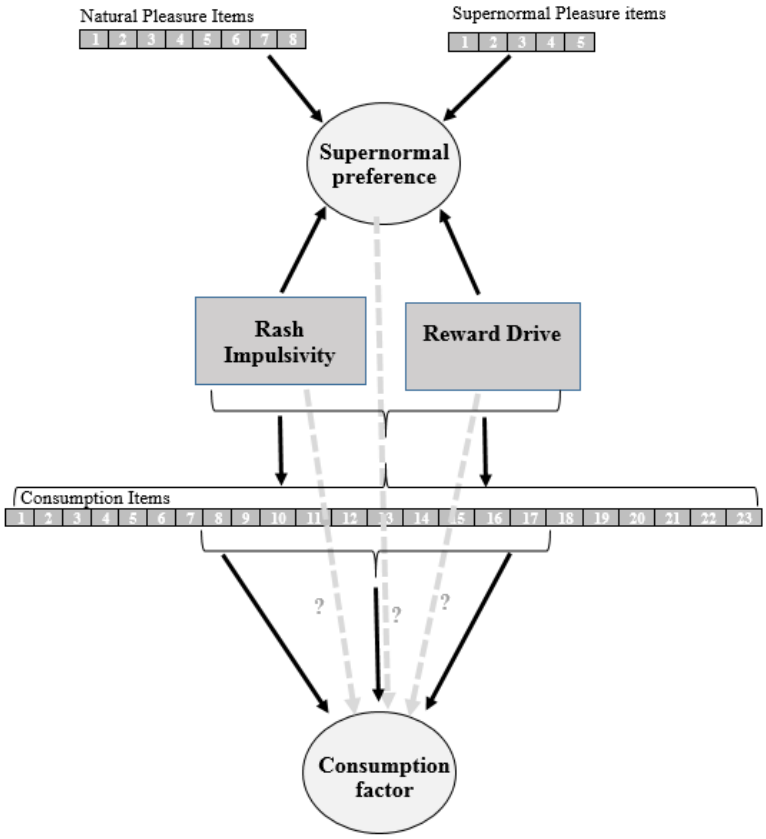

Figure 9.1 A diagrammatic, simplified representation of the relationships addressed thus far (solid black lines) and the relationships yet to be tested (broken grey lines).

9.2 Method

9.2.1 Participants and procedure

Variables from the data collected and analysed in chapters 5, 6, & 8 were re-analysed in this post hoc analysis, thus, much of the methodological details here are repeated from previous chapters. Participants consisted of 5389 (51% female) members of an online survey panel maintained by an agency specializing in the recruitment of survey participants (myopinions.com.au). Participation was remunerated with credit points that could be accumulated and exchanged with the agency for cash. The survey took approximately 20 minutes to complete. Ages ranged from 18 to 87 years old (M=49.01, SD=16.50).

Participants were born in Australia (74%), the United Kingdom (8.4%), New Zealand (2.7%) and other countries (14.9%).

9.2.2 Measures

Behavioural Items: Behavioural items represented the consumption of hedonic stimuli including energy dense foods and beverages, illicit and/or restricted substances, and various media products. The brief AUDIT C (Bush et al., 1998) and the Consumption Scale for Problem Gambling (CSPG; Rockloff, 2011) were utilized as validated measures of alcohol and gambling consumption. A further nine variables were aggregated from a set of additional novel measures capturing frequency of use/consumption of drugs, fast food, gambling products, cigarettes, salt, caffeine, alcohol, meat, snacks, internet and television. To maintain consistency, the resulting 11 behavioural items reflected those which were considered to be part of the latent factor presented in Chapter 4. Scores on each behavioural variable were standardized before analysing.

Rash Impulsivity: Rash impulsivity was measured using a short version of the Barratt Impulsivity Scale (BIS-11; Spinella, 2007). This measure consists of 15 statements, whereby the participant must rate the extent to which the statement applies to them. Responses are recorded on a 4-point Likert scale (1, Rarely/never; 2, Occasionally; 3, Often; 4, Almost always/always). The measure includes three subscales; Attentional (e.g., *"I don't pay attention"),* Motor (e.g., *"I act on the spur of the moment"*), and Non-planning (e.g., *"I am a careful thinker. [inverted]").* The total BIS-11 score was utilized in the current study Cronbach's alpha in the present sample was .83

Reward Drive: The Behavioural Approach Scale (BAS) from the Behavioural Inhibition and Approach Scale (BIS/BAS; Carver & White, 1994) was used to measure RD. This 13 item

measure involves three subscales 1) Drive, assessing a persistence in pursuing desired goals (e.g., *"When I want something, I usually go all out to get it"*), 2) Reward Responsiveness scale, focused on the response to occurrence or anticipation of reward (e.g., *"When I'm doing well at something, I love to keep at it"*), and 3) Fun seeking (e.g, *"I crave excitement and new sensations"*). Responses were recorded on a 4-point Likert scale (1, Rarely/never; 2, Occasionally; 3, Often; 4, Almost always/always). The total BAS score was utilized in the current study. Cronbach's alpha coefficient in the current study was .88.

Supernormal Preference: Preference for supernormal pleasure was measured using the Supernormal and Natural Pleasure Scale (SNPS; Goodwin, Browne, & Rockloff, 2015). It contains two subscales that measure anticipatory pleasure in response to supernormal stimuli (5 items; e.g., "*Watching my favourite TV show*") and natural stimuli (8 items; "*Seeing other people's smiling faces"*). Participants are asked how much pleasure they anticipate in response to each experience, responding on a 5 point Likert scale (1 = "*none or neutral*" to 5 = "*There is nothing I would enjoy more*"). Items were averaged within each subscale to create aggregate scores. General anticipatory pleasure was calculated via the sum of the two means. Cronbach's alphas for the natural subscale, the supernormal subscale and in total were .88, .78, and .89 respectively.

9.2.3 Data Analysis

A structural equation model was defined using the Mplus software package (see *Figure 9.2*). Three latent variables were specified:1) the five supernormal pleasure items (SNP); 2) the eight natural pleasure items (NP), and 3) the 11 behavioural consumption items (Factor C). Covariance between items on the supernormal preference scale (e.g., watching TV) for which item content matched those on the consumption variable (e.g., hours spent watching TV) was controlled for by specifying these correlations in the model. This was done to ensure that the

relationship between supernormal preference and Factor C could be interpreted as a general preference towards supernormal stimuli predicting a broad class of hedonic consumption, rather than simply reflecting that fact that people tend to consume products that they anticipate as being pleasurable. Factor C was regressed onto the SNP and NP factors and the observed RD and RI variables. A correlation between the SNP and NP factor was also specified in the model, meaning that each factor could be interpreted as a preference for either natural or supernormal pleasure, as the shared variance between them (representing overall pleasure) was controlled for. Correlations between RD, RI and the two pleasure scales were also specified.

9.3 Results

The data fit the model reasonably well (RMSEA= .062, 90%CI = .061 - .063; SRMR=.048; CFI=.842) (Bentler, 1990; Browne & Cudeck 1992). The overall fit of the model would have been improved markedly if residual covariance in behavioural items (e.g. between alcohol and smoking) were specified. However, the purpose of the analysis was not to achieve optimal model fit but rather to estimate the parameters of interest. Nonetheless, all behavioural items loaded positively on the latent consumption factor; as did the natural pleasure items onto the natural factor and supernormal pleasure items on the supernormal pleasure factor. RD (b =.22, p <.001), RI, (b =.18, p <.001), supernormal preference (b =.25, p <.001), and natural preference (b =.-22, p <.001) predicted consumption (i.e, the latent consumption factor). Together, these four variables described 19% of the variance in consumption, with the consumption factor explaining 11% of the total variance in behavioural items. Note that interactions between RI, RD and supernormal preference were tested, however, no significant interaction effects were apparent.

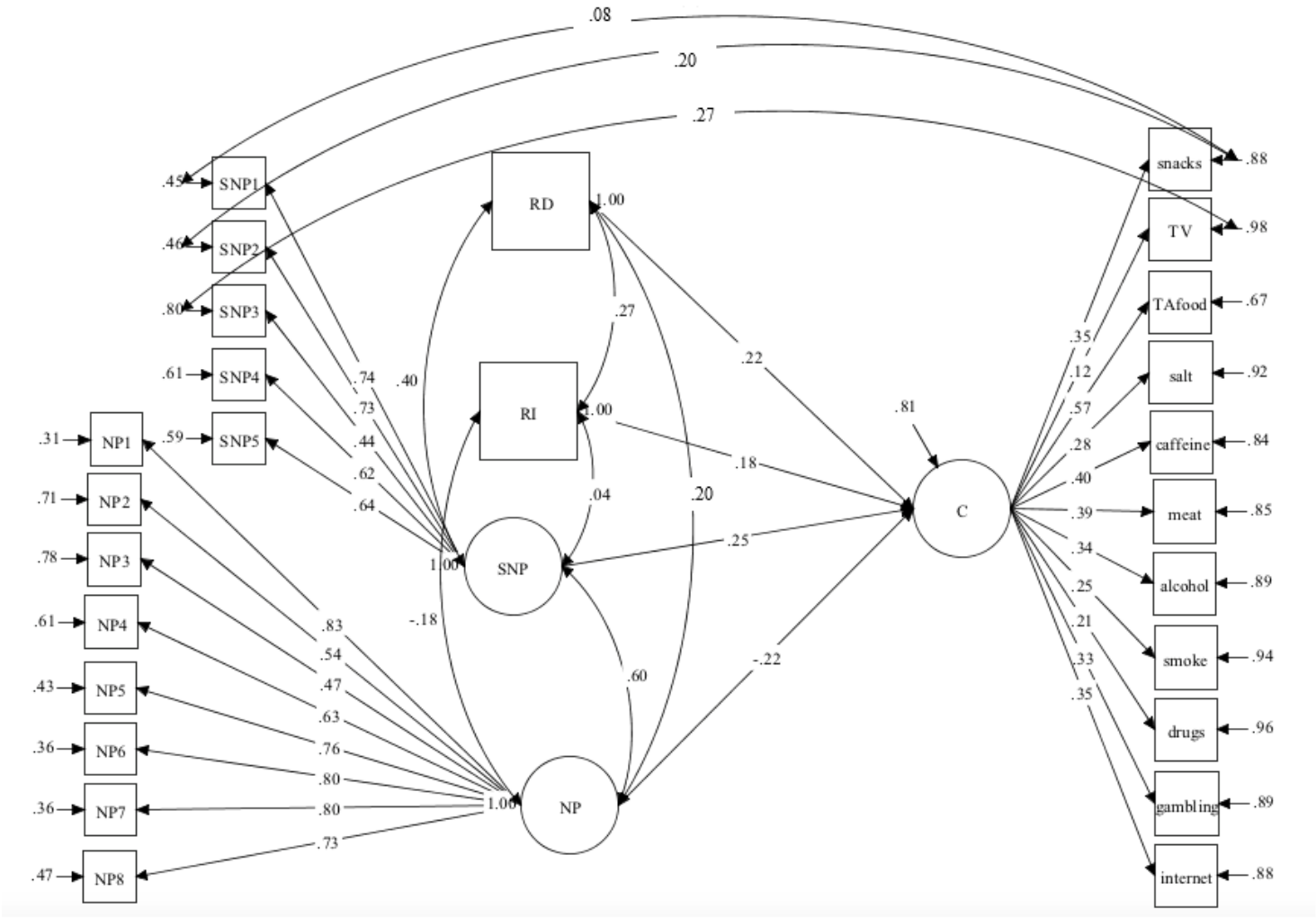

Figure 9.2 Structural Equation Model assessing the relationship between the latent variables, supernormal pleasure (SP) and natural pleasure (NP), and the observed variables reward drive (RD) and rash impulsivity (RI) on the latent consumption factor (C).

9.4 Discussion

The purpose of this study was to complete the previous research findings by assessing the, until now untested, relationships between RD, RI, supernormal preference and the latent behavioural consumption factor. As predicted, these variables positively predicted the latent factor, suggesting that shared variance amongst a broad range of consumption behaviours can be partly attributed to one's preference for supernormal stimuli, RD, and RI.

In Chapter 5 it is shown that RI and RD uniquely and differentially predict excessive consumption in several classes of consumption behaviours (i.e., illicit, entertainment, and foods). In the current study it is shown that both traits also predict a general propensity to over consume. However, the effect for high RD people might be expressed in an above average level consumption of entertainment, communication and food products, whereas for those high in RI it might be expressed in above average levels of food and illicit product consumption. Potentially, those high in both RD *and* RI are susceptible to over-consumption of all forms of stimuli.

These differential effects of RD and RI are also evident in their unique relationships with the natural and supernormal subscales in the current model. That is, when shared variance between RD and RI is accounted for, it is evident that the unique component of RI is related to higher supernormal pleasure ratings and lower natural pleasure ratings, whereas RD is associated with higher ratings of both forms of pleasure. This is congruent with the interpretation of results in Chapter 8, where it is suggested that highly reward driven individuals tend to anticipate all pleasure experiences highly regardless of whether the experience is natural or supernormal; whereas rash impulsive people tend to rate all experiences as less pleasant but show a preference for supernormal over natural pleasures. This suggests that RI, rather than RD, appears to be instrumental in specifically prompting unhealthy lifestyle choices.

Results from Chapter 4 were confirmed in a new sample; that is, all behavioural items loaded positively on the consumption factor. Each behaviour that contributes to the factor involves the provision of immediate consummatory reward, is readily accessible, and tends to require little effort or time to attain. This highlights the wide range of modern day consumer products that exhibit these characteristics (e.g., fast foods, coffee, apparel, digital devices, and substances) are those which the excess-consumption prone person is oriented towards. Natural pleasure ratings were negatively related to the consumption factor, providing further support for the notion that the construct underlying our factor reflects *supernormal* reward characteristics rather than the fact that all products merely involve some form of pleasure or reward. It should be noted that in some cases, only very small proportion of variance in each consumption behaviour is explained in the model. For example, only 2% of the variance in watching TV can be attributed to the consumption factor. In other words, individual variation in these behaviours are influenced and/or motivated by a multitude of other variables. Considering this model includes only a small sample of a theoretically infinite number of targets of excess-consumption, an average of 11% variance explained per item is noteworthy.

Findings from the current study complete our understanding of the relationships between key measures in this research. Together, results increase the ability to recognize individuals who are prone to engage in more than one form of unhealthy consumption. This, along with an understanding of the shared characteristics of various consumption behaviours, is valuable in terms of targeting individuals and behaviours for public health intervention efforts.

Chapter 10: An overall discussion of research findings.

10.1 A summary of the key research findings

Harms can occur as a result of excess consumption, even at sub-clinical levels within the general population. Investigation into consumption behaviour in a community sample is therefore vital. The primary aim of this program of research was to identify, explain, and measure individual differences in consumption behaviour in the general population. The studies in the preceding chapters yielded the following key findings:

1. Activities and products that are susceptible to pathological addiction such as alcohol, substances, food, retail goods, and media and gambling products tend to be the same or similar to those that are consumed excessively at sub-clinical levels in the general population.

2. Shared variance amongst several types of hedonic stimuli; including fast food, salt, caffeine, television, gambling products, and illicit drugs; can be explained by a single underlying factor.

3. An evolutionary perspective on reward preference may be useful in explaining and measuring individual differences in reward preferences. That is, people tend to systematically vary in their preference toward artificial modern-day consumer products (i.e., supernormal) reward over natural reward and this can be reliably and validly measured using a two-factor pleasure scale.

4. Reward drive and rash impulsivity uniquely and differentially predict the above-average consumption of variety of consumer products and activities as well as a preference towards modern-day consumer products over natural reward. Further to this, rash impulsivity is negatively related to overall pleasure experience.

5. Supernormal preference, RD, and RI are positively related to the latent factor reflecting the consumption of several types of hedonic, modern day consumer products.

The following sections consider these key research findings and discuss implications from health, personality, neurobiological, and evolutionary perspectives.

10.2 Implications

10.2.1 The comorbidity of consumption

The finding that a latent trait that underlies shared variance in consumption behaviour partially accounts for why so many addictive behaviours tend to be co-morbid. Valid explanations for various comorbidities in consumption behaviours have been presented in the literature. For example, socio-economic status has been found to underlie comorbid substance use (Bonevski, Regan, Paul, Baker, & Bisquera, 2014) and shared genetics can explain covariance in alcohol abuse and binge eating (Slane, Klump, McGue, & Iacono, 2014). Emotional dysregulation (Baumeister, Gailliot, DeWall, & Oaten, 2006; Mitchell et al., 2002) and 'general problematic involvement' (Hodgins, von Ranson, & Montpetit, 2015) have also been linked to comorbidity amongst behaviours such as overeating, substance abuse, gambling, and over-spending. Further to this, some products and activities tend to 'go hand in hand' in particular environmental contexts. For example, a licensed gaming lounge encourages drinking alongside gambling in the same way that watching television at home is a favourable environment for snacking (Francis et al., 2003; Gore et al., 2003). Findings from the current research contribute another valid (partial) explanation for comorbidity in consumption behaviours. Post hoc analysis suggests that this latent construct can be somewhat explained by rash impulsivity and reward drive as well as a preference for supernormal stimuli.

It is useful to be able to identify multiple predictors of a health behaviour when developing and implementing intervention. For example, some readily prescribed and successful strategies to reduce alcohol consumption are based on optimizing emotional

regulation (Baumeister et al., 2006) and problem gambling can be reduced via changing one's environment (Ladouceur, Sylvain, & Gosselin, 2006) - both known to be influential factors in exacerbating addictive behaviours. These strategies, however, might prove unsuccessful for a client whose behaviour is driven by a general preference to seek pleasure through certain consumer products or an impulsive personality type. Later discussion considers health interventions that might be suited to people with these characteristics (see section 10.2.6).

Addictive behaviour and unhealthy consumption habits tend to be co-morbid. This is evident from previous comorbidity studies and the current research; with the latter providing valuable insight into the types of modern day consumer products that are amenable to excess consumption. An examination of all of the behavioural items that predict the latent consumption factor, clearly reveals product characteristics that are common to every item. That is, each behavioural item involves the provision of immediate reward, is readily accessible, and requires very little effort or time to attain. These characteristics are common to a wide variety of modern synthetic products. Section 10.2.4 discusses these implications from an evolutionary perspective. In terms of health interventions however, an awareness that some individuals may be high in a consumption trait, combined with knowledge of the stimuli characteristics for which they are oriented towards, gives treatment providers useful insight regarding client risk for other forms of excess-consumption.

10.2.2 Consumption and the two factor model of impulsivity

To date, research into the effects of impulsivity on behaviour has focused on single pathological or disordered behaviours. Furthermore, the recently revealed, two-factor model of impulsivity has been under-used in such research, despite evidence that it is the most suited and parsimonious impulsivity framework to apply when investigating addictive behaviours (see Gullo et al., 2014).

Current findings suggest that the two-factor model of impulsivity has utility in explaining a wide range of consumption behaviour as well as a preference for artificial consumer products over natural rewards. The unique and differential relationships that RD and RI exhibit with consumption preference and behaviour strengthen our current conceptualisations of the two factor model. In previous research, when entered simultaneously in regression models, RI and RD both explain unique variance in gambling, alcohol use, and drug use, yet RI is consistently the stronger predictor of the two (Gullo et al., 2011; Loxton et al., 2008; MacLaren et al., 2012). In addition to this, high RD individuals often report positive outcomes such as greater psychological well-being, hope, sociability and lower levels of loneliness – with RI being associated with less positive outcomes (Carver & White 1994; Clark et al., 2015; Harnett et al., 2013). Current findings support the notion that RD reflects reward approach in a reflective, socially driven manner, whereas RI reflects an approach to reward that lack controls and consideration for negative consequences. Compared to RI, RD showed stronger effects for above average levels of economic and digital social media consumption. In addition, RD was associated positively with an overall higher propensity to experience pleasure and natural pleasure alone, yet provided no unique contribution to predicting a preference for supernormal pleasure. Taken together, these findings suggest people high in RD are more attracted to reward experiences that take some planning and reflection, and lead to longer term rewards in terms of feelings of social interaction, affluence, or increased social standing.

Research into RD has recently placed more emphasis on the positive aspects and outcomes of reward drive, particularly since revisions were made to the measure (see Jackson, 2009). For example, revised RD has been linked to adaptive reward seeking behaviours (Romer, Reyna, & Pardo, 2016), music involvement (Loxton, Mitchell, Dingle, & Sharman, 2016), and life satisfaction (Harnett et al., 2013). Current findings, although reliant

on the original measure, support this more optimistic view of the trait, yet also caution that high RD can nevertheless lead to harm through excess consumption of, and high anticipated pleasure regarding, some potentially unhealthy products and activities such as caffeine, social networking, high calorie snacks, and spending.

10.2.3 The neurobiology of excess consumption

As discussed in Chapter 1, neurobiological evidence concerning dopaminergic pathways within the brain provides insight into the mechanisms by which one might demonstrate an orientation toward unhealthy consumer products and activities. Numerous imaging studies have shown activation of areas within the limbic, mid-regions of the human brain such as the ventral striatum, insula, orbitofrontal cortex, amygdala, and the hypothalamus, in response to reward-related function. (Bechara, 2005; Olds, 1977; Robinson & Berridge, 1993). In addition, theory underpinning the two-factor model of impulsivity is based upon such evidence. Gray and McNaughton's (2000) motivational Behavioural Approach System (BAS), from which the RD construct derives, reflects activity in mesolimbic dopaminergic pathways associated with reinforcement as found in response to food, sex and drugs. Dawe and Loxton (2004) propose that RI involves dysfunction in the orbitofrontal cortex and the ventromedial prefrontal cortex; areas associated with impulse control and decision-making. See *Figure 10.1* for diagrammatic representation of some of the key brain regions referred to in this section.

Applying a neurologically based reinforcement learning framework to the current research findings, we can provide further insight into the biological underpinnings of reward preferences and consumption behaviour and the differential effects of the two-factor model of impulsivity. A temporal difference reinforcement learning (TDRL) framework approach to describing dopamine driven consumption behaviour would posit that reward predictions and

subsequent consumption behaviour are based on previous consumption experiences. For example, if eating a salty snack proves to be a pleasurable experience, one is likely to repeat the action. If the next time they consume the same salty treat it is not as pleasant, their prediction for this particular reward will change and they are less likely to consume the snack again. From this perspective, we might assume that excess consumption behaviour reflects pleasant associations with previous consumption experiences, however, as reported in Chapter 3, many people experience negative emotional and physical impacts from over-indulgence, yet continue to consume in excess. The TDRL framework has been criticised for its simplicity in this respect and it is proposed that other mechanisms are at play in explaining human behavioural choices (O'Doherty, 2012).

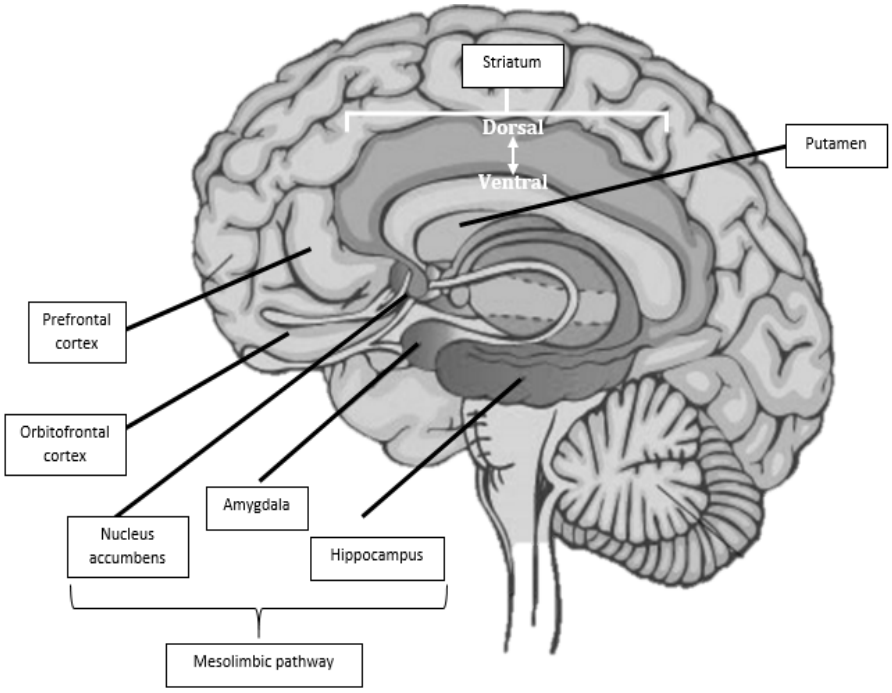

Figure 10.1 A visual depiction of some of the key brain regions involved in reward approach and reinforcement.

Balliene and Dickinson (1998) propose that behavioural choice is directed by at least two distinct motivations; 1) a goal-directed mechanism in which behaviour is based on the value of the reward associated with the outcome (similar to the TDRL framework described

above), and 2) a habit-driven, stimulus–response mechanism whereby behaviour is a reflex to a stimulus, and therefore relatively automatic, impulsive, and habitual in nature regardless of consequence (Balleine & O'Doherty, 2009). Evidence strongly suggests that the dopamine activity associated with RD is that which reflects the prediction or *anticipation* of potential reward and is therefore instrumental in goal-directed action selection, whereas the release of opioid neurotransmitters tend to be associated with the enjoyment or *consummatory* phase of reward (Berridge, 2007; 2009; Peciña et al., 2006; Small et al., 2001).

Varying levels of anticipatory reward might be reflected in differential relationships between RD and RI and outcomes variables in the current research. RD was associated with overall pleasure anticipation and the consumption factor. That is, individuals high in RD demonstrated a greater tendency to anticipate pleasure from both natural and supernormal experiences, and to consume more in general, suggesting that their consumption behaviour might be based on anticipatory pleasure and goal-directed choice. RI was negatively associated with overall pleasure, yet positively predicted general consumption. This might suggest that while RD predicts consumption via goal directed 'value of reward' driven behaviour (i.e., anticipating high amounts of pleasure from these products causes one to consume them), RI predicts consumption via habitual learning (i.e., sub or un-conscious automatic motor/cognitive response)

Interestingly, fMRI studies suggest that different systems in the striatum (a subcortical part of the forebrain and a critical component of the reward system, see *Figure 10.1*) are implicated in the two reinforcement learning mechanisms proposed by Balleine and Dickinson (1998). The ventral system is implicated in goal directed motivation, whereas the dorsolateral region and putamen is implicated in the motor and cognitive responses involved in habitual behaviour (Yin, Knowlton, & Balleine, 2004; 2006; O'Doherty et al., 2012). Combined with the current study findings, this may provide further neurological insight into

the distinct attributes of RD and RI. It might suggest that RD reflects functioning in the mesolimbic pathway, whereas RI not only reflects functioning in the prefrontal and orbitofrontal cortex responsible for executive functioning and self-control, but also a specific part of the dopaminergic system within the striatum – that is associated with habitual learning. This conceptualisation is further supported by evidence from Chapter 5 that impulsivity tends to predict behaviours with the most intense, immediate and accessible reward properties. Not only is this tendency in high RI individuals potentially driven by a lack of inhibition or self-control, but might also reflect their tendency to rely on a stimulus-response (or habitual learning) neural pathway for action selection.

Individual differences in a propensity to consume a generalized class of consumer products has also been proposed to reflect neural functioning. Recent studies on animals suggest that dorsolateral striatum activity is key in action generalization (i.e., the extent to which one generalizes reward predictions from one stimulus to another) (Hilario, Holloway, Jin, & Costa, 2012). This might suggest that habitual behaviours (also reflected in this region of the brain) such as prolonged excess-consumption are also associated with the tendency to generalize reward predictions. The relationship between RI and a general propensity to consume might somewhat reflect this action generalization along with the finding that supernormal preference appears to be manifested across multiple modalities (see Chapter 6). For example, a heavy gambler, high in RI, might be more likely to expect reward (and subsequently engage in) a variety of other consumer products that he or she perceives as comprising similar reward characteristics (i.e., immediate, low effort, intense), including products such as alcohol, cigarettes, and salty foods.

As mentioned in Chapter 1, there are two somewhat opposing mechanisms by which dopamine levels are thought to affect approach toward hedonic stimuli (Franken & Muris, 2005); one based in Reinforcement Sensitivity Theory (RST) and the other based on Reward

Deficiency Syndrome (RDS). In summary, RST posits that addictive behaviour results from over-active dopamine function and RDS from under-active dopamine function. See Section 1.3.1 for a review. The current research findings support an explanation whereby both reward deficiency and reward sensitivity can lead to excess consumption. As previously described, dopamine functioning is thought to reflect the capacity to predict or anticipate the pleasure associated with a particular reward (Berridge, 2007). According to RDS, this capacity is diminished in individuals who lack D_2 receptors due to inherited genetics and environmental factors (Comings & Blum, 2000; Bowirrat, & Oscar-Berman, 2005). Findings from the current research suggest that the behaviour of a highly rash impulsive individual might reflect a lower capacity to anticipate reward in two ways: 1) they are more likely to consume, and prefer, stimuli that offer the most intense and easily attained reward, and 2) they rely on habitual learning processes in action selection that do not require reflection on the perceived value of a reward. On the other hand, according to RST the capacity to anticipate reward is enhanced in those with hyperactive dopamine receptors (Berridge, 2007; Schienle et al., 2009; Volkow et al., 2010).). Findings from the current research suggest the consumption behaviour of a highly reward driven individual might reflect a *higher* capacity to detect reward in that, 1) they are more likely to anticipate high amounts of pleasure and consume more in general, yet 2) do not prefer stimuli that exhibits intense, easy to attain reward characteristics. These differential motivations for, and mechanisms behind, consumption behaviour may explain why RD tends to be associated with less harmful and sometimes positive consequences, whereas RI tends to be associated with more illicit and unhealthy product consumption.

It should be acknowledged that the above interpretation is somewhat incomplete. RD and RI are weakly to moderately positively related (r=.26). This bears the question: What mechanisms drive consumption behaviour and preferences in a person who is high in both

RD and RI? Significant interaction effects of the two measures were not found in this study, but in terms of additive effects the combination of high RD and high RI ought to lead to excess-consumption. However, this cannot be explained by either theory presented above. In order to effectively answer this question, one might identify the attributes that reflect the *shared* variance in RD and RI. As discussed in the limitations section (10.3), the construct overlap is likely due to the fun-seeking subscale of RD that correlates highly with RI, therefore a closer look at the items within this scale might provide some insight into mechanisms that drive high RD, high RI behaviour. For example, the items *"I crave excitement and new sensations,"* and *"I'm always willing to try something new if I think it will be fun"* on face value appear to indicate novelty-seeking behaviour, which from a neurological perspective is thought to reflect glucocorticoid and serotonin (as opposed to dopamine) activity in the hippocampal region of the brain (Kabbaj, Devine, Savage, & Akil, 2000).

10.2.4 Effort discounting and reward.

Every action selection decision is associated with both benefits and costs. According to *the law of less* (Hull, 1943), when faced with a choice between two actions that will result in equally reinforcing outcomes, an organism will tend to choose the least laborious action. As discussed in section 1.5, animals and humans tend to select their actions by weighing up the value of the outcome against the effort required (Hull, 1943; Kool, McGuire, Rosen, & Botvinick, 2011; Phillips, Walton, & Jhou, 2006). Often referred to as *effort discounting*, this process is thought to be an adaptive method of conserving physical and mental energy, whilst still acquiring optimal reinforcement. Neuroimaging studies show that mesolimbic dopamine release – that which is associated with the anticipated value or *wanting* of reward –is dependent on effort discounting, suggesting that this 'effort versus benefit' calculation is an

implicit and automatic process that occurs prior to reward appraisal, and subsequently drives action selection (Kool et al., 2010; Phillips et al., 2007). Phillips et al. (2007) suggest that depleted dopamine is associated with higher effort discounting (i.e., perceiving a higher effort to reward ratio). If treated as a proxy measure for dopamine functioning, RD ought to be negatively related to effort discounting and, in turn, show stronger associations with anticipated pleasure towards higher effort activities. Current study findings support this theory in that a person high RD is more likely to anticipate high reward value (i.e., pleasure) in all experiences, yet does not show a preference for supernormal stimuli such as snacking, watching TV, and social networking, which represent relatively low effort reward compared to natural experiences such as helping others, viewing a landscape, or taking part in hobbies.

In addition to implicit effort discounting, the law of less suggests that humans will also consciously or explicitly select low over high demand actions, when outcomes hold similar reinforcement value (Hull; 1943; Zipf, 2016). Everyday observations of human behaviour demonstrate this (e.g., taking the most direct route to a destination). To date, no literature addresses or attempts to reconcile these two temporally different descriptions of effort conservation in action selection, nevertheless, they appear complementary. It is plausible that when faced with stimuli, an organism applies effort discounting in calculating anticipated pleasure *and again* when consciously deciding on what action to take. Data from the current study provide support for the influence of RD on both instances of effort discounting. The relationship between RD and anticipated pleasure ratings might reflect dopamine functioning in implicit stages of reward appraisal, whereas the relationship between RD and actual consumption behaviour might, in addition, reflect the fact that highly reward driven people tend to be willing to exert more effort for reward. This is congruent with the conceptualization of RD as motivating goal-directed and reflective action and might further explain why RD is more strongly associated with relatively more active forms of

consumption such as shopping, social networking, and sending SMS, compared to more passive forms, such as watching television and snacking on sweets, packaged foods and soft drinks (see chapter 5).

10.2.5 An evolutionary perspective on consumption

One of the key aims of the current research was to empirically investigate evolutionary theories on human consumption; a topic that is widely discussed in the literature, yet rarely tested. As detailed in Chapter 1, there are several expressions of the human condition that are adaptive in a natural environment, yet promote unhealthy behaviour in modern day society (see section 1.5 for a review). In sum, reinforcement mechanisms evolved for the purpose of motivating organism approach to the acquisition of survival and reproduction resources in their environment. It is thought that humans tend to consume unhealthy stimuli, regardless of negative consequences, in part due to the fact that these reward systems evolved in a time when resources were scarce and *limiting* consumption was not an adaptive behaviour. In a modern day context, where these resources are abundant, the application of a "take all you can get" behavioural heuristic can be detrimental to health (Barrett, 2010). A key focus of the current study was to investigate human consumption of supernormal stimuli; that is, stimuli that elicit a reward response that is more intense than the one for which the reward system was originally were evolved for (Barrett, 2010; Tinbergen, 1951). The current findings show that there is individual variability in this trait – that some people show a greater preference for products and experiences with supernormal (and inherently unhealthy) characteristics.

Species typicality

Although findings revealed individual differences in supernormal preference, a species-wide orientation towards supernormal stimuli over natural reward was not supported

in the current research. Overall, participants tended to show a preference towards natural and traditional consumables, activities and experiences. That is, overall mean ratings for natural pleasure are higher (see Table 8.1) and response times were faster in the natural congruent condition than in the supernormal congruent condition of the IAT experiment (see section 7.4). It appears, although predisposed to asymmetric selection, modern humans have learnt to associate unhealthy or unnatural products with negative emotions (e.g. guilt, regret) and unhealthy short or long-term consequences (e.g., sedentary behaviour, pain, poor-health, and debt). This means that although the anticipation of supernormal stimuli typically excites reward pathways and motivates approach behaviour, people nevertheless typically associate modern forms of synthetic reward stimuli with negative outcomes. This mismatch between negative attitudes and positive approach behaviour towards synthetic stimuli is an interesting apparent paradox that is not completely resolved by the present work. Theories on *cultural* evolution apply a Darwinian explanation for species or population wide human adaptions in beliefs, knowledge, and attitudes that are socially transmitted over generations (Durham, 1991). It might be that although biologically we remain 'hardwired' for excess-consumption, our negative associations with unhealthy consumption, reflect a cultural adaption to modern day environments.

Evolution and individual differences

Although natural reward experiences (as measured in the current study) appear to be preferred by the majority, the findings do suggest that a substantial amount of people tend to prefer supernormal over natural stimuli or show a relative preference towards supernormal stimuli (i.e., the difference between natural and supernormal pleasure ratings/implicit attitudes is small). This preference, and/or relative preference, positively predicts actual consumption of unhealthy stimuli, warranting exploration into what is arguably an

evolutionarily driven individual difference. An evolutionary view on human behaviour tends to predict species wide characteristics, however, a growing body of literature promotes the way in which studying the interaction between evolution and individual differences can enrich our understanding of human behaviour (Marsh & Boag, 2013; Marsh et al., 2010). Buss and Greiling (1999) suggest that inherited genetic predispositions, combined with differing environmental and developmental contexts, explains individual variability in species-typical are expressed differently within individuals (Buss & Greiling, 1999). This notion is supported in epigenetic studies demonstrating that chemical cellular reactions to the environment can turn specific genes on or off, altering one's developmental trajectory (Champagne, 2010). Based on this gene-environment interactionist perspective, a preference for supernormal stimuli might reflect individual differences in the expression of a genetic predisposition; a disposition that is an evolutionary by-product of an ancient, natural environment where resources are scarce or subject to high competitive pressure.

A preference for supernormal stimuli is an example of one way in which evolutionary design may not be adaptive in a modern day environment for some individuals. Supernormal theory suggests that the brain's reward system can be hijacked by products with the most exaggerated reward characteristics, reducing or replacing approach to non-supernormal stimuli. This is supported by the negative associations between fruit and vegetable intake, the consumption factor and to supernormal preference, which suggest that those who prefer supernormal consumption experiences are less likely to consume natural alternatives. While being prone to excess-consumption of unhealthy stimuli, they may also may find that the reward they experience from this consumption reduces or replaces the need for reward associated with a range of health enhancing behaviours such as nutritious eating, exercise, and stress reduction activities. This provides a theoretical basis for understanding the widely

recognised problems in the dietary profile and unhealthy habits of populations in developed countries.

Supernormal preference. Is it all bad news?

We have thus far framed supernormal preference as problematic, due to the potential harms resulting from excess-consumption; implying overall decreased well-being. However, one might question whether this reward preference could actually lead to a satisfying and happy existence. Humanistic theorist Abraham Maslow (1943) proposed the 'hierarchy of needs' model, positing that once basic physiological and social needs have been met, individuals will pursue further needs involving confidence and self-esteem, later striving for self-actualization; a sense of fulfilment when full potential is reached. According to this theory, a purely evolutionarily driven reinforcement system might stunt one's development potential through a lack of desire or motivation to pursue higher-order achievement, Some evolutionary theorists criticize this model, arguing that there is no evidence or plausible explanation for an adaptive drive to seek self-esteem or fulfilment, and that these higher levels of the pyramid can be entirely explained by the survival and reproductive goals lower in the hierarchy (Kenrick, Griskevicius, Neuberg, & Schaller, 2010). According to this perspective, an orientation towards supernormal stimuli may result in complete need fulfilment and subsequently, general well-being and life satisfaction.

The universality of models such as the hierarchy of needs are often criticized; it being argued that human development is somewhat more diverse across different individuals and their environments (Tay & Diener, 2011). The current research supports a more context specific perspective on need fulfilment and life satisfaction. *Hedonic* and *eudomainic* describe two differing philosophically based perceptions of well-being. Hedonic well-being refers to the experience of positive states and the satisfaction of desires, whereas eudomainic

well-being refers to the presence of meaning and development of one's potential. It might be that an individual's own philosophical take on well-being moderates positive or negative effects of supernormal preference on overall life satisfaction. Assuming that people are, for the most part, behaving in a way that aligns with their values, it might be that individuals who pursue natural pleasure experiences such as helping others and viewing picturesque landscapes, increase their well-being through achievement and self-actualization, whereas individuals with a preference towards supernormal pleasures are content to focus on purely hedonic pursuits. Future research into the effects of reward preference on perceived well-being might provide a better understanding of the consequences of supernormal preference on development and satisfaction in life; it may be that supernormal preference does not have a negative impact for people who subscribe to a hedonistic definition of well-being.

10.2.6 Reducing excess-consumption

A key aim of the current research was to open up an investigation into excess-consumption in the general population. One motivation is that even subclinical levels of overconsumption can accrue harm to physical health and well-being. We shall therefore discuss the ways in which the current findings might contribute to intervention and psychoeducation efforts.

Intervention

The clearest and strongest predictor of a preference towards, and excess consumption of, unhealthy stimuli in the general population was that of trait RI as measured by the (BIS-11; Spinella, 2007). Traits by definition are personal characteristics that tend to remain stable across an individual's lifetime, however treatments have successfully reduced impulsivity (Bear & Nietzel, 1991), or at the very least resulted in increased impulse *control* over

behaviour (Young, 2011; Bickel, Marsch, & Budney, 2013; Garland, Froeliger, & Howard, 2013; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Studies into the effects of ego depletion, suggest that effortful control over a dominant cognitive response is a finite resource and that depletion often leads to weakened self-control (Hagger, Wood, & Stiff, 2010; Kool, McGuire, Wang, & Botvinik, 2013). This might suggest that for individuals with a dominant orientation towards responding to supernormal over natural stimuli, find it harder to resist unhealthy products when they are cognitively strained; this cognitive strain being reflected by lower prefrontal cortex function in the brain. They might then rely on the neural mechanisms underpinning habitual action selection to respond, hence less applying reflection on goals and/or consequences and more reliance on automatic motor response (see 10.2.3 for a review of habitual learning).

Our findings regarding the association between RI and supernormal preference and consumption suggests that the key to reducing impulsive consumption behaviour lies in the strengthening and conditioning of cognitive responses to potential reward. Through the modification of cognitive processes and behaviours, therapeutic interventions such as mindfulness (Garland et al., 2013; Papies, Barsalou, & Clusters, 2013), cognitive behavioural therapies (Young et al., 2011), personal intention setting (Adriaanse, de Ridder, & de Wit, 2009), and retraining action-tendencies (Wiers et al., 2010), have been successfully applied in managing impulsive behaviour. These cognitive-behavioural techniques may prove to be key in overriding the automatic habitual responses that lead to excess consumption behaviour**.** In particular, one study demonstrated that approach to attractive food can be substantially reduced via the application of mindfulness exercises (Papies et al., 2013). As Papies, et al., (2013) suggest, this is a particularly promising technique for reducing impulsive reactions to stimuli as mindfulness training encourages a continuing and generalized contemplative practice (Baer, 2003; McKenzie & Hassed, 2012). Mindfulness training might therefore

reduce re-occurrence of impulsivity driven consumption across a wide domain of unhealthy products and activities. As suggested by current findings, a more reflective approach to reward is associated with natural (and inherently healthier) reward preferences and less harmful forms of consumption. An intervention method that simultaneously increases control over behaviour and reflective thought processes is therefore a suitable therapy for the impulse driven consumer.

The current research demonstrates multivariate comorbidity amongst a range of hedonic, consummatory activities, as well as providing a comprehensive picture of the types of products that people high in RI tend to prefer and over consume (i.e., substances, gambling products, retail products, high calorie foods, and media products – see Chapter 5 & 6). For some, restricting consumption of one product can lead to compensatory behaviour including an increase in other forms of consumption. For example, abstaining from nicotine smoking, increases calorie intake for many (Hatsukami, LaBounty, Hughes, & Laine, 1993). These 'side effects' of behavioural change might be common to individuals who have a preference and/or an orientation towards consummatory activities which, according to the current research, have in common the tendency to be immediately and highly satisfying, accessible, and exhibit fabricated or exaggerated (i.e., supernormal) reward characteristics. Equipped with an understanding of the reward properties common to readily over-consumed products, people can exert some control over their exposure. In the same way that a diagnosed problem gambler can be excluded from a venue to reduce temptation, a highly rash impulsive person might be encouraged to reduce their exposure to consummatory stimuli by reducing time at shopping centres or bars, avoiding the confectionary aisle at the supermarket, or restricting the amount of digital appliances they keep about their home.

Fortunately, some modern activities can provide an alternative to unhealthy over-consumption. Gamification refers to the application game playing elements - such as

collecting points or resources, competition, and rules - to other activities. From a marketing perspective, it is a useful tool in promoting customer engagement (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2015). These activities, including various forms of electronic entertainment (including gambling) are often designed so as to promote uncontrolled approach behaviour through the acquisition of perceived resources and status. The 'Pokemon-Go App' is a recent example of a game that effectively appeals to consumption heuristic; the aim of the game being to search for and collect a range of digital characters spread out over various locations. The virtual characters have perceived value and rarity; which appealing to our 'hunter-gatherer' instincts. A key feature of Pokemon-Go is the requirement to do exercise (e.g. through walking or jogging) in order to obtain these rewards. Though most humans have trouble doing regular exercise for the future benefits of health and fitness, a surprising number of people have been willing to do a great deal of exercise in order to progress in the Pokemon game. This is an example of designing an interactive system that causes 'incidental benefits' in the process of appealing to consumption / acquisition behaviour.

Psychoeducation

One key to success in implementing behavioural change is self-efficacy; a belief that one has the power to effect change. Self-efficacy is negatively impacted by the stigma and self-blame (Klose, 2010) that surrounds many maladaptive health behaviours such as problem gambling (Hing, Holdsworth, Tiyce, & Breen, 2014), eating disorders (Farrell, Lee, & Deacon, 2015), and drug use (Room, 2005). An effective way to reduce these counterproductive symptoms is with psychoeducation. For example, providing psychological education, that emphasizes biological and cognitive explanations for behaviour, increases optimism and self-efficacy in those recovering from eating disorders (Farrell et al., 2015).

Further to this, patients undergoing cognitive behavioural therapy for an anxiety disorders are often presented with an evolutionary explanation for their condition. For example, in our evolutionary past the ability to flee or fight in dangerous situations was adaptive to survival; but in modern times, this response often results in debilitating hyper-vigilance, anxiety or panic disorders (Clark & Beck, 2011). Thus, using psychoeducation to provide an understanding of the origins of one's symptoms can aid and empower recovery from mental health conditions such as anxiety and depression (Donker, Griffiths, Cuijpers, & Christensen, 2009). Educating people on the evolutionary underpinnings of biologically driven excess-consumption behaviour, not only promotes understanding and thus a sense of control over their behaviour, but also reduces any self-blame or stigma associated with it allowing individuals to overcome such barriers when confronting the problem.

10.3 Limitations and future research

Limitations unique to each study have been detailed within their respective chapters, however, some broader limitations are worth consideration when interpreting combined study findings. Firstly, the construct of RD continues to be refined and a new revised Behavioural Approach System Scale (rBAS; Jackson, 2009) based on revised reinforcement sensitivity theory was being developed and validated during the earlier stages of data collection for the current research and was therefore not utilized. This scale appears to assess the more functional aspects of reward sensitivity/drive (Clark et al., 2015; Harnett et al., 2013; Jackson, 2009). There is expected be an overlap between the RD based on either version of the BAS and measures of RI due to neurologically shared reward circuitry. However, this overlap is more pronounced for the original BAS measure used in the current study because it includes a fun seeking subscale that is found to be highly correlated with measures of rash impulsivity (Dawe & Loxton, 2004; Gullo et al., 2011). In future research into the construct

of RD, it is recommended that a revised BAS scale is used (e.g., Jackson 5; Jackson, 2009). Note that the current interpretations based on the original BAS are in line with the revised conceptualization of the construct, however, when testing models involving RD (particularly those where shared variance with RI is not controlled for) the revised version of the scale is recommended for more pronounced unique effects of RD.

Secondly, caution must be exercised in interpreting significance values due the extremely large sample size used in Chapter 5, 6, 8, & 9. Some of the effect sizes associated with the key findings are small. Considering it can be difficult to directly predict specific behavioural outcomes based on general attitudes or personality traits (Ajzen & Timko, 1986), these effects are still substantial and worthy of attention. However, other variables clearly exist in predicting consumption behaviour and preference such as environmental factors, mental health, mood states, and perceptions of healthfulness. This thesis takes a somewhat 'nature over nurture' perspective in explaining consumption, yet it is acknowledged that other environmental factors may contribute equally or more so to health outcomes than the evolutionary or biological grounded explanations proposed here.

Thirdly, self-report measures regarding activities that convey unhealthy behaviour are often subject to a social bias whereby people attempt to present themselves positively when responding to health based questions (Adams et al., 2005; Hebert et al., 1995). The current study provides some evidence for the utility of the SNPS for capturing actual attitudes by relating them to implicit measures of supernormal preference, however, effect sizes associated with this relationship is small. It must therefore be considered that the self-report pleasure ratings and consumption behaviours are in part likely to be capturing participant motivations to appear healthy.

Lastly, although the consumption factor is referred to as a latent 'trait', which by definition is stable and long lasting, these cross-sectional studies lack the ability to assess the

stability of such a trait. For this reason longitudinal studies might be conducted in future research to examine the development and continuity of consumption behaviour and preferences across time.

The current research provides scope and direction for future research into health behaviour from a number of disciplinary perspectives. The utility and importance of including measures of both RD and RI in future research into health and consumption behaviour research is demonstrated. Controlling for the overlap between the two measures allows for a more pure interpretation of each trait and its differential effect on specific behaviours. Future research into the effects of personality and individual differences on addiction, consumer behaviour and health psychology will benefit from the application of the two-factor model of impulsivity.

Our findings also provide valuable understanding of the characteristics of, and thereby the types, of products that might elicit excess-consumption or addictive behaviour (i.e., those that are consumer based, provide immediate reward, and little effort to attain). This greatly extends the range of products and behaviours that might be an interesting focus in future studies of health behaviour; such as specific retail items or the use of digital entertainment. In addition, the SNPS provides a valid tool for research into consumption from an evolutionary point of view. The scale might be useful in predicting individual differences in a range of other consumer behaviour believed to be grounded in evolutionary adaptiveness.

As mentioned, several other explanations are likely to be evident in predicting consumption behaviour and a preference towards supernormal pleasure. The original purpose of the Snaith Hamilton Pleasure Scale (modified to create the SNPS) was to measure anhedonia; a key symptom of depression, expressed as an inability to feel pleasure in normally pleasurable activities (Snaith et al., 1995). It is suggested that this may be partly due to their vulnerability for negative feedback which results in lower anticipation of pleasure

(Diener, 2013). Depressed people consistently report higher rates of unhealthy consumption behaviour such as excessive internet use (Yen et al., 2007), drug and alcohol abuse (Robinson et al., 2009), and binge eating (Stice, Presnell, Shaw, & Rhode, 2005). Potentially, depressed individuals are more likely to rely on habitual (i.e., stimulus response) action section, rather than goal directed action selection which relies on the perceived value reinforcement when making behavioural choices (see Section 10.4.3). Future research might test a standard measure of depression (e.g., Beck Depression Inventory; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) alongside the supernormal and natural subscales on the SNPS and find that depressed individuals show a preference for supernormal pleasures which are more amenable to stimulus response based action selection, than the natural items.

Another avenue for future research exists in investigating the effects of intervention on changing supernormal preference. As discussed in section 10.2.6, cognitions involved in impulse control might affect one's anticipation of reward and subsequent consumption behaviour. Experimental research into the effects of ego depletion on supernormal preference may provide insight firstly into the stability of supernormal preference as a trait and secondly demonstrate whether state supernormal preference changes as a result of a reduction cognitive resources. An experimental manipulation where participants complete the SNSP at a baseline time point and again after a cognitively loaded task might be one way to achieve this.

10.4 Conclusion

Considering the harms that can affect individuals as a result of excess-consumption, the current program of research provides vital insight into maladaptive health behaviour in the general population. Together, findings from this research suggest that a propensity for excess-consumption can be partly attributed to one’s preference for varying pleasure

experiences and their level of impulsive traits. These findings provide future researchers and treatment providers with a base for approaching the issue of excess-consumption at sub-clinical levels in the general population, by focusing on rash impulsivity and reward preference as key predictors.

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Appendices

Appendix 1. Qualitative consumption questionnaire/script.

I am going to ask you some questions about things that you feel you either, do, eat, drink, take or buy too much of in your life. I am going to ask you a series of questions and give you 1-2 minutes to list as many things as you can think of for each question.

"So, let's talk about things you enjoy in your life. What sort of things do you enjoy?

Would you say you sometimes had too much / did that too much?"

"What kinds of things make you feel relaxed? What activities do you find satisfying?

Do you find it hard to cut-down on X? / Is it something you'd prefer to do less of?"

Prompts:

Can you think of some activities you spend too much time **doing**?

Can you think of some things that you **eat** too much of?

Can you think of some things that you **drink or take** too much of?

Can you think of some things that you **buy or use** too much of?

Great, let me know if you come up with an others while we are talking *(I will also ask 'anything else'? leaving some silence after some questions, if I feel I can get some more from them)*

Can you think of some things that you often strongly desire to **do?**

Can you think of some things that you often strongly desire to **eat?**

Can you think of some things that you often strongly desire to **drink or take?**

Can you think of some things that you often strongly desire to **buy or use?**

Can you think of some things that you desire to **do** and when you do them, it makes you feel better?

Can you think of some things that you desire to **eat** and when you do, it makes you feel better?

Can you think of some things that you desire to **drink or take** and when you do, it makes you feel better?

Can you think of some things that you desire to **buy or use** and when you do, it makes you feel better?

Can you think of some things that you desire to **do** more when you are feeling bored, angry or sad?

Can you think of some things that you desire to **eat** more when you are feeling bored, angry or sad?

Can you think of some things that you desire to **drink or take** more when you are feeling bored, angry or sad?

Can you think of some things that you desire to **buy or use** more when you are feeling bored, angry or sad?

Can you think of some things that you desire to **do** that you cannot stop thinking about?

Can you think of some things that you desire to **eat** that you cannot stop thinking about?

Can you think of some things that you desire to **drink or take** that you cannot stop thinking about?

Can you think of some things that you desire to **buy or use** that you cannot stop thinking about?

Can you think of some things that are very hard to resist **doing** in certain circumstances (for example, others are doing it, it is free or easy and within reach)

Can you think of some things that are very hard to resist **eating** in certain circumstances (for example, others are doing it, it is free or easy and within reach)

Can you think of some things that are very hard to resist **drinking or taking** in certain circumstances (for example, others are doing it, it is free or easy and within reach)

Can you think of some things that are very hard to resist **buying or using** in certain circumstances (for example, others are doing it, it is free or easy and within reach)

Can you think of some things that when you start **doing** them you struggle to stop yourself from **doing** too much?

Can you think of some things when you start **eating** you struggle to stop yourself from **eating** too much?

Can you think of some things when you start **drinking or taking** them you struggle to stop yourself from **drinking or taking** too much?

Can you think of some things when you start **buying or using** you struggle to stop yourself from **buying or using** too much?

Can you think of some things that you **do** too much of that ends up have a negative impact on your health or other aspects of your life? (Even if you feel that it's very minor)

Can you think of some things that you **eat** too much of that ends up have a negative impact on your health or other aspects of your life? (Even if you feel that it's very minor)

Can you think of some things that you **drink or take** too much of that ends up have a negative impact on your health or other aspects of your life? (Even if you feel that it's very minor)

Can you think of some things that you **buy or use** too much of that ends up have a negative impact on your health or other aspects of your life? (Even if you feel that it's very minor)

Can you think of some things that you **do** a lot of that doesn't have any negative impacts on your health or life?

Can you think of some things that you **eat** a lot of that doesn't have any negative impact on your health or life?

Can you think of some things that you **drink or take** a lot of that don't have any negative impact on your health or life?

Can you think of some things that you **buy or use** a lot of that don't have any negative impact on your health or life?

Can you think of some things that other people in life (for example your friends, colleagues or family) tell you that you **do** too much of?

Can you think of some things that other people in life (for example your friends, colleagues or family) tell you that you **eat** too much of?

Can you think of some things that other people in life (for example your friends, colleagues or family) tell you that you **drink or take** too much of?

Can you think of some things that other people in life (for example your friends, colleagues or family) tell you that you **buy or use** too much of?

Do you agree to any extent with any of these?

Thinking now about the other people in your life (including friends, acquaintances, colleagues, peers, and family members), can you think of some things that other people you know do too much of that impact there life in a negative way? (Even minor impacts) You don't have to say who you are talking about.

Appendix 2. Explanation of correlation specification for the a-priori and post hoc models.

A literature search was conducted for cross-sectional studies that reported bivariate regression or correlation relationships between the variables considered in this study. These were then specified as direct correlations in the a-priori correlation model. The variables and citations are given below in Appendix Table 2.1.

Appendix Table 2.1. *Associations amongst reward-oriented behaviours in the literature. Basis for A-Priori direct correlation specification.*

Variable	Correlated with	Citation
Alcohol	Smoking	Bobo & Husten, 2001; Greenberg, Lewis, & Dodd, 1999
Alcohol	Drugs	Bachman, Wadsworth, O'malley, Johnston, & Schulenberg, 2013
Alcohol	TV	Greenberg et al., 1999
Alcohol	Gambling	Greenberg et al., 1999
Alcohol	Internet	Greenberg et al., 1999
Alcohol	Caffeine	Greenberg et al., 1999
Alcohol	Snacks	Greenberg et al., 1999
Smoking	Drugs	Bachman et al., 2013
Smoking	TV	Greenberg et al., 1999
Smoking	Gambling	Greenberg et al., 1999
Smoking	Internet	Greenberg et al., 1999
Smoking	Caffeine	Greenberg et al., 1999; Penolazzi et al., 2012
Smoking	Snacks	Greenberg et al., 1999
Drugs	Gambling	Petry, 2001
TV	Gambling	Greenberg et al., 1999
TV	Internet	Greenberg et al., 1999
TV	Caffeine	Greenberg et al., 1999
TV	Snacks	Greenberg et al., 1999; Gore, Foster, DiLillo, Kirk, & Smith West, 2003
Gambling	Internet	Greenberg et al., 1999; Villella et al., 2011
Gambling	Caffeine	Greenberg et al., 1999
Gambling	Snacks	Greenberg et al., 1999
Internet	Caffeine	Greenberg et al., 1999
Internet	Snacks	Greenberg et al., 1999
Caffeine	Snacks	Greenberg et al., 1999

For full references from table refer to reference list in manuscript.

The post-hoc group of models were those in which the direct correlation matrix was specified by the data at hand in a stepwise process using modification indices, in a model which included a latent factor with freely estimated loadings. Specifically, correlation inclusion was based on the largest expected parameter change of the chi-square statistic. The process was stopped when adding of an additional degree of freedom would result in a non-significant chi-square change. Note that this mode of correlation specification is vulnerable to over-fitting due to sampling variability. Therefore, the generally improved fit of post-hoc models as compared to a-priori specification should not be interpreted. Importantly, the hypotheses of the present study pertained to model comparisons *within* each direct correlation condition (none / post-hoc / a-priori). We also comment that, due to the presence of the latent factor, this list of 'significant' bivariate correlations is not equivalent to the significant *raw* bivariate correlations. For example, the raw correlation between gambling and salt consumption was significant +0.10 (t=3.35, p <0.001), but after accounting for the latent factor, inclusion of a further residual correlation was not justified.

Appendix Table 2.2. *Direct correlations included in the Post Hoc scenario for fixed and free to vary factor loadings.*

		Correlation Coefficients	
Variable	Correlated with:	*Loadings Fixed*	*Loadings free to vary*
Drugs	Smoking	.272	.165
Drugs	Caffeine	-.102	-.163
Smoking	Caffeine	.168	.107
Snacks	Smoking	-.196	.188
Fast Food	Internet	.147	.177
Smoking	TV	-.156	-.161
Alcohol	Gambling	.162	.172
Drugs	Alcohol	.146	.142
Fast Food	Smoking	-.109	-.140
Snacks	Fast Food	.134	.150
Snacks	Internet	.099	.128
Fast Food	Meat	.106	.112

Appendix Table 2.3. *Item factor loadings for the first model displayed separately by gender and age groups.*

	Under 46	**46 and over**	**Male**	**Female**
Alcohol	.482	.275	.338	.345
Caffeine	.379	.401	.430	.334
Drugs	**.416**	**.062**	**.317**	**.180**
Fast Food	.284	.244	.360	.302
Gambling	.429	.364	.405	.420
Internet	.029	.151	**.157**	**.328**
Meat	.292	.190	**.291**	**.097**
Salt	**.263**	**.402**	.287	.209
Smoking	.364	.341	.290	.351
Snacks	.054	.131	.200	.158
TV	.139	.233	**.055**	**.158**

Large discrepancies mention

Appendix 3. Consumption behaviour measures: Items included in each variable and response scales.

Variable	Question	Response Scale
	On a typical WEEK DAY/WEEKEND or WORKING DAY/NON-WORKING DAY, how much time do you spend doing each of the following:*	1= none, 2 = < 10 mns, 3 = 10 – 30 mns, 4= 30mns to 1 hr, 5= 1-3 hrs, 6 = 3-5 hrs, 7 = 5 -7 hrs, 8 = 7+ hrs
TV	- Watching TV	
Internet Social Networking	- Browsing the internet on a computer, smart phone or tablet - Using social networking websites (such as Facebook, Twitter or My Space)	
Pornography	- Viewing erotic or romantic images, videos or books	
Video Gaming	- Gaming on a desktop computer, game console, portable gaming system, mobile phone or tablet?	
	On average how often do you do the following:	1 = never, 2 = < once a wk, 3 = 1-2 per wk, 4 = 5-7 per wk, 5 = twice a day, 6 = 3 + per day
Take away	- Purchase foods for a meal or snack from fast food outlets such as KFC, MacDonald's, Hungry Jacks, Red Rooster	
Take away	- Purchase foods for a meal or snack from other food outlets such as a, bakery, service station, … Chinese food, etc	
Desserts	- Eat desserts such as ice-cream, cake and cookies	
Meat Products	- Eat meat products? (such as sausages, frankfurter, Devon, fritz, salami, meat pies, bacon, or ham)	
Sweets	- Eat chocolates, lollies, or other sweets	
Snacks	- Eat chips, crackers or nuts	
Soft Drinks	- Drink NON-CAFFEINATED soft drinks such as lemonade, etc	
Caffeine	- Drink CAFFEINATED soft drinks such as Coke or Pepsi	
Caffeine	- Drink ENERGY drinks such as Redbull, Mother or V	
Caffeine	- Drink TEA	
Caffeine	- Drink COFFEE	
SMS	*How often do you send a text message from your phone (not for work or business)?*	1= Never, 2 = once a wk, 3 = 2 -3 times per wk, 4= almost everyday, 5= once a day , 6 = 2 -3 times a day, 7 = 3-5 times a day, 8 = 5-7 times a day, 9 = 7+ times per day.
Social Networking	*How often do you check your social networking account (e.g., Facebook, Twitter or My Space)*	1= never, 2 = < once a wk, 3 = once a day 4= 1-10 times per day, 5= 10 – 20 times per day, 6 = 30 – 40 times per day, 7 = 50 + times per day
Caffeine	*When you drink COFFEE, how much would you typically drink in one sitting? (1 serve is equal to either one espresso shot, or one teaspoon of instant coffee)*	1 = I don't drink coffee, 2 = I serve, 3 = 2 serves, 4 = 3 + serves

Salt	*How often do you add salt to your food WHILE cooking or preparing it?*	1 = never, 2 = rarely, 3 = sometimes, 4 = usually
Salt	*How often do you add salt to your food AFTER cooking or preparing it?*	1 = never, 2 = rarely, 3 = sometimes, 4 = usually
Soft Drink	*When you drink NON-CAFFINATED soft drink (such as lemonade etc) how much would you typically drink in one sitting?*	1 = I don't drink soft drink, 2 = < 250 mls (small glass), 3= 250 – 400 mls (small can or bottle), 4 = 400ml – 1 litre (mid bottle), 5 – 1 + litres
Caffeine	*When you drink CAFFINATED soft drink (such as lemonade etc) how much would you typically drink in one sitting?*	1= I don't drink soft drink, 2 = < 250 mls (small glass), 3= 250 – 400 mls (small can or bottle), 4 = 400ml – 1 litre (mid bottle), 5 – 1 + litres
Caffeine	*When you drink ENERGY soft drink (such as lemonade etc) how much would you typically drink in one sitting?*	1 = I don't drink soft drink, 2 = < 250 mls (small glass), 3= 250 – 400 mls (small can or bottle), 4 = 400ml – 1 litre (mid bottle), 5 – 1 + litres
Drugs	*Have you used any illicit drugs in the past 12 months? This includes drugs such as cannabis,…, amphetamines, etc.*	1 = never, 2 = once a month or less, 3 = 2 – 4 times per month, 4 = 2 -3 times per wk, 5 = 4 -5 times per wk, 6 = 6+ times per wk.
Shopping	*Approximately how many new items of clothing do you purchase for yourself per month? Include things like shoes, tops, pants, jackets, and so on*	1 = none, 2 = < one item a month, 3= 1-2 items a month, 4 = 3 -5 items a month, 5 = 6 -10 items a month, 6 = 11-15 items a month, 7 = 15+ items per month
Shopping	*Approximately how many collectable items do you purchase for yourself per month? Include things like DVDs or Blu-ray movies, CDs, Books, Games or other collectables*	1 = none, 2 = < one item a month, 3= 1-2 items a month, 4 = 3 -5 items a month, 5 = 6 -10 items a month, 6 = 11-15 items a month, 7 = 15+ items per month
Brochures	*How often do you browse advertising catalogues that arrive in the mail*?	1 = never, 2 = once a month, 3= 2 -3 times per month, 4 = once a wk 5 = 2 -3 times per wk 6 = almost everyday
Browse Online	*How often do you browse or search for retail products on online shopping websites?*	1 = never, 2 = once a month, 3= 2 -3 times per month, 4 = once a wk 5

		= 2 -3 times per wk 6 = almost everyday
Packaged Food	*When grocery shopping, what percentage of your trolley or basket would you estimate is made up of packaged food and bottled drinks?*	1 = 0%, 2 = < 20%, 3= 20 – 40%, 4 = 40 – 60%, 5 = 60% - 80%, 6 = 80-100%
Alcohol	***AUDIT C (for items and scale see Bush et al., 1998)***	
CSPG	***CSPG (for items and scale see Rockloff, 2011)***	

* Two separate questions were asked for working and non-working days for items for these items. Scale previously published in Goodwin et al., 2015.

Appendix 4.

DECLARATION OF CO-AUTHORSHIP AND CONTRIBUTION (Chapter 4)

Title of Paper	Do gamblers eat more salt? Explaining covariance in the consumption of reward-oriented stimuli using a latent trait model.
Full bibliographic reference for Journal/Book in which the Paper appears	Goodwin, B., Browne, M., Rockloff, M.J. & Donaldson, P. (2015). Do gamblers eat more salt? Explaining covariance in the consumption of reward-oriented stimuli using a latent trait model. *Journal of Behavioural Addictions*, *4*(3), 170 – 180. doi: 10.1556/2006.4.2015.022

Nature of Candidate's Contribution

Ms. Belinda Goodwin completed the analysis of results and drafting of this manuscript.

Nature of Co-Authors' Contributions

This study utilised archived data collected by Dr Matthew Rockloff and Dr Matthew Browne. Co – authors Dr Matthew Browne, Professor Matthew Rockloff, and Dr Phillip Donaldson contributed to manuscript with guidance on content and editing.

Candidate's Declaration

I declare that the publication above meets the requirements to be included in the thesis as outlined in the Research Higher Degree Theses Policy and Procedure

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DECLARATION OF CO-AUTHORSHIP AND CONTRIBUTION (Chapter 5)

Title of Paper	Differential effects of reward drive and rash impulsivity on the consumption of a range of hedonic stimuli.
Full bibliographic reference for Journal/Book in which the Paper appears	Goodwin, B. C, Browne, M., Loxton, N. & Rockloff, M. (2016) Differential effects of reward drive and rash impulsivity on the consumption of a range of hedonic stimuli. *Journal of Behavioural Addictions* 5(2), 192-203. doi: 10.1556/2006.5.2016.047 10.

Nature of Candidate's Contribution

Ms. Belinda Goodwin was primarily responsible for the design, data collection, analysis of results and drafting of this manuscript.

Nature of Co-Authors' Contributions

Co –authors Dr Matthew Browne, Professor Matthew Rockloff, and Dr Natalie Loxton contributed to manuscript with guidance on content and editing.

Candidate's Declaration

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Date

DECLARATION OF CO-AUTHORSHIP AND CONTRIBUTION (Chapter 6)

Title of Paper	Measuring preference for supernormal over natural rewards: A two-dimensional anticipatory pleasure scale.
Full bibliographic reference for Journal/Book in which the Paper appears	Goodwin, B. C., Browne,. M., & Rockloff, M. (2015) Measuring preference for supernormal over natural rewards: A two-dimensional anticipatory pleasure scale *Evolutionary Psychology, 13*(4), doi: 10.1177/1474704915613914

Nature of Candidate's Contribution

Ms. Belinda Goodwin was primarily responsible for the design, data collection, analysis of results and drafting of this manuscript.

Nature of Co-Authors' Contributions

Co –authors Dr Matthew Browne and Professor Matthew Rockloff contributed to manuscript with guidance on content and editing.

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DECLARATION OF CO-AUTHORSHIP AND CONTRIBUTION (Chapter 7)

Title of Paper	Is explicit supernormal preference associated with implicit attitudes towards supernormal consumer products?
Full bibliographic reference for Journal/Book in which the Paper appears	Goodwin, B, C., Browne, M., & Rockloff, M. *(Under Review)* Is explicit supernormal preference associated with implicit attitudes towards supernormal consumer products? *Journal of Behavioral Health.*

Nature of Candidate's Contribution

Ms. Belinda Goodwin was primarily responsible for the design, data collection, analysis of results and drafting of this manuscript.

Nature of Co-Authors' Contributions

Co –authors Dr Matthew Browne and Professor Matthew Rockloff, contributed to manuscript with guidance on content and editing.

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DECLARATION OF CO-AUTHORSHIP AND CONTRIBUTION (Chapter 8)

Title of Paper	Rash impulsivity predicts lower anticipated pleasure response and a preference for the supernormal.
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Nature of Candidate's Contribution

Ms. Belinda Goodwin was primarily responsible for the design, data collection, analysis of results and drafting of this manuscript.

Nature of Co-Authors' Contributions

Co –authors Dr Matthew Browne, Professor Matthew Rockloff, and Dr Natalie Loxton contributed to manuscript with guidance on content and editing.

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