Environmental Harshness and its Effect on Appetite and the Desire for Conspicuous Signalling Products

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Doctor of Philosophy Thesis Declaration

I, James B. Swaffield declare that the PhD thesis entitled *Environmental Harshness and its Effect on Appetite and the Desire for Conspicuous Signalling Products* is a presentation of my original work that has not been submitted for any other degree or award. All additional sources of contribution have been acknowledged accordingly. The work was completed under the supervision of Prof. S. Craig Roberts from the University of Stirling, United Kingdom.

James B. Swaffield April 8, 2018

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Abstract

There is often an assumption that there is a right and a wrong way for consumers to behave. For example, with regard to eating, people should make food choices based on maximizing vitamins and minerals and not consuming more calories than one expends in a day. Likewise, it is assumed that buying products to conspicuously signal a message to another is wasteful and maladaptive. The research in this thesis challenges these assumptions and argues that these behaviours can be both adaptive and maladaptive depending on one's environmental conditions.

In this thesis, I describe three experiments that examine how perception of environmental harshness affects appetite for different types of foods. The data shows that food desirability in adulthood varies depending on early childhood socio-economic status, the type of environmental stressor (harsh social, harsh economic and harsh physical safety) and the intensity of the stressors within each of these environments. It was also found that different types of environmental harshness differentially affects food desire based on energy density and food category type.

In addition to the experiments on harshness and food desirability, I have examined how environmental harshness affects desire for products that are used to conspicuously signal information to others. For example, under conditions of environmental stress, products may be used to advertise that a male possesses financial or physical power which is desirable to a potential mate. Likewise, a women may buy products to display she possess financial power or she may purchase products that augment her beauty and sexual

attractiveness. These studies reveal that product desire is also affected by different types of environmental harshness and the intensity of the stress generated by these environmental conditions.

Through the research described in this thesis, we gain a more comprehensive understanding of the proximate variables that influence two subsets of consumer behaviour, namely food desire and product signalling, and how these behaviours may have been selected for due to their adaptive value.

Publications, papers ready for publication, conference and poster presentations arising from this thesis

1. Published papers

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Swaffield, J., & Roberts, S.C. (2017). Stress and trait appetite mediate the relationship between early childhood socioeconomic status and adult food preference.

Swaffield, J., & Roberts, S.C. (2017). Environmental harshness influences the desire for signalling products used during sexual competition.

3. Conference oral presentations

International Society for Human Ethology Conference (2016) - Scotland, UK. Poster Presentation: Assessing the Impact of Socio-Economic Conditions on Food Preference.

4. Conference poster presentations

International Society for Human Ethology Conference – Belem, Brazil (2014) Poster title: Exposure to Harsh Environment Primes Alters Food Preference.

International Society for Human Ethology Conference – Boise, Idaho, USA (2017). Poster title: Environmental harshness influences the desire for signalling products used during sexual competition.

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Chapter 1

Introduction

The work in this thesis studies two domains of consumer behaviour from an evolutionary perspective. Consumer behaviour involves more than the act of purchasing a product; it includes "all activities associated with the purchase, use and disposal of goods and services, including the consumer's emotional, mental and behavioural responses that precede or follow these activities" (Kardes, Cronley & Cline, 2011, p.7).

The specific areas of consumer behaviour studied include food desire and the desire for products used to signal messages during a sexual competition. In the latter, sexual competition was not primed, but rather it was studied indirectly. As harsh environments tend to be reproduction focused, it was hypothesized that as the environment becomes increasingly harsh sexual competition should increase. This increase in sexual competition should be associated with an increase in desire for products used to signal messages that intimidate same sex rivals and attract members of the opposite sex.

Both topics are analyzed from a life history perspective with a focus on how desire varies between safe (slow) and harsh (fast) life history environments. This approach enables a deeper understanding of how environmental conditions interact with our evolved biology to unconsciously influence consumer behaviour. This research will also help to identify environmental triggers that lead to maladaptive behaviours such as over eating and over spending. It should also aid in identifying potential strategies to reduce

maladaptive behaviours.

1.1 An overview of life history theory

Life history theory provides a framework for understanding how organisms, including humans, allocate scarce resources between survival (somatic growth and maintenance) and reproduction. In humans somatic growth involves investing personal energy and financial resources into growth and maintenance of one's body and mind, whereas reproduction effort refers to investing personal energy and financial resources into initiatives which increase the probability of mate acquisition and reproductive success. Reproduction efforts include activities associated with intra- and intersexual competition (Mittal & Griskevicius, 2014).

How an organism allocates scarce resources between competing needs is central the study of life history theory. As resources are limited, trade-offs are made between competing needs. Once resources have been allocated to satisfy a particular need the resource is considered to have been spent; that is, it can no longer be reassigned to satisfy a different need (Stearns, 1992). Life history theory research also aims to discover how an organism decides how these scarce resources are to be allocated and, how do these allocations aid in survival or reproduction (Stearns, 2000; Del Giudice, Gangestad & Kaplan, 2015).

Life history theory posits that the decision to invest effort and financial resources into somatic growth or reproduction is driven by environmental conditions. Environmental conditions can be viewed as being on a continuum

anchored with *safe* on one end and *harsh* on the opposite. Organisms raised in a safe environment tend to adopt a slow life history strategy. Characteristics of a slow life history strategy include a focus on somatic development, stable and predictable home conditions, a longer than average lifespan, and greater parental investment in offspring. In contrast, harsh environments are associated with a fast life history strategy. Characteristics of a fast life history strategy include a focus on mate acquisition and reproduction. In humans, a fast life history environment includes unstable and unpredictable home conditions, a shorter than average life span and, lower parental investment in offspring (Kruger & Kruger, 2016; Mittal & Griskevicius, 2014). Harsh environments are also associated with scarce resources such as food and other necessities of life and, high competition for these limited resources (Hill, Rodeheffer, Delpriore, & Butterfield, 2013). Fisher (2013) states, a limited supply of potential mates should also be considered a scare resource that is competed for.

1.2 The relationship between environmental harshness and nutrition

The nutritional quality and quantity of food varies between fast and slow life history ecologies. Bergland (as cited in Flatt and Heyland, 2011, p. 127) states that three environmental factors are associated with food quality and quantity. These factors include photoperiod (length of daylight), temperature and nutrition. The term nutrition refers to both macronutrients that are sources of energy and micronutrients (vitamins, minerals and protein) that are required for cell growth and maintenance (https://mynutrition.wsu.edu/nutrition-basics).

When analyzing the relationship between slow and fast life history strategies and nutritional resources, it is important to ask, are the findings a result of the amount of energy available and consumed or due to the presence or lack of micronutrients contained within the food?

1.2.1 The impact of environmental harshness and poor nutritional resources on simple life forms.

An environment could be classified as being harsh due to poor nutritional resources. In simple life forms such as insects, poor nutritional resources affect body size and the development of weaponry. Insects in nutrient rich environments tend to have a larger body size and weaponry. Having a larger body and better developed weaponry provides an insect an advantage in male intrasexual competitions (Gress & Pitnick, 2017). The relationship between nutrition and male body size has been demonstrated in studies of yellow dung flies. Gress & Pitnick (2017) report that studies have shown that dung flies and other insects from less nutrient rich environments tend to be smaller than males from nutrient rich environments. These smaller males tend to bypass precopulatory mate competition when larger dung flies are present. This withdrawal from an intra-sexual competition decreases the mating success of small male dung flies.

In addition, Hodin (2009) found that ladybird beetles and honey bees from nutritionally poor environments tend to produce a higher number of eggs than those raised in a nutrient rich environment. These eggs also tend to be lower in quality and in size which decreases offspring survival rates. Thus, in

harsh environments there is a trade-off between the number of eggs produced and egg quality. This trade-off may be adaptive under harsh environmental conditions as many of the hatched flies are unlikely to live long enough to reproduce.

In a nutrient poor environment simple life forms often experience a reproduction-somatic development trade-off. Research by Hodin (2009) provides an example of a trade-off and states that in a nutrient deprived environment female insects allocate body nutrients away from their own wing development (wing length) to provide more nutrition for the development of offspring.

Hodin (2009) also notes that under *extreme* nutritional deficit conditions female insects often go into a state called diapause which is similar to a state of hibernation. During this time the female insect's ovaries regress, become dormant and cease from producing offspring. When environmental conditions improve the ovaries reinitiate the reproduction process. This same dauer diapause stage has been found to occur in the nematode *C. elegans* as well as other simple organisms when environmental conditions become increasingly harsh and nutritional supplies begin to diminish (Gerisch and Antebi, 2004)

1.2.2 The relationship between environmental harshness, food shortage and life expectancy.

Up to this point the research reviewed implies that harsh environments are associated with low nutrition and food shortages. These shortages have

been shown to have a negative impact on an organism's reproductive health, somatic development, maintenance, and life span. These relationships however, are more complex than they first appear. For example, despite varying definitions of what constitutes caloric restriction, in many organisms including unicellular organisms, invertebrates, nematodes, fruit flies, lab mice and dogs, caloric restriction has been shown to extend an organism's life-span. The caveat is, a calorie restricted diet can increase life expectancy providing there is not an associated reduction in essential nutrients such as vitamins and minerals (Bauer and Helfand (2011) as cited in Flatt and Heyland).

This association between caloric restriction and life expectancy is not universal. Some organisms such as house flies (Cooper, Mockett, Sohal, Sohal, & Orr, 2004) and wild mice (Harper, Leathers & Austad, 2006) do not experience an extended life span under a calorie restricted diet.

1.2.3 The relationship between food shortage and life expectancy in nonhuman and human primates.

Non-human primates such as rhesus monkeys can live up to 40 years in captivity (http://genomics.senescence.info/species/entry.php?species=Macaca_mulatta) and human primates can live over 100 years (Rafi & Alavi, 2017). These long lifespans make primate life-history research difficult to conduct as a single study could last longer than the career of a researcher. In addition, the longer the study the greater the financial commitment needed (Bauer and Helfand (2011) as cited in Flatt and Heyland). It stands to reason that human life-history

strategies could also be difficult to study because an individual's environmental conditions can vary over the lifespan and thus, include periods of both safe and harsh environmental conditions. These alternating environmental conditions may confound the research findings and thus, make it difficult to draw explicit conclusions.

At this time, researchers must make inferences about humans from research conducted on nonhuman primates such as rhesus monkeys. Research shows that rhesus monkeys age in ways similar to humans (Ramsey, Laatsch, & Kemnitz, 2000; Francis, Appukuttan, Simmons, Landauer, Stoddard, Hamon, S., . . . Neuringer, 2008). For example, like humans, as rhesus monkeys age they experience greying and thinning of hair, they have a similar redistribution of body fat and a loss of muscle tone (Mattison, Colman, R. J., Beasley, Allison, Kemnitz, Roth, G. S., . . . Anderson, 2017).

Numerous studies have examined the relationship between caloric restriction and life-expectancy in rhesus monkeys. These studies have shown significant improvements in life expectancy when rhesus monkeys are put on a restricted calorie diet (Mattison et al. 2017; Bodkin, Alexander, Ortmeyer, Johnson, & Hansen, 2003; Colman, Anderson, Johnson, Kastman, Kosmatka, Beasley, . . . Weindruch, 2009;). In contrast a study conducted at the National Institute on Aging (Mattison, Roth, Beasley, Tilmont, Handy, Herbert, R. L., . . . Cabo (2012) found no significant improvement in life expectancy. However, they did find a near significant improvement in overall health. As the majority of the rhesus monkey studies find support for the hypothesis that a calorie

restricted diet (without a loss in nutrients) improves life-expectancy, it is suggested that these findings are likely generalizable to humans (Mattison et al., 2017).

1.3 The effect of environmental harshness on human appetite and food preference

As previously noted, harsh environments are often associated with food scarcity. Wells (2010) states, throughout history food scarcity has been more common than food excess. Those who were most likely to survive were sensitive to environmental cues that would signal conditions were becoming increasingly harsh and, that a food shortage may be forthcoming. Under harsh conditions there are two adaptive responses that can increase the likelihood that one will acquire their daily energy needs and thus survive. The first adaptive response is to increase foraging behaviour and to continue to eat in the absence of an energy deficit. This is enables the development of fat stores that can be drawn upon during a famine.

This drive to eat when one is not currently hungry is a dormant trait that is turned-on when an individual senses cues associated with harsh environmental conditions. When harsh environmental cues are experienced in childhood they can calibrate the brain in a manner that makes this a fixed trait that is carried into adulthood. Hill, Griskevicius, Prokosch, & Kramer (2016) discovered that some adults who live in a safe environment have eating patterns similar to those from harsh environments. They also discovered that this group of adults who continue to eat in the absence of an energy deficit

shared a common factor which was, that they were more likely to have been raised in a low socioeconomic status (SES) environment during childhood. This research demonstrates that childhood SES can have a lasting effect and can influence adult eating patterns despite decreases in environmental harshness. This drive to eat in the absence of an energy deficit becomes an enduring personality trait which is called *high trait appetite* (Cepeda-Benito, Gleaves, Williams & Erath, 2000).

Sapolsky (2014) adds, the relationship between stressful environments and eating is dependent on the intensity of the environmental stressor. He also states that unlike chronic stress, when one experiences acute stress appetite decreases. Experiencing a decrease in appetite under acute stress is adaptive as acute stress is often associated with life threatening events. Sapolsky (2014) reasons, it would not be beneficial to engage in foraging and eating behaviours that benefit long-term survival when one's physical safety or short-term survival is at risk.

A second adaptive response that can increase the likelihood that one will acquire their daily energy needs is to focus foraging efforts on energy dense foods. By preferring energy dense foods, one increases the probability that the amount of energy consumed would exceed the energy required to obtain the food. This too would enable the development of body fat stores.

In addition to serving as an energy store, the drive to eat to and put on body fat helps in reproduction and survival in other ways. Body fat contributes

to other biological functions such as maintaining one's reproductive fitness. Females need a body fat content of at least 22% for normal ovulatory function and fertility (Williamson, 2006). Males who have less than 20% body fat also experience lower fertility (Jensen, 2004). Therefore, in harsh environments that are reproduction focused (Griskevicius et al., 2013) it may also be adaptive to try to increase one's body fat to enable reproduction.

Harsh environments are also associated with high pathogen levels. Wells (2010) states, the human immune system requires a substantial amount of energy to function and to respond to infections. Stored body fat and the associated nutrients found in energy dense foods contribute to a healthy immune system and tissue repair. A final benefit associated with over eating energy dense foods is that abdominal fat stores aid in thermoregulation by increasing resting metabolic rate which in turn increases heat production. This, extra insulation provided by extra body fat can help one keep warm in cold conditions (Snodgrass, Leonard, Tarskaia, Alekseev & Krivoshapkin, 2005).

1.4 Life history ecologies and eating disorders

Life history ecologies are also associated with different personality traits and eating disorders. Del Giudice (2014) states three personality types are linked to the fast-slow life history spectrum. Harsh environmental conditions are associated with a *dysregulated* personality profile, whereas safe conditions are associated with *perfectionist* and *over-controlled* personality profiles.

Characteristics of a dysregulated personality include high impulsivity and low self-control and, are associated with compulsive over eating, binge eating and bulimia nervosa. Bulimia nervosa is an eating disorder where one over eats then purges to expel food before it can be digested (Collins, MDowell, Miller, Breithaupt, Thompson, & Fischer, 2017). While Bulimia can be found across the life history continuum, it is associated with emotionally dysregulated, under-controlled, and impulsive personality traits (Western & Harnden-Fischer, 2001) which are more strongly associated with a fast life history ecology (Del Giudice, Gangestad & Kaplan, 2015). In contrast, slow life history environments are associated with *perfectionist* and *overcontrolled* personality traits. These personality subtypes lead to eating disorders associated with restricting food intake. Anorexia nervosa is the most common eating disorder in this category (Del Giudice 2014).

1.5 The trait to desire high energy dense foods and salt is adaptive

The trait to desire high energy dense foods is supported by a number of evolutionary adaptations. First, humans have 5 different types of taste buds. These include taste buds for sweet, umami (savoury or meaty), salty, bitter and sour (King, 2013). Taste buds communicate nutrient quality of foods and help humans decide which foods should be ingested and which ones should not. Sweet and umami foods are pleasurable to eat, tend to be energy dense (Chapter 2, Table 2.1) and are therefore, a good source of fuel. Cooked meat has a umami flavour. It is believed that umami flavour may be a marker of easily digested protein (Breslin, 2013). Humans also enjoy salt in small quantities when consumed with other foods. Salt is important for a number of

biological functions such as nerve and muscle functioning. It also helps to promote hydration by stimulating the consumption of fluids (Leshem, 2009).

While humans often enjoy small qualities of sour and bitter foods, in high concentrations these foods can be harmful. The taste of bitter is associated with toxic compounds that can be harmful if consumed (Wooding, Bufe, Grassi, Howard, Stone, Vazquez, M., . . . Bamshad, 2006). Likewise, sour foods tend to be more acidic (Meyerhof, 2008).

The second adaptation is the development of the brains reward system that produces the neurotransmitter dopamine when sweet and umami tasting foods are consumed. The production of dopamine reinforces behaviour that humans find pleasurable. This includes the consumption of sweet and umami tasting foods (Carter, 2010).

1.6 Harsh environments differ in type and intensity

Not all harsh environments are the same. An environment that has an unsupportive social network can be described as being socially harsh. Socially harsh environments could include non-nurturing environments that make one feel lonely and rejected (Troisi & Gabriel, 2001) and environments where one experiences emotional abuse and controlling behaviours can also be considered socially harsh (O'Shaughnessy & Dollos, 2009; Gunstad, 2006).

An environment where people struggle financially and are unable to afford the necessities of life is an economically harsh environment. Lastly, an

environment where one feels their personal safety is at risk can be described as being physically harsh. A physically harsh environment can include verbal, physical, and sexual abuse. These types of harshness lead to a chronic feeling of insecurity due to a concern that they may be physically harmed (Williamson, Thompson, Anda, Dietz & Feiitti, 2002).

While there are different types of harshness, most harsh environments include a combination of these three types. In addition, a common theme that is associated with all three types of environmental harshness is that of uncertainty. It is logical to assume that this uncertainty can contribute to a sense of perceived risk.

1.7 The relationship between environmental harshness and signalling behaviour

A signal is something that provides information to another. Signals can be intentional such as when an animal growls to scare away a potential threat. A signal can also be unintentional; for example, a bird's bright plumage could signal health and virility (Laidre & Johnstone, 2013; Seyforth & Cheney, 2017). Animals can also signal through body language such as posture, facial gestures, eye contact, vocal tone and speed (Roberts, Vick, & Buchanan-Smith, 2013; Smith & Delgado, 2015). Animals can also signal through the display of external physical possessions (Doerr, 2012).

Whether the signalling is conducted through body language or through physical possessions the behaviour is considered to be adaptive because it

aims to influence the thoughts and behaviours of others in a manner that benefits the sender (Rendall, Owren & Ryan, 2009; Laidre & Johnstone, 2013; Seyforth & Cheney, 2017).

Walter and Elgar (2012), provide an example of how spiders signal through the use of external items. These authors state spiders signal through web construction and design. Spiders spin various silk web patterns depending on whether the objective is to build or decorate the web. It is believed that some web design patterns serve as decorations that lure prey into the web where they will be trapped. Other design patterns (which the spider sits at the center of) create an illusion that the spider is larger than it really is. This decreases the likelihood that the spider will themselves become prey.

The male bowerbird also uses physical objects from the environment to signal information to potential mates. The male bowerbird collects and decorates its bower with items such as stones, bones, shells (Doerr, 2012; Doerr, 2015) and other small items found in the environment. It is inferred that male 'building skills' may be perceived by females as signals of cognitive skills (Endler, Endler, & Doerr, 2010; Kelley & Endler, (2012) and good health (Matsumasa, Murai, & Christy, 2013).

1.7.1 The role of signalling in the development of dominance hierarchies

Scarce resources such as food are often a product of harsh environmental conditions. In these environments the toughest or most dominant animals are the most likely to have first access to the existing limited resources (Enquist, Ghirlanda & Hurd, 1998) whereas less dominant animals may go without. This same concept can be applied to mate acquisition; as noted by

Fisher (2013), a shortage of potential mates can also be considered a scarce resource. In sum, scarce resources may be distributed in an orderly fashion first among those who have high dominance or status and second, to those who have lower dominance or status.

Smith & Harper (as cited in Dawkins & Guilford, 1991) state there are three ways in which dominance hierarchies are developed among animals; by all out fighting, limited fighting and through signalling (posturing). The objective of signalling is to communicate that if a rival is challenged they are likely to lose the battle. Signalling dominance to intimidate a rival is preferred over physical fights because fighting consumes energy and often leads to injuries and sometimes death (Riechert, 2013).

1.8 Chapter Summaries

This literature review shows that harsh environmental conditions can impact food desire. There are however, many questions that remain unanswered. Such as, do different types of environmental harshness impact appetite in the same manner? Do different types of harshness influence the desire for low and high energy dense foods in the same direction? How does harsh social, harsh economic and harsh physical safety conditions impact the desire for the six different food categories (dairy, sweets, meats, grains, fruits and vegetables)? These are a few of the questions that the studies in these chapters aim to answer. The following is a summary of each chapter.

1.8.1 Overview of Chapter 2: Exposure to cues of harsh or safe environmental conditions alters food preferences

This chapter discusses an experiment aimed to test whether simple manipulations of perceived environmental conditions can influence changes in desire for different kinds of food. Based on evolutionary insights about foraging behaviour, perceived resource availability, and environmental cues of harshness, it was hypothesized that when presented with cues of environmental harshness, participants would show a preference toward high energy dense foods.

The methodology used in this experiment included showing participants images of 30 food items and asking them to rate how desirable each food item was. Second, they were then asked to read either a safe or harsh scenario story. Once the scenario story was read they were asked to reflect on how they would feel if they lived in these conditions. Next, they were then shown the same 30 food images for a second time and asked again to rate how desirable each food item was.

After the results from the pre-and post-tests were compared. The data showed that the only significant change in food desirability scores occurred in the group exposed to the harsh scenario. These results confirm that people exhibit behavioural sensitivity to how they perceive their environment. These findings specifically show that cues of environmental safety or harshness affected participants' desires to consume energy dense foods.

1.8.2 Overview of Chapter 3: Environmental stress effects on appetite: changing desire for high and low energy dense foods depends on the nature of the perceived threat

In the experiment described in Chapter 2 the scenario stories blended three types of harshness into each story. The three types of harshness included social, economic and physical safety dimensions. Combining three types of harshness into a single scenario limits our understanding of the effect of each dimension on appetite. In Chapter 3, I describe an experiment that isolated and analyzed the effect of each type of harshness on food preference.

The same experimental design was used as in Chapter 2. The only difference was that six scenario stories were used in this experiment. These scenario stories were written around the following themes: safe social, safe economic, safe physical safety, harsh social, harsh economic and harsh physical safety.

Overall, the analysis showed that for participants exposed to harsh scenarios depicting social isolation or a threat to their physical safety, food desirability was reduced. Economic harshness, on the other hand, had little to no effect on desirability. When the energy density of the foods in question was considered, a difference was observed only for those exposed to the physical safety scenarios. Specifically, the findings show that the reduction in food desirability were stronger for low-energy foods than for high energy foods. When analysed based on the major food categories, it was found that for those exposed to the scenario depicting threat to physical safety, the reduction in desire for sweets was much less than desires for vegetables, fruits, grains,

dairy, and meat.

1.8.3 Overview of Chapter 4: Stress and trait appetite mediate the relationship between early childhood socioeconomic status and adult food preference

Chapter 4 describes a path analysis study that examined the relationships between childhood and adult socioeconomic status (SES), the desire for low and high energy dense foods, stress and trait appetite. Specifically, this study shows how stress and trait appetite are influenced by environmental harshness experienced during early childhood. It also shows that in some situations, these traits and food preferences are developed in childhood are carried over into adulthood.

The methodology involved showing participants images of 30 food items and asking them to rate how desirable each food item was. These foods were then categorized into low and high energy dense categories. Next, participants were asked a series of questions that helped to determine their childhood SES, and current stress levels. They also answered the State and Trait Food-Cravings Questionnaire.

Through this analysis it was confirmed that both stress and trait appetite play mediating roles between childhood SES and adult food preference. More specifically, it shows how early childhood SES is indirectly related to adult food preference and that this relationship is significantly stronger with females than males.

1.8.4 Overview of Chapter 5: Environmental harshness influences the desire for signalling products used during sexual competition

In a harsh environment, survival is a challenge and many offspring do not survive long enough to reproduce. The species that do survive are the ones that reproduce at a younger age and have many offspring. These species are known to be reproduction focused rather than somatic development focused (Mittal & Griskevicius, 2014). In an environment that is harsh and reproduction focused it is logical to assume that there should be more intense intra- and intersexual competition than in a safe environment.

To assist during a sexual competition humans often purchase and conspicuously display products that intimidate same sex rivals and attract members of the opposite sex (Wang and Griskevicius, 2014). Based on this line of reasoning I hypothesised that as environments become increasingly harsh, we should see an increase in desire for conspicuous consumption and the desire for signalling products. Chapter 5 describes a study that was designed to answer the question, does environmental harshness increase the desire for products that intimidate same sex rivals or attract members of the opposite sex?

It was found that under harsh economic conditions female participants felt a higher sense of intersexual completion than intrasexual competition. With regards to product preference, in the safe economic scenarios there was no significant difference between change in desire for beautifying and financial power products. However, in the harsh economic scenario desire for financial power products decreased significantly more than beautifying products. It is

also noteworthy that in the economic and physical safety scenarios the participants' desire for both beautifying and financial power products decreased significantly more in the harsh than the safe conditions.

With regards to the male participants, the data showed that in the social scenarios there was no significant effect between environmental harshness and product category. However, in the harsh economic scenario there was a significant decrease in desire for both physical power and financial power products. There was also a significant difference in the magnitude of the decrease in desire between the physical power and financial power products.

1.9 Conclusion

In summary, these four data chapters examine the relationship between consumer behaviour and environmental harshness. They show that desire for both food and signalling products are sensitive to cues of environmental harshness. It also shows that some consumer behaviours are driven by unconscious drives that can be adaptive in that they can promote survival and assist with mate acquisition and reproduction initiatives. In addition, they show that the motives behind these behaviours are unconscious and a not a product of the environment itself, but rather a product of an interaction between our evolved biology and environmental stimuli. In the following chapters these studies will be presented in their entirety to provide a more detailed and comprehensive understanding of the relationship between environmental harshness and consumer behaviour.

Chapter 2

Exposure to Cues of Harsh or Safe Environmental Conditions Alters Food Preference

2.1 Abstract

In humans, psychological stress is positively correlated with an increased desire for certain energy-dense food items, indicating that stress may trigger foraging behaviour that adapts to perceived current and future resource availability. However, the extent to which such processes influence desire for different kinds of foods remains unclear. Here I examined the effects of perceived environmental conditions on food preferences across the food spectrum of dairy, meats, vegetables, fruit, grains, and sweets. I first showed participants images of 30 different food items to participants and recorded their stated desire to eat each kind of food. I then repeated this procedure after exposing participants to cues of either a harsh or a safe environment. As predicted, I found cues of environmental harshness increased the desirability of energy-dense food items. However, there was also evidence for decreased desirability for energy-dense food items following exposure to cues of a relatively safe environment. These findings indicate that simple manipulations of perceived environmental conditions may trigger changes in desire for different kinds of food. This study has relevance for increasing efforts to understand eating behaviour in order to promote uptake of healthier diets.

2.2 Introduction

Humans are thought to have evolved in environments where food was often scarce and its availability varied seasonally. As in other animals, humans have a propensity to over-eat when food is readily available and the ability to store excess energy as fat. These excess fat stores can then be drawn upon during future food shortages (Kardum, Gracanin & Hudek-Knezevic, 2008; Korte, Koolhaas, Wingfield & McEwen, 2005; Zafon & Simo, 2011; Saad, 2011). Natural selection would also likely favor preferences among different food items, with positive selection for preferences which maximize caloric intake rate - this logic is the foundation of optimal foraging theory (Dusseldorp, 2012; Lieberman, 2006; Pinel, Assanand, & Lehman, 2000; Pyke, Pulliam, & Charnov, 1977).

Furthermore, physiological and psychological mechanisms may lead to adaptive foraging behaviour that is sensitive to current local resource availability and environmental cues of how this availability may vary in the future. For example, stress responses can be triggered when an individual senses a threat, real or implied, to its psychological or physiological well-being. The stressor can be sensed in the present moment or anticipated at some future time (Greenberg, Carr, & Summers, 2002) and can be perceived and take effect subconsciously (Adam & Epel, 2007; Tamashiro, Hegeman, & Sakai, 2006). Acute stress and chronic stress influence the desire to eat in different ways. Acute stress triggers the suppression of appetite and hunger (Sinha & Jastreboff, 2013; Torres & Nowson, 2007); perhaps because it would be counter-productive for an organism to engage in food search while at the

same time trying to remove an immediate threat (Dagher, 2009). In comparison, chronic stress increases appetite and hunger (Born et al., 2009). Chronic stress results from experiencing unfavorable conditions over an extended period of time, such as persistent concern about where the next meal will come from and concerns about personal safety. Chronic stress therefore increases appetite while at the same time functioning as a mediator in directing food selection toward energy-dense food (Dagher, 2009; Torres & Nowson, 2007; Dallman et al. 2003). Energy-dense foods, which are often high in fat and sugar, are also preferred during times of chronic stress because they stimulate dopamine production in the brain's reward center. The increase in dopamine produces a pleasurable feeling (Carter, 2009) which leads to a decrease in cortisol production, repairs one's mood and helps return the body to a homeostatic state (Sapolsky, 2004; Adam & Epel, 2007; Sinha & Jastreboff, 2013).

2.2.1 Food preferences and environmental conditions

In general, relatively harsh environments are associated with increased exposure to pathogens, inhospitable climate and weather, and scarcity of resources such as food (Brumbach, Figueredo, & Ellis, 2009). Humans may subconsciously detect cues of environmental harshness and up-regulate attention towards scarce resources needed for survival. In response to cues of environmental harshness, people may exhibit risk-averse behaviours and seek-out and consume energy-dense foods to build fat reserves, which can serve as a buffer against the possibility of future food shortages (Torres & Nowson, 2007). There is some evidence that resource availability during childhood, in

particular, may also shape subsequent behaviour in later life, possibly by altering an individual's life history trajectory (Griskevicius et al., 2013).

Laran & Salerno (2013) conducted an experiment to directly investigate the effects of cues on environmental adversity on people's eating behaviour. They found that when participants were exposed to words such as 'shortfall' and 'adversity', individuals consumed more of a food item that they were led to believe contained higher calorific value ('high calorie' versus 'low calorie M&M candies). On the other hand, when participants were exposed to neutral words, consumption was unaffected. A limitation of this study was that it did not identify whether harsh environmental conditions affects appetite for all foods in the same manner. The current study was designed to address this limitation.

Specifically, in this study I investigated how cues of environmental conditions might alter preferences across a wider range of food items which vary in nutritive value. I developed an experimental procedure to test how the perception of environmental harshness influences preference for different food items across the five primary food categories (vegetables, fruits, breads, dairy, meats and sweets). I measured food preference by having participants look at images of food that were displayed on a computer screen in random order. Next, the participants were asked to rate how much they would currently like to eat each food item. Participants completed this task twice; before and after exposure to a stimulus which aimed to manipulate their perception of environmental harshness. Half the participants were randomly assigned to the 'harsh scenario', which involved reading a text passage that involved a young

woman describing her living conditions which included phrases describing poor economic/employment, social support and personal safety conditions.

My experimental design differs from that of Laran & Salerno in several critical respects. First, I can address the question of whether the influence of perceived environmental severity might generalise across a range of food items of variable nutritive value. Second, it allows me to test whether the effect of increased desirability of high calorie foods extends to people's implicit judgments of nutritive value, rather than their decision-making when calorific value is explicitly highlighted. Third, I used a within-subjects design, which allows us to control for a range of individual differences, for example in food preferences and current hunger, which could potentially have influenced Laran & Salerno's results. Fourth, rather than focusing solely on environmental harshness by comparing associated words against neutral controls, I explicitly compared scenarios of harsh versus safe environments. This distinction opens up the possibility to test not just the predicted effects of harsh environments on increased desire for high calorie foods, but also the opposite effect in which the potential for decreasing desire for high calorie foods might be elicited. This aim is of particular interest in the context of attempts to use evolutionary insights to change behaviour in order to promote a healthier diet in contemporary society (e.g. Roberts, van Vugt & Dunbar, 2012; Whitehead, Ozakinci & Perrett, 2012), and was made possible because the within-subjects approach allowed us to compare change in behaviour before and after exposure to cues of both kinds of environmental condition.

Based on the above-reviewed previous research, I hypothesized that cues of environmental harshness would trigger changes that might reflect changing strategies in consumptive behaviour, particularly of increased preference for high calorie food items. Furthermore, I hypothesized that cues of a safe or benign environment might trigger decrease in desire for high calorie food types.

2.3 Methods

2.3.1 Participants

This experiment comprised a total of 167 participants from a large Canadian university. Participants included both students and support staff. Students received a course research participation credit for participating. Participants were told the purpose of the study was to investigate influences on food preferences. In keeping with prior research, a questionnaire administered at the end of the experiment aimed to identify whether participants had any form of food allergy, were vegetarian/vegan, or had religious beliefs that influenced their food choices. If a participant stated ‘yes’ to any of the above questions they were excluded from the analysis. This left 126 participants in the final analysis, of whom 70 participants (25 men, 45 women) were randomly allocated to the safe scenario condition and 56 participants (34 men, 22 women) were allocated to the harsh scenario condition.

2.3.2 Procedure

Having provided informed consent, participants were provided with a URL to the online experiment. They were then shown images of 30 food items,

as displayed in Figure 2.1. These images constituted five items from each of the major food categories (vegetables, fruits, grains, dairy, meat/poultry, and sweets).

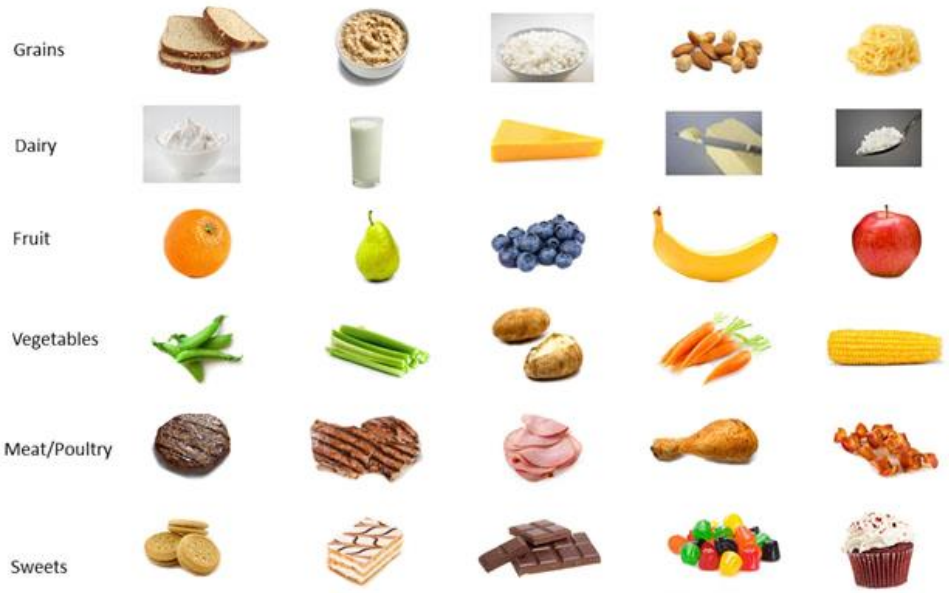

Fig. 2.1. Food images used in experiment.
Images were shown individually and in randomised order. They include five examples of each of six main food groups: Grains (from left to right: bread, oatmeal, rice, peanuts, spaghetti), Dairy (ice cream, milk, cheese, butter, cottage cheese), Fruit (orange, pear, blueberries, banana, apple), Vegetables (peas, celery, potato, carrots, corn), Meat (hamburger, steak, ham, chicken, bacon), and Sweets (cookies, pastry, chocolate, candy, cupcake).

Images were presented in a different randomised order for each participant. Participants viewed each image and rated it according to the following question which was displayed below the image: “How desirable is this food item to you right now?” Ratings were recorded using a 7-point scale (anchored with the descriptors 1 = extremely undesirable and 7 = extremely desirable).

After the 30 food items had been rated for preference, participants were randomly assigned to either the ‘safe’ or ‘harsh’ environmental condition. They

were asked to read a scenario text (see Appendix 1). Scenarios were adopted from a study by Little et al. (2007) who used them to test facial preferences under hypothetical high and low harsh environmental conditions. Each scenario depicted circumstances including elements concerned with a social environment, level of social support networks, and current economic well-being. Each text concluded with a statement forecasting future social and personal economic conditions (note, there was no direct mention of food availability in either scenario). Participant were then asked to imagine how they would feel if this was their situation. Once the allocated scenario had been presented, the participants were asked to rate the same 30 food items for a second time. The food images were presented in a new randomized order. Finally, participants completed a background questionnaire to obtain demographic details.

2.3.3 Summary of Materials Used

2.3.3.1 Desktop or laptop computer. In this study, the participants used a personal desktop or laptop computer.

2.3.2.2 Internet connection. As the study was hosted on the Qualtrics server an internet connection was required.

2.3.2.3 Isolated food images. Individual food items were placed on a white background with no other images or patterns on the slide as the food item was being viewed.

2.3.2.4 Sex and age information was collected through drop-down question boxes at the end of the survey.

2.3.2.5 Participant Consent. Once the participants had accessed the Qualtrics site they were presented with the following information:

“Please note, this study cannot be done on a cellphone. Please use a laptop or desktop computer.

Who is conducting this experiment?

This experiment is being conducted by researchers in the Department of Psychology at Stirling University, UK. The study is being run by Jim Swaffield (j.b.swaffield@stir.ac.uk) and Dr. Craig Roberts (craig.roberts@stir.ac.uk).

What is being investigated?

The purpose of the study is to investigate product preferences.

Who can participate?

This experiment is open to anyone who is 18 years old or older.

What will participation involve?

In this experiment you will be shown 30 product images and asked to rate how desirable each item is to you. After the 30th image has been viewed you will be asked to read a 1 page story. Once the story has been read you will be shown an additional 30 images and asked once again to rate how desirable each product item is.

This experiment will take approximately 10 - 12 minutes to complete.

Your answers are completely anonymous and confidential. The information you provide cannot be attributed to you personally.

Consent

Your participation is voluntary. You can stop the survey at any time by closing your web browser. It is assumed that you give your consent to participating in the experiment by clicking on the ">>" symbol, found at the bottom of the first page, to start the survey.

2.3.3.6 Environmental scenario stories. The stories that had been used in this study were adopted from a study conducted by Little et al. (2007). The rationale for using these stories was twofold; first because they had proven to generate a priming effect. Second, because I wanted to contribute to the body

of knowledge on how perception of environmental harshness affects appetite.

2.4 Results

First, I tested whether participants' exposure to the safe or harsh environment scenario would alter overall food desirability across the 30 food items. I used repeated-measures ANOVA to test for changes in participants' scores before and after the scenario manipulation (*Test*), with pre- and post-exposure scores for the 30 food items nested within *Food Group* (6 levels: meat, vegetables, fruit, dairy, grains, sweets), and with *Scenario* (safe, harsh) as a between-subjects factor. I found a significant *Test* x *Scenario* interaction, $F(1, 124) = 10.45$, $p = .002$; while pre-exposure and post-exposure scores were similar for participants exposed to the safe scenario, post-exposure scores increased among participants who were exposed to the harsh environmental scenario.

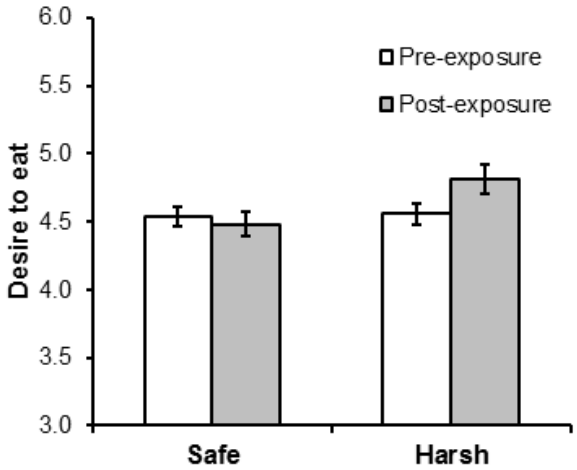

Fig. 2.2. Mean (± s.e.m) 'desire to eat' scores across 30 foodstuffs, measured pre-exposure (open bars) and post-exposure (grey bars) to a scenario depicting either a safe or harsh environment. Scores increased post-exposure only when participants were exposed to cues of harsh environments; the interaction is significant ($p = 0.002$).

Furthermore, the *Test* x *Scenario* x *Food Group* interaction was also significant, $F(5, 620) = 13.68$, $p < .0001$), such that changes in food desirability scores changed after exposure only in the harsh environment and that these changes varied across food groups. As shown in Figure 2.3, desirability scores were considerably higher following exposure to harsh environment cues for meat and sweets, and somewhat higher for grain, while desirability of vegetables and dairy did not change and was somewhat reduced for fruit.

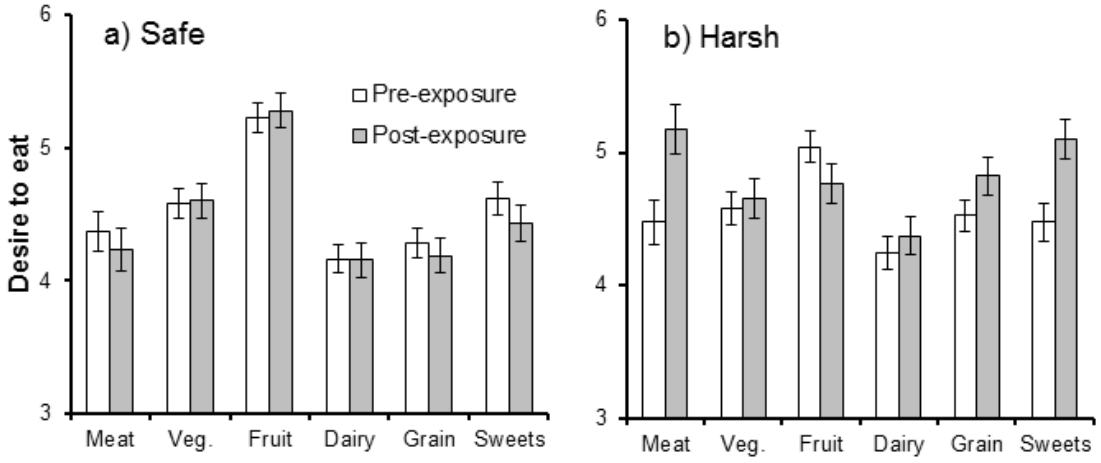

Fig. 2.3. Mean (± s.e.m) 'desire to eat' scores across six major food groups, measured pre-exposure (open bars) and post-exposure (grey bars) to a scenario depicting either a safe or harsh environment. Scores do not alter following exposure to cues of a safe environment, but changes occurred across different food groups following exposure to cues of a harsh environment.

I also re-ran the model to include gender of participant as a between-subjects factor. The main effect of *Gender* was not significant ($p = .14$), nor were there any significant interactions involving *Gender* and *Scenario* ($p > .4$), and all the other interaction effects reported from the first model remained significant. This indicates that men and women responded similarly to the experimental manipulation.

Next, I investigated whether this effect was driven by a change in preference for energy density among the individual food items, by examining items in relation to calorific value. I determined the calorific values of the 30 food items using the dataset of the British Nutrition Foundation (http://www.nutrition.org.uk/healthyliving). I then split the 30 foods into two equally sized groups (*Energy Value*, 15 "high energy" foodstuffs, 15 "low energy" foodstuffs) based on their calorific value (see Table 2.1), and included this as a within-subjects factor in repeated measures ANOVA. This analysis revealed a significant *Test* x *Scenario* x *Energy Value* interaction, $F(1,14) = 28.46$, $p < .0001$, such that desirability scores decreased after exposure to the safe scenario while, in contrast, they increased post-exposure to cues of environmental harshness, but only in the high energy food group.

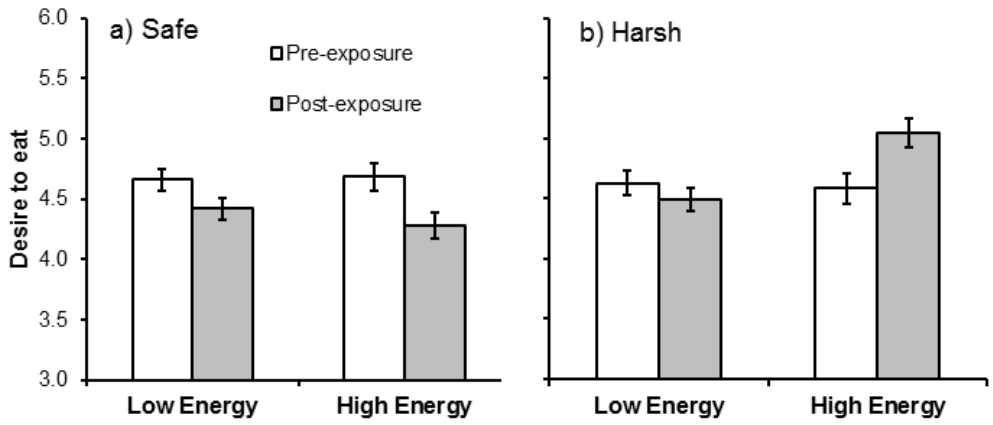

Fig. 2.4. Mean (± s.e.m) 'desire to eat' scores across measured pre- and post-exposure to a scenario depicting either a safe or harsh environment, across 15 low energy and 15 high energy food items. While scores decreased post-exposure to the 'safe environment' scenario, scores increased following exposure to cues of a harsh environment, but only for high-energy food items; the interaction is significant ($p < .0001$).

Results from the analyses for individual food items (Table 2.2) support this: there was a significant interaction effect for 13 of the 15 "high energy" food

items (in the same pattern as shown in Fig. 2.4), but this was markedly different among the “low energy” food items. Here, only one foodstuff (potato) followed a similar pattern with a significant interaction effect, with scores for rice being marginally significant. The only other significant interaction among the low energy foods was a significant decrease in desirability for the lowest energy value food, apples, after exposure to cues of environmental harshness.

Calorific value thus appears to be positively associated with the extent to which people desired specific foodstuffs following cues of harsh environments. I analysed this further by examining changes in desirability for individual food items. I first calculated change in desirability by subtracting mean desirability scores for food items before the manipulation from the equivalent scores given by participants after the manipulation (positive change indicates a food item is given higher scores following the manipulation). I then correlated change in desirability scores for food items with their calorific value. This analysis revealed that, in participants exposed to cues of a harsh environment, change in desirability of food items was positively correlated with their calorific value (r = .576, n = 30, p = .001). In contrast, the reverse was found for participants exposed to the safe scenario (r = -.492, n = 30, p = .006), indicating that desire for higher energy foods may be reduced by cues of benign environmental conditions (see Fig. 2.4a). This analysis reveals that cues of environmental conditions may both increase and decrease desire for high energy foods, according to perceived future availability and need.

Interestingly, however, plots of these data revealed that these effects of calorific value on change in desirability scores were curvilinear rather than

linear and that a quadratic function fitted the data better than a linear one (Fig. 2.5; safe: $F(2,27) = 14.63$, $p < .0001$; harsh: $F(2,27) = 14.66$, $p < .0001$; $r^2 = .52$ in each case, compared with .242 and .332 for linear functions in the safe and harsh scenarios, respectively). The curve was u-shaped in participants exposed to the safe scenario (function: $y = -.135x + .017x + .092$), and n-shaped in participants exposed to the harsh scenario ($y = .428x - .050x - .257$).

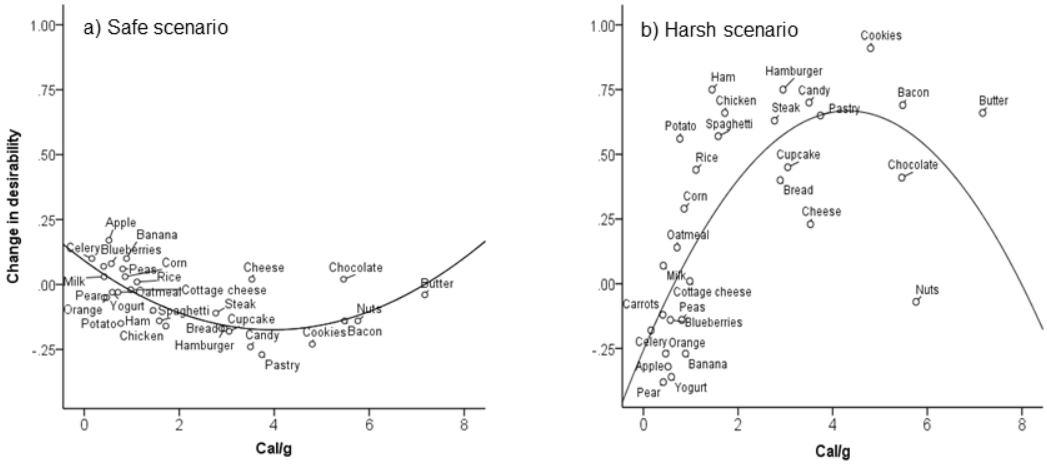

Fig. 2.5. Association between calorific values of 30 food items and mean change in 'desire to eat' scores awarded to food items after viewing a scenario depicting either a safe (n = 70 participants) or harsh environment (n = 56 participants). Regression curves depict quadratic functions ($r^2 = .52$ in each scenario).

This suggests that the negative and positive effects, respectively, of calorific value on food item desirability following exposure to cues of safe and harsh environments were driven by food items of low to moderate calorific value only. Although food items with extremely high calorific value (i.e., cookies, chocolate, bacon, nuts, butter) followed the general pattern of other high energy foods, the change in food item desirability associated with the scenario manipulation was relatively modest.

2.5 Discussion

The data supported the hypothesis that predicted as environmental harshness increases the desire for energy dense foods will also increase. It was also found that as the environment is perceived to be less harsh (safer) the desire for both low and high energy dense foods decreased.

These findings add to the existing evidence that there is behavioural sensitivity to how people perceive their environment. For example, previous work, using the same textual scenarios depicting harsh or safe environmental conditions, has reported a potentially adaptive shift in female preferences from less masculine-looking male faces towards more masculine-looking faces under harsh environmental conditions (Little et al., 2007). Other studies have found changes in preference among different foods when participants are primed with words associated with deprivation or hardship (Torres & Nowson, 2007; Laran & Salerno, 2013). In this study, a simple text scenario describing either safe or harsh environmental conditions altered participants' expressed desire to eat foods with relatively high calorific value, even though there was no direct reference in either scenario to food availability.

Based on earlier research, I had predicted that environmental harshness would likely increase desire for energy-dense food items. However, I did not know whether this increased desire would be limited to energy-dense foods; that is, whether desire for food would increase across food items more generally.

Table 2.1. **Standard energy content of the presented food items (in calories per gram).**

Low energy foods	Cal/g	High energy foods	Cal/g
Celery	0.16	Ham	1.45
Carrots	0.41	Spaghetti	1.58
Pear	0.42	Chicken	1.72
Milk	0.42	Steak	2.77
Orange	0.47	Bread	2.89
Apple	0.52	Hamburger	2.95
Blueberries	0.57	Cupcake	3.05
Yogurt	0.59	Candy	3.50
Oatmeal	0.71	Cheese	3.53
Potato	0.77	Pastry	3.74
Peas	0.81	Cookies	4.80
Corn	0.86	Chocolate	5.46
Banana	0.89	Bacon	5.48
Cottage cheese	0.98	Nuts	5.76
Rice	1.11	Butter	7.17

Data come from the British Nutrition Foundation (2009). Although the British Nutrition Foundation defines low energy foods as those having ≤ 1.5 cal/g, here I classified 'ham' as a high energy food to produce equally sized samples of low energy and high energy foods – results are qualitatively identical if ham is reassigned as a low energy food item.

The results suggest that there was no significant change in desire for foods that were relatively energy-poor after exposure to the harsh environmental scenario, suggesting that the manipulation did not affect appetite generally. Thus, the results support the idea that harsh conditions increase perceptions of resource scarcity, which in turn triggers optimal foraging behaviour such that attention is specifically directed towards high calorific/high-motivation foods.

Table 2.2. Mean (± s.e.m.) scores for individual food items pre- and post-exposure to scenarios depicting safe or harsh environments.

	Safe scenario		Harsh scenario		*F*	*p*
	Pre-test	Post-test	Pre-test	Post-test		
Low-energy items						
Apple	5.30±.11	5.47±.14	5.20±.12	4.88±.15	6.24	*.014*
Banana	5.10±.15	5.20±.18	5.07±.17	4.80±.20	2.67	.105
Blueberries	5.49±.19	5.57±.18	4.98±.21	4.84±.21	1.03	.313
Carrots	4.87±.16	4.94±.18	4.91±.18	4.79±.20	.89	.347
Celery	4.10±.17	4.20±.19	4.38±.19	4.20±.21	2.13	.147
Corn	4.77±.16	4.80±.17	4.82±.18	5.11±.19	1.78	.185
Cottage cheese	3.53±.22	3.51±.23	3.45±.25	3.46±.25	.02	.886
Milk	4.24±.21	4.28±.21	4.48±.23	4.55±.24	.05	.823
Oatmeal	3.87±.21	3.84±.21	4.07±.23	4.21±.23	.63	.427
Orange	5.16±.17	5.11±.17	5.02±.19	4.75±.19	1.22	.271
Peas	4.80±.17	4.86±.19	4.46±.20	4.32±.21	.81	.370
Pear	5.09±.15	5.04±.17	4.95±.16	4.57±.19	2.69	.103
Potato	4.36±.16	4.21±.17	4.32±.18	4.88±.19	11.81	*.001*
Rice	4.29±.17	4.30±.17	4.45±.19	4.89±.19	3.45	.066
Yogurt	4.94±.17	4.91±.17	4.84±.19	4.48±.19	2.88	.092
High-energy items						
Bacon	4.41±.21	4.27±.22	4.77±.24	5.46±.25	17.15	*<.001*
Bread	4.23±.16	4.06±.17	4.39±.18	4.79±.19	8.57	*.004*
Butter	3.37±.16	3.33±.19	3.63±.18	4.29±.21	14.99	*<.001*
Candy	4.40±.20	4.16±.19	4.14±.22	4.84±.21	14.50	*<.001*
Cheese	4.74±.17	4.76±.19	4.86±.19	5.09±.21	.96	.329
Chicken	4.70±.18	4.54±.18	4.86±.20	5.52±.20	19.00	*<.001*
Chocolate	5.14±.16	5.16±.16	5.20±.18	5.61±.18	4.14	*.044*
Cookies	4.44±.18	4.21±.18	4.14±.20	5.05±.20	26.23	*<.001*
Cup cake	4.84±.18	4.66±.19	4.59±.20	5.04±.21	5.66	*.019*
Ham	3.76±.19	3.66±.21	3.63±.21	4.38±.23	16.32	*<.001*
Hamburger	4.34±.18	4.17±.20	4.41±.20	5.16±.22	21.49	*<.001*
Nuts	4.73±.14	4.59±.17	5.11±.16	5.04±.19	.102	.750
Pastry	4.26±.18	3.99±.19	4.30±.20	4.95±.21	14.48	*<.001*
Spaghetti	4.30±.17	4.16±.18	4.61±.19	5.18±.20	11.70	*.001*
Steak	4.64±.22	4.53±.24	4.71±.24	5.34±.26	10.75	*.001*

Significant interactions are highlighted in italic text

*For a Bonferoni correction compare the *p* values against 0.001667

In addition, the data revealed two further interesting results. First, analyses using food item as the unit of analysis showed that, in contrast to the positive correlation between calorific value and increased desirability ratings of high-calorie food items in the harsh environment condition, there was an inverse relationship in the safe environment condition. This may suggest that cues of experiencing a safe and benign environment may serve to reduce

attention towards higher calorific food items. As Figures 2.4 and 2.5 show, this response was considerably less marked compared with the increased desire precipitated by the harsh environment cues, but the effect is nonetheless of interest. For example, it might be that a stronger effect would be obtained in participants from a population where standards of living are lower.

Second, the response in desire to food items varying in calorific value following exposure to cues of environmental harshness was curvilinear (Fig. 2.5b), indicating that although desire for extremely energy-dense items did increase, it did not increase as much as might have been expected. It may be that these items (including cookies, chocolate, and bacon) are so highly desirable that responses to them are relatively stable, in which case stronger or more realistic scenario manipulations might be required to overcome 'inertia' in preference for these items. Alternatively, these responses could be the result of a ceiling effect, such that there is less scope for increased desire in the post-exposure measures because expressed desire was already high in the pre-exposure measure. Further work may help to clarify this question, but consideration of the shape of the response curve in participants exposed to the safe scenario (Fig.2.5a) is also relevant here. In this group, the same kind of effect (in this case, a floor effect) would not explain the relative stability of ratings for the same food items, because higher ratings in the pre-exposure measure would mean that these items could potentially decrease even further than items rated only moderately desirable in the pre-exposure measure. Thus, I tentatively concluded that the relative stability in ratings of these items might

be due to psychological affinity for these items as common comfort foods, which is difficult to overcome with simple scenario manipulations.

It should be acknowledged that while this study demonstrated that simple cues of environmental conditions influences food preferences, it cannot be inferred from this that manipulations of perceptions of environmental harshness or safeness would impact on actual caloric intake. Tests of actual consumption, rather than stated desire for food items, are a logical next step. Furthermore, it would be of interest to further disentangle the influence of cues of economic and social hardship, which were conflated in the scenarios. However, the results demonstrate that preference for different food items that vary in calorific value can be altered by simple and brief primes of prevailing environmental conditions, which has potential impact on strategies for behaviour change aiming to tackle the obesity crisis and its associated implications for human wellbeing.

Chapter 3

Environmental stress effects on appetite: changing desire for high and low energy dense foods depends on the nature of the perceived threat

3.1 Abstract

It is well-documented that harsh environmental conditions influence appetite and food choice. However, the experience of environmental harshness is complex and shaped by several underlying dimensions, notably threats to one's social support, economic prospects, and physical safety. Here, I explored the differential effects of these three dimensions of environmental harshness on short-term changes in people's expressed desire for specific food items. I first showed participants images of 30 food items, which were representative of each of the major food categories. I then asked them to rate the desirability of each food item. Participants were then randomly allocated to read one of six scenarios describing someone's current experience: scenarios emphasised one of the three dimensions (social support, economic prospects, physical safety), with two levels (safe, harsh). Following this, participants repeated their scoring of the food items images. The results show that exposure to cues of low social support and high physical threat reduce general desire to eat, but cues of economic harshness had little effect. Further analysis revealed a significant interaction between energy level of different food items and perceived threat to physical safety: while overall appetite declines, this is less marked for high energy compared with low energy food items, and less marked for sweet food items than any other food type. These findings are important in helping to

understand how current environmental conditions influence changes in appetite and desire for different kinds of food items**.**

3.2 Introduction

It is believed the drive to consume energy dense foods when an individual is stressed is an adaptive response that aids survival. For example, short-term acute stress may result from threats in the environment that may cause physical harm; these threats and the associated stress response helps to prepare the body for a fight or flight response (Sapolsky, 2004). Under conditions of mild stress, the body prepares for this response by increasing the desire to eat which in turn provides fuel for the muscles. In the longer term, chronic stress may also influence eating behaviour. One example of a chronic stressor is the perceived likelihood of a future food shortage. It is hypothesized that, as environmental conditions become harsher, a sense of food resource scarcity is triggered (Nettle, Andrews, & Bateson, 2016). According to the *Insurance Hypothesis,* in an environment where food resources vary in supply, the drive to over-consume is adaptive because it enables the development of excess fat stores that might buffer the impact of a future famine (Nettle et al., 2016). In support of this idea, Hill et al. (2016) have demonstrated that harsh environments experienced during childhood can have long-term prospective effects, calibrating the body to prefer high energy dense foods later in adulthood. Such adaptive responses can also occur rapidly in response to changes in perceived environmental conditions. For example, Laran and Selarno (2013) and Swaffield and Roberts (2015) have shown experimentally

that even simple and transient manipulations of the perception of environmental harshness can trigger an immediate desire for food consumption, particularly for high energy dense foods.

While it is well-established that perception of environmental harshness can influence eating behaviour, harshness in these terms is a multi-dimensional concept and includes a number of different conditions that contribute to a state of being stressed. A harsh environment may include having a poor social support network, poor economic conditions needed to acquire the necessities of life and perhaps, also threats to one's emotional and physical safety. To better understand how the perception of current and possible future environmental conditions influences food consumption, these variables need to be isolated and analyzed individually. Hence, the focus of this study is to examine the effect of different types and levels of harshness on food preference.

3.2.1 The impact of the social environment on food consumption

A safe social environment is one where an individual feels emotionally connected and valued by their family and peers. Safe social environments promote food sharing (Kaplan, Hill, Lancaster, & Hurtado, 2000) which in turn, can promote survival and may communicate that one is valued by others. As humans have an apparently innate need to be socially connected (Baumeister & Leary, 1995) it is logical to assume that food sharing can have a positive effect on an individual's physical and emotional well-being.

People from safe social environments make better food choices and eat less than those who come from harsh social environments (MacFarlane, Crawford, Ball., Savige, & Worsely, 2007; Pott, Albayrak, Hebebrand, & Pauli-Pott, 2009). Bauer, Hearst, Escoto, Berge, & Neumark-Sztainer (2012) also state that supportive families are more likely to have meals together. Eating together as a family provides an opportunity for members to connect with one another emotionally and enables parents to teach and reinforce healthy eating habits.

Parents who are unresponsive to their children's emotional and physical needs, and who are abusive and excessively controlling also contribute to harsh environmental conditions which can lead to elevated stress, excessive weight gain and obesity (O'Shaughnessy & Dollos, 2009; Gunstad, 2006). Individuals from these non-nurturing environments often state they feel insecure, isolated, rejected and lonely (Troisi & Gabriel, 2011). This lack of social support can lead to emotional eating and the consumption of energy dense comfort foods to make one feel better (Stojek, Fischer & MacKillop, 2015). If these harsh social conditions are chronic, they can lead to disordered eating behaviours (Latzer, Hochdorf, Bachar, & Canetti, 2002; Tate, Spruit-Metz, Pickering, & Pentz, 2015; Ty & Francis 2013; Sinha & Jastreboff, 2013).

3.2.2 The impact of economic status on food consumption

Prior research has shown that there is a strong negative association between both income and obesity (Borders, Rohrer & Cardarelli, 2006; Garawi, Devries, Thorogood, & Uauy, 2014; Shaw, Green, Popham, & Benzeval, 2014;

McLaren, 2007) and between low income and preference for high energy dense foods (Dressler & Smith, 2013). However, it is difficult to conclude that low income alone is the driver of excess food consumption because income is related to other psychosocial factors such as education and stress levels. Others have suggested the reason low income individuals often have a higher body mass index is because high energy food is often less expensive than low energy foods (Drewnowski & Specter, 2004). The price of food argument has some limitations as it does not explain why low income women are more likely to be obese than low income men. Nor, does it explain why low income individuals often eat more than their daily caloric needs.

3.2.3 The impact of perceived physical safety on food consumption

Individuals who live in harsh environments are often abused or live in fear of being abused. Abuse can come in a variety of forms including verbal, physical, sexual, as well as being threatened or bullied. A less obvious form of abuse is benign neglect that creates a feeling of insecurity and being unprotected from physical dangers (Williamson, Thompson, Anda, Dietz, & Feiitti, 2002). Physically harsh environments are highly correlated with both childhood and adolescent obesity (O'Shaughnessy & Dollos, 2009; Gunstad et al., 2006) as well as adult obesity (Alvarez, Pavao, Baumrind, & Kimerling, 2007; Williamson et al., 2002). It has also been reported that childhood sexual and physical abuse doubles one's likelihood of being overweight or obese as an adult (Rohde et al., 2008).

3.2.4 The current study

As I have briefly reviewed, there are established links between different environmental conditions and eating behaviour. Here, to develop a deeper understanding of how environmental harshness influences food desirability, I explicitly examine and compare the effects of three core dimensions of environmental harshness (social, economic, physical safety). I build on the earlier work (Swaffield & Roberts, 2015) showing that when humans are exposed to primes of a harsh environment they experience an increased desire to consume high energy dense food. In that study, participants were randomly assigned to either a "safe" or "harsh" environment condition, where they read a 3-4 paragraph story about the situation of a young woman in her early 20's, with a 'safe' or 'harsh' version of her story. These environmental scenarios interwove each of the various social, economic and physical safety aspects. As a result, it is unknown whether all three dimensions played an influential role in triggering the increased desire for energy dense food, or if one dimension was more important than the others. In addition, the three dimensions may not be wholly independent: for example, good economic conditions enable the acquisition of resources that promote physically safe environmental conditions, and both may enable the development of supportive social networks. To address these issues, I developed a new set of scenarios that isolate the social, economic and physical safety dimensions and vary them so that there is a "safe" and "harsh" version of each. This allowed me to parse the effects of different dimensions of environmental harshness on individual's desire to eat different food items.

3.3 Methods

3.3.1 Participants

I recruited a total of 859 participants, residing in the United States, to participate in an online study through Amazon Mechanical Turk (M-Turk), an online crowd sourcing service. Each participant was paid a nominal fee (~$1.25) to participate. Before analysis, I inspected the distribution of response times and excluded any participants whose response time indicated they had spent insufficient attention to the task (less than 330s). Participants were asked if they suffered from any form of food allergy, were vegetarian/vegan, or had religious beliefs that influenced their food choices. If a participant stated “yes” to any of these questions, their responses were also excluded from analyses. This left 564 participants in the final analysis (mean age 37.2, SD = 11.73), of whom 278 (49.3%) were women and 286 (50.7%) were men.

Table 3.1 Mean age and sex of participants in each scenario.

Scenario	**Male**			**Female**		
	Mean age	Standard deviation	Number	Mean age	Standard deviation	Number
Safe Social	36	13	47	39	13	44
Harsh Social	36	10	42	40	13	48
Safe Economic	38	13	54	39	12	49
Harsh Economic	35	11	48	37	12	46
Safe Physical	34	10	49	41	13	42
Harsh Physical	36	10	46	37	11	49

3.3.2 Procedure

Having provided informed consent, participants were provided with a URL to the online experiment. They were then shown images of 30 food items, as displayed in Figure 2.1. These images constituted five items from each of the major food categories (vegetables, fruits, grains, dairy, meat/poultry, and sweets); original images are available from the authors on request. Images were presented in a different randomized order for each participant. Participants viewed each image and rated it according to the following question which was displayed below the image: “How desirable is this food item to you right now?” Ratings were recorded using a 7-point scale (anchored with the descriptors 1= extremely undesirable and 7= extremely desirable).

After the 30 food items had been rated for preference, participants were randomly assigned to one of six conditions; safe/harsh social support, safe/harsh economic prospects, or safe/harsh physical safety. They were asked to read an accompanying scenario text (see Appendix 2). Each scenario text depicted environmental conditions associated with the condition group to which they were assigned. The scenario text concluded with the sentence, “Pause for a moment and think about the story you just read. How would you feel if this really was your situation?” Note, there was no direct mention of food availability in any scenario. Once the scenario had been read, the participants were asked to rate the same 30 food items for a second time. The food images were presented in a new and fully randomized order. Finally, participants completed a background questionnaire to obtain demographic details.

3.3.2.1 Summary of Materials Used

With one exception, the materials used in this study are the same as the materials used study in Chapter 1. For a detailed list of these materials please refer to page 28, *2.3.3 Summary of Materials Used.* The exception was the development of new environmental scenario stories.

New environmental scenario stories were written for this study (see Appendix 2). In the first experiment the scenario stories that were originally developed by Little et al. (2007) interwove the dimensions of safe/harsh social, safe/harsh economic and safe/harsh physical conditions (see Appendix 1). It is possible that different types of environmental harshness could generate different types of emotion and thus, may impact food desire in different ways. Therefore, combining the different types of harshness could create confounding variables. For this reason the scenario stories that were used in this study were written in a manner that isolated each type of harshness to better assess the effect of each type of scenario on food preference.

3.3.3 Analysis

I performed three main analyses. First, I conducted a two-way ANOVA to examine the effect of scenario (i.e., social, economic and physical) and level of harshness (i.e., safe versus harsh conditions) on changes in overall food desirability, using computed mean scores across all food items. I did not include sex as a between-subjects factor because preliminary analysis revealed no significant main sex effect, nor any significant interactions, on change in food desirability scores. Next, I used repeated-measures ANOVA to look at the effect

of food energy density (low and high calorific value) and environmental harshness on food preference for each scenario separately. The calorific value of each food item was determined based on the dataset of the British Nutrition Foundation (http://www.nutrition.org.uk/healthyliving). Food items were split into two equally sized groups (*Energy Value, 15 "high-energy" foodstuffs, 15"low-energy" foodstuffs)* based on their calorific value. High energy foods included ham, spaghetti, chicken, steak, bread, hamburger, cupcake, candy, cheese, pastry, cookies, chocolate, bacon, nuts and butter; low energy foods were celery, carrots, pear, milk, orange, apple, blueberries, yogurt, oatmeal, potato, peas, corn, banana, cottage cheese and rice (for full details of calorific values, see Table 2.1). Finally, I conducted a further repeated-measures ANOVA to investigate the differential effects of the scenarios on desire among different major food categories represented in the image set (vegetables, fruits, grains, dairy, sweets and meats).

3.4 Results

3.4.1 Changes in general food desirability

I first used a two-way ANOVA to examine the between-subject effects of *scenario* (i.e., social, economic and physical safety) and *harshness* (i.e., safe versus harsh conditions) on changes in general food desirability (i.e. mean desirability change for all foods combined). This analysis (Figure 3.1) revealed a significant main effect of *scenario* on food preference $F(2,558) = 7.93$, $p < .001$. There was a slight increase in food desirability scores in those participants who read the economic scenarios (mean change =.003) but, in contrast, participants who read the social (-.165) and physical safety scenarios (-.236) experienced decreases in food desirability. Post-hoc Least Significant Difference (LSD) tests indicated that changes in desirability scores in the social ($p=.007$) and physical safety ($p<.001$) scenarios were significantly different from the economic scenario, but not different from each other. There was also a main effect of *level of harshness* on food preference $F(1,558) = 11.45$, $p=.001$, with a much larger decrease in food desirability in participants exposed to the harsh scenarios (mean change = -.219) compared to those exposed to the safe scenarios (-.047).

More importantly, however, there was also a significant interaction effect between *scenario* and *level of harshness*, $F(2,558) = 10.62$, $p<.001$. As shown in Figure 3.2, participants exposed to the safe conditions experienced minimal change in food desirability across all three scenarios (social -.042, economic -.068, physical safety -.030). In contrast, in the harsh conditions, participants

experienced minimal change in the economic scenario (.074), but food desirability scores were significantly reduced in the social (-.288; p<.001) and especially the physical safety (-.443; p<.001) scenarios.

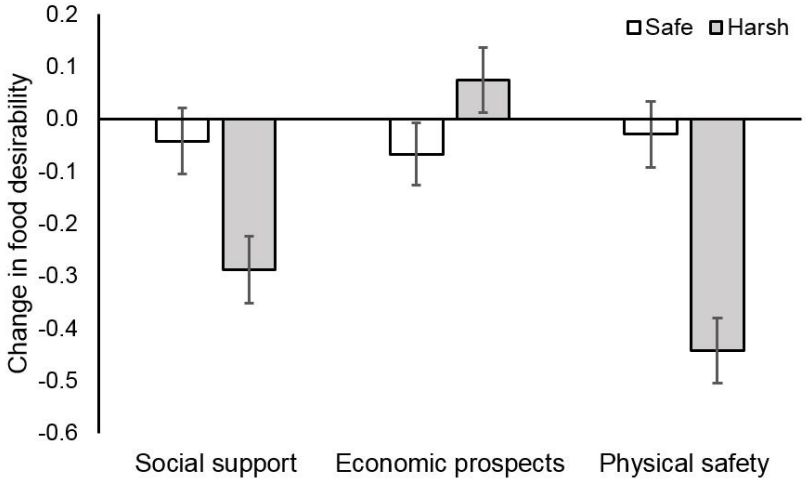

Fig. 3.1 Difference in mean pre-test and mean post-test desirability scores across all food items. Negative scores indicate a decrease in food desirability scores whereas a positive number refers to an increase in food desirability, following the scenario manipulation.

3.4.2 Effects of calorific value

Next, I examined whether the effect of environmental condition (safe, harsh) in each scenario (social, economic, physical) affected changes in food desirability differently depending on food energy density level (low and high calorific value). I therefore conducted a repeated-measures ANOVA with *energy level* as the within-subject factor and *harshness* as between-group factor, for each scenario separately. In this analysis, an *energy level* x *harshness* interaction effect would indicate that changes in food desirability scores following exposure to the scenario would be influenced by calorific value. This analysis (see Figure 3.2) revealed that, while the interaction effects were not significant in either the social (F(1,179) = 2.01, p= .158) or economic (F(1,195) = .33, p= .564) scenarios, the *energy level* x *harshness* interaction

was significant in the physical scenario (F(1, 184) = 6.69, p= .010). Here, the overall decrease in desirability was less marked in the high energy foods (mean change = -.398) than the low energy foods (-.488), compared to the equivalent changes in the safe condition (high energy: -.077; low energy: .018). It is perhaps also interesting to note that the main effect of *energy level* was only significant in the social scenario (F(1,179)=25.927, p<.001) where, after reading the social environment scenarios, participants experienced a greater decrease in desire for low energy (mean change = -.28) than high energy foods (-.051).

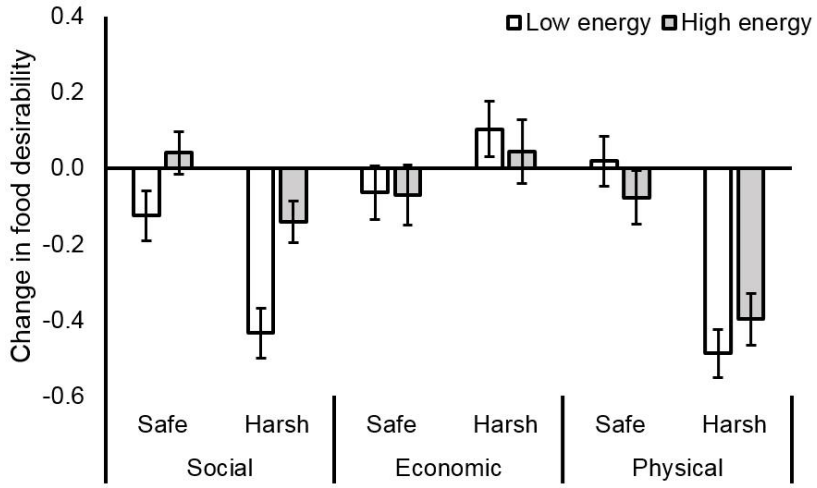

Fig. 3.2 Difference in mean pre-test and mean post-test food desirability scores by energy density level (open bars, low calorific value; shaded bars, high calorific value). Negative scores indicate a decrease in food desirability scores after reading a scenario, whereas a positive number indicates an increase in food desirability. There was a significant energy density level x harshness interaction only in the physical safety scenario (p=.010).

3.4.3 Changes in desirability for main food categories

Finally, I investigated effects of environmental harshness on changes in desirability for foods in the major food categories (vegetables, fruits, dairy, grains, sweets and meats). I therefore conducted a further repeated-measures ANOVA with *food category* as the within-subject factor and *harshness* as the

between-group factor. This analysis (Figure 3.3) revealed no significant *food category* x *harshness* interaction effects in either the social ($F(5,895)= 1.36$, $p=.251$) or economic ($F(5,975)= 1.59$, $p=.188$) scenarios. However there was a significant interaction effect in the physical scenario ($F(5,920)= 2.67$, $p=.030$), such that the generally large decrease in desirability scores in the harsh condition was much less marked for the category “sweets”. Indeed, post-hoc analyses showed that while there was no significant difference between food categories in the safe scenario, in the harsh physical scenario the desire for sweets decreased significantly less (mean change = -.291) than the remaining food categories: vegetables (-.482; $p=.028$), fruits (-.518; $p=.004$), dairy (-.440; $p=.051$), grains (-.465; $p=.022$), meats (-.463; $p=.018$).

In this analysis, I also found a significant main effect of *food category* for the social scenarios ($F(5,895) = 18.90$, $p < .001$) but not for either the economic ($F(5,975) = .60$, $p = .669$) or physical safety ($F(5,920) = .90$, $p = .419$) scenarios. Figure 3.3 suggests this is again largely driven by the positive response to sweets, while desirability of all other food categories decreased following the manipulation. Indeed post-hoc analysis showed that the desirability for sweets across the social scenario was significantly higher than for vegetables (.438), fruits (.486), dairy (.291), grains (.435) and meats (.313; all $p < .001$).

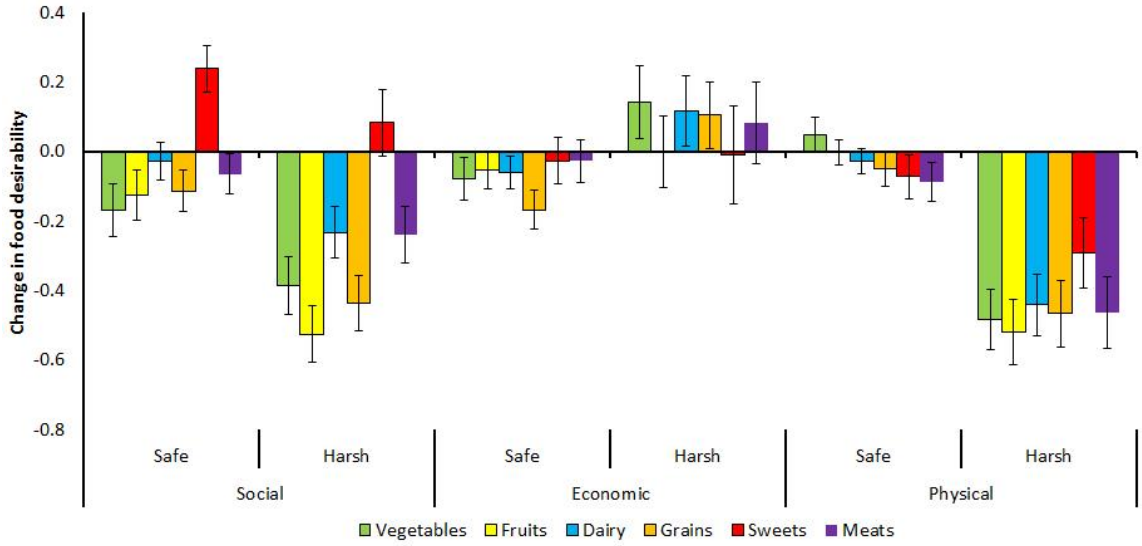

Fig. 3.3 Difference in mean pre-test and mean post-test food desirability scores by food category. Negative scores mean there was a decrease in food desirability scores whereas a positive number refers to an increase in food desirability. The only significant food category x harshness interaction effect across all food groups was in the physical safety scenario (p = .030); a main effect of food category was significant only in the social support scenario (p < .001).

3.5 Discussion

Previous research has demonstrated that the desire for food can be influenced by manipulating perceptions of environmental harshness (e.g. Laran & Salerno, 2013). Swaffield & Roberts (2015) also showed that reading a simple text scenario that included dimensions of harsh social, economic and physical safety conditions could also increase the desire for high energy dense foods. In light of this, the current study aimed to isolate and compare the effects of these three environmental dimensions on desirability of different kinds of food. Specifically, in the first analysis a between-subjects comparison was performed. This analysis showed there was a small increase in appetite for all foods when exposed to the harsh economic scenario. Second, when an

analysis was performed based on energy density, it was found that there was a significant difference in desire for low and high energy dense foods in the harsh social scenario. The significant finding was that when exposed to the harsh social scenario the desire for low energy dense foods decreased significantly more than high energy dense foods. Lastly, when individual food categories were analysed, there was a consistent decrease in desire for all foods in the harsh physical scenario.

At first sight, the overall pattern of these results may appear to be at odds with the previous findings in Chapter 2 which showed the desire for high energy dense foods increased in response to perceived levels of environmental harshness. Whereas in the current study, there was more often a decrease in food desirability scores for both low and high energy dense foods. The reason for this discrepancy is most likely due to the use of different scenario manipulations. In the previous study, the safe and harsh scenarios were short (about 140 words). These original scenarios blended together the social, economic and physical safety dimensions into each story. In contrast, in this experiment, each harshness dimension was isolated and presented as its own scenario. Each of these scenarios were also approximately three times longer (each about 440 words). It is possible that the longer scenario length and the adapted content may have been perceived to be harsher thus generated a higher level of stress. If the scenarios were perceived to be more stressful, this would likely have contributed to the general effect of reducing food desire. Apart from this difference, however, the results are not inconsistent with the previous study, as the reduction in desirability in the physical safety condition (the only scenario which generated a significant interaction between perceived

harshness and calorific value) was less pronounced in high energy foods; that is, they were more desirable under these conditions than low-energy foods. The same pattern is evident in the harsh social condition (Figure 3.2), although the interaction was not significant.

Overall, the analyses showed that the three kinds of environmental harshness do have different effects on food desirability. First, perceived social isolation and threat to physical safety each reduced desirability, while economic harshness had little or no effect. Second, when the calorific value of the food items was taken into account, there was a differential effect on desirability only in the physical safety scenarios, such that the reduction in food desirability arising from threats to physical safety were stronger for low energy foods than high energy foods. Third, when foods were split into the six major food categories, the reduction in desirability under threat of physical safety was much less marked for the category ‘sweets’ compared to vegetables, fruits, grains, dairy and meats.

Why do these different forms of perceived environmental harshness affect overall desire for foods, and affect it differently for different kinds of food? One reason may be related to the levels of stress induced by the different scenario manipulations. Prior research has shown that low intensity stressors increase appetite (Born et al., 2009) whereas high intensity stressors decrease it (Sinha & Jastreboff, 2013; Torres & Nowson, 2007). If, as we might suppose, immediate threats to physical safety are more salient and present high levels of stress compared with threat to social connections and economic prospects, this would explain the differences observed in the results. At the same time, even if overall desire for foods is reduced under physical or social harshness, this

appears to be less marked for high energy foods, consistent with expectations about dietary preferences under relatively poor environmental conditions.

Another notable finding from the third analysis is the special case of the food category ‘sweets’. This was the only food category for which desirability increased for participants after reading the social scenarios, and the one that was substantially less affected compared to other food categories in the harsh physical safety scenario (see Figure 3.3). Sweets rank among the foods offering highest calorific returns and are most easily digested (although it should be noted that while sweets usually contain high concentrations of sugar, they frequently contain fat too). These points are relevant for the interpretation of the effect in the physical safety scenario, but there may be a different explanation for the increase following the social scenarios. The safe social scenario was written in a manner that included a gathering of family and friends and was very much a celebration of friendship. These types of social gathering often involve sweets and other high energy dense foods as they increase the hedonic value of the social gathering. In addition, when food is a part of a social gathering, it may contribute to bringing a group together and promote group bonding (Wittig et al., 2014). These associations may be responsible for the increased desire for sweets after reading the social scenarios, and perhaps are especially important under threat of social isolation.

It is important to note that, while this study measured changes in food preference, it did not measure actual food intake. I cannot say with certainty that the scenarios will either increase or decrease the volume of foods consumed, even under experimental settings, and this is an important step for

future research. However, these results do demonstrate that different types of perceived environmental harshness influence appetite in different ways, even when this perception remains simply a perception in an experimental setting, elicited by short and transient mental and emotional manipulations. If these are indicative of how environmental situation influences actual food consumption, then these results have implications for our wider understanding of context-dependent eating behaviour.

3.6 Clarification on a perceived limitation of this study

In the *Safe Social* and *Harsh Social* scenarios there was a brief mention of food or a food concept. One might ask, “Could the mention of food be a confounding variable that could influence the results obtained?” It is logical to assume that these mentions would not bias the results. The following are the reasons why.

First, this is a within subjects design. Just seconds before reading the scenario, the participants had just looked at pictures of 30 food items and, rated their desire for each item. Briefly mentioning a few additional foods in text form (safe scenario, 1 item; harsh scenario, 5 items) would have no material impact.

Second, the objective of each scenario was to generate a mood or feeling. The mood that was to be generated by the harsh social scenario was a feeling of loneliness and despair. In this scenario there was approximately 25 harsh statements that worked together to generate a feeling of social harshness. Five of these statements mentioned food (milk, chicken soup, pizza, rice and beef). The mention of the food item was secondary to the sentence’s

objective which was to generate a feeling of harshness. For example, "*yesterday's can of chicken soup* and the *remains of the beef and rice from the night before*." It is the notion of cold food from the day before that would contribute to feeling of harshness, not the mention of the food itself.

In the safe social scenario there were 26 positive non-food related statements and only 2 mentions of a food or a food concept (cookie and savory spices). Likewise, these two mentions need to be considered in context; that is they are part of a sentence that invokes a feeling of safety and social support.

For these reasons, it is safe to conclude that the mention of these food items in the context presented, are not likely to be a confounding variable.

Chapter 4

Stress and trait appetite mediate the relationship between early childhood socioeconomic status and adult food preference

4.1 Abstract

Prior research has shown that adults who were raised in a low socio-economic status (SES) environment are more likely to desire energy dense foods. Research has also shown a positive correlation between current stress level and the desire for energy dense foods. I hypothesized that stress and trait appetite mediate the relationship between childhood SES and the desire for low and high energy dense foods. In this study, 311 adults participated in an online experiment in which they were shown images of 5 food items from each of the 6 major food categories (vegetables, fruits, grains, dairy, meat/poultry, and sweets) and rated how desirable each food item is. Next, I asked a series of questions that identified the participant's gender, early childhood socio-economic conditions and their current stress level. I used a path analysis to confirm the hypothesis that stress plays a mediating role between SES and food preference, however, the examination of the precise relationship among these variables were exploratory. Thus, this study does not try to explain causal relationships, but rather the aim is to test the hypothesis that these relationships exist and, that there is an orderly relationship between these variables.

The results show the hypothesis was supported; stress does play a mediating role between low childhood SES conditions and adult desire for low and high energy dense foods. In addition, this analysis showed that stress can both increase and decrease the desire for high energy dense foods. The results suggest that desire for low and high energy dense foods is indirectly influenced by one's early childhood environment, and that food desirability is mediated by both stress and trait appetite. These findings also contribute to our understanding of how environmental conditions (slow and fast life history ecologies) affect appetite and the desire for low and high energy dense foods. It also provided a deeper understanding of how these food choices can be adaptive under different ecological conditions.

4.2 Introduction

The World Health Organization reported that, in 2014, more than 1.9 billion adults were overweight and over 600 million were obese. In addition, 41 million children under the age of 5 are either overweight or obese (World Health Organization, 2016). Excessive body weight and obesity is associated with a number of medical conditions such as metabolic disorders, heart disease, diabetes, cancer, stroke, and orthopaedic problems (O'Flanagan, Bowers & Hursting, 2015). In addition, carrying excessive body weight lowers life expectancy (Dhana et al., 2016) and creates an economic burden as it increases the costs of delivering public healthcare services (Grieve, Fenwick, Yang, & Lean, 2013).

The etiology of obesity is complex as it is an outcome of an interaction between multiple genetic and environmental factors (Kaushik & Anderson, 2016; Wells, 2010). To gain a deeper understanding of the obesity epidemic we need to understand not only what environmental factors are correlated with obesity, but also how environmental factors interact with each other and how environmental factors interact with genetic factors. For example, it is well-established that early childhood socioeconomic status (SES) (Tamashiro, 2011; Dietz, 1994), gender (Garawi et al., 2014; Kanter, 2012), and stress (Björntorp, 2001) are strongly correlated with obesity. However, what is less well understood is how these factors interact and lead to specific food preferences and the volume of food desired.

With regards to obesity and psychosocial factors, there is a gap in the extant literature in terms of identifying what variables mediate the relationship between low childhood socio-economic conditions, food preference and the desire to eat. Understanding these interactions may help to develop strategies that promote healthier food consumption behaviour and reduce health problems associated with having excess body weight.

Therefore, in this paper I examine the relationships between childhood and adult socioeconomic status (SES), stress, trait appetite and gender, and how these factors collectively influence food preference.

4.2.1 The effects of socioeconomic status on eating

Research has shown that harsh SES conditions experienced during childhood can adversely affect an individual's physical and psychological development and create patterns of behaviour that are carried into adulthood. More specifically, early childhood SES conditions can influence how an adult responds to stress, their food preferences, the volume of food consumed (Elgar, Xie, Pförtner, White & Pickett, 2016); Nicklaus, Boggio, Chabanet, & Issanchou, 2004); Ventura & Worobey, 2013), the likelihood that one will desire to eat in the absence of an energy deficit (Hill, Griskevicius, Prokosch, & Kramer, 2016), the development of eating disorders (Salafia & Lemer, 2011) and the likelihood that one will suffer from adult obesity (Tamashiro, 2011; Dietz, 1994).

Studies have also shown that stress influences food preference and the volume of food consumed. Stress can both increase and decrease appetite depending on the type and intensity of the stressor (Tamashiro, 2011). Low intensity chronic stress tends to increase appetite whereas acute stress tends to reduce appetite (Sinha & Jastreboff, 2013; Torres & Nowson, 2007). Mild stress tends to increase the desire to consume high energy dense food (Manister & Gigliotti, 2016; Born et al. 2010; Dagher, 2009; Torres & Nowson, 2007) and decrease the desire for low energy dense foods (Swaffield & Roberts, 2015).

These differences also vary between genders. Males and females experience stressful stimuli differently with females reporting higher levels of

stress (Matud, Bethencourt, & Ibanez, 2014); Blodgett Salafia, & Lemer, 2012). One of the reasons why females report higher stress may be explained by differences in how males and females process stress inducing stimuli. Balhara, Verma, & Gupta (2012) report that when stressed, men tend to show more prefrontal cortex brain activity whereas females, show higher activity in the limbic system which is responsible for processing emotions. In addition, in a study by Jääskeläinen et al. (2015) it was found that stress related eating was more common in women than in men.

Socioeconomic status and stress both affect appetite and food choices. Studies that have looked at the association between SES and stress have produced mixed and sometimes contradictory results. For example, Macleod, Smith, Metcalfe, & Hart (2005) concluded there is a robust correlation between income, education, functional health and SES; however, they did not find a relationship between reported stress level and SES. In contrast, research by Matthews, Gallo, & Taylor (2010) and Macleod et al. (2005) have found a strong association between low SES, stress and poor health.

Gallo et al. (2013) explain that a contributing reason for these inconsistent findings may be due to the use of different methods used to measure SES and stress. Both SES and stress can be assessed through subjective and objective measures. Subjective measures of socioeconomic status may include opinion surveys that ask participants to rate how much money they or their family has relative to others, whereas objective measures may include assessing adult or parent education levels, occupation or income.

Some studies focus on specific domains of stress such as financial, physical safety, health or relationship stressors. These dimensions are sometimes measured through subjective measures such as opinion surveys that ask how stressful one's life is, or through objective measures such as assessing biological markers of cortisol through saliva or hair assays (Vliegenthart, 2016).

As previously noted, there are many different sources of stress. Nettle, Andrews, & Bateson (2016) postulate that the primary type of stress that motivates excessive food consumption is insecurity due to competition for scarce resources such as food. This theory claims that SES and food insecurity are associated. What creates high insecurity and stress in low SES environments is not the environmental conditions *per se*, but rather an individual's low relative standing within the SES hierarchy. Thus, the stressors experienced are often due to the competitive presence of others. Individuals who are of higher status receive preferential treatment and greater access to scarce resources that are needed for survival; those lower down the SES hierarchy would have a chronic sense of insecurity about their current and future ability to acquire scarce resources needed for survival and therefore, have higher chronic stress. What is important to note is that it is not the actual amount of resources that are available, but rather the presence of others with higher SES that triggers stress and excessive feeding behaviour.

4.2.2 The current study

Previous studies have shown that gender (Garawi et al., 2014; Kanter, 2012) and childhood SES (Hill et al., 2016) are important factors that influence

the desirability for high and low energy dense food. But, no study has examined what factors mediate the relationship between gender, childhood SES and food desirability. Therefore, in this study, I investigated the role of stress as an important mediator of this relationship. In addition to stress, I also investigated the roles of current adult SES and trait appetite in this relationship. More specifically, I aimed to address whether current adult SES, stress, and trait appetite play a mediating role in the relationship between childhood SES, gender and the desire for high and low energy dense food.

4.3 Methods

4.3.1 Participants

I recruited 311 participants who reside in the United States to participate in this online experiment. Participants were recruited through Qualtrics Panels, an online crowd sourcing service for human intelligence tasks such as online surveys. Each participant was paid a nominal fee (~ $1.00) to participate. Subjects who were younger than 18 years of age, and those who had any form of food allergy, were vegetarian/vegan, or had religious beliefs that influenced their food choices were not permitted to participate in this experiment as these traits would be confounding variables. The participants were 133 men and 178 women, with a mean age of 51.9 years (s.d.=16.03).

4.3.2 Procedure

Having provided informed consent, the participants were provided with a URL to the online experiment. They were then shown images of 30 food items

(Chapter 2, Figure 2.1, page 27), consisting of five items from each of the major food categories (vegetables, fruits, grains, dairy, meat/poultry, and sweets). The images were presented in a different randomized order for each participant. Participants viewed each image and rated it according to the following question which was displayed below the image: “How desirable is this food item to you right now?” Ratings were recorded using a 7-point scale (anchored with the descriptors 1=extremely undesirable and 7=extremely desirable).

The calorific value of each food item was determined based on the dataset of the British Nutrition Foundation (http://www.nutrition.org.uk/healthyliving). The food items were split into two equally sized groups (*Energy Value, 15 “high-energy” foodstuffs, 15“low-energy” foodstuffs)* based on their calorific value. For the individual food item’s calorific content per gram please refer to Table 2.1.

4.3.3 Measurements

4.3.3.1 Trait appetite. Once the participants rated their preference for each food they answered a 15 question General Food Cravings Questionnaire. This questionnaire identified whether the participant had high or low trait appetite. A person with high trait appetite is one who has a strong enduring psychological desire for food in the absence of hunger. (Meule, Hermann, & Kübler, (2014); Cepeda-Benito, Gleaves, Williams & Erath, 2000). Trait appetite was assessed by the Trait General Food Cravings Questionnaire (α =.94) which has been determined to be a reliable and valid measure of general

trait-like food cravings (Nijs, Franken & Muris, 2007). For further details on the construct and discriminant validity for this survey instrument please refer to (Cepedai-Bento et al., 2000).

*4.3.3.2 Past and current socioeconomic status***.** Next, the participants were asked 3 questions that would indicate whether they were from a low childhood socioeconomic environment (SES) or a high SES environment. Past childhood SES and current SES was determined by using an established measure (Griskevicius et al., 2013; Griskevicius, Tybur, Delton & Robertson, 2011). Specifically, past childhood SES was determined by asking the participants to indicate how strongly they agreed with the following three statements (α =.83): "My family usually had enough money for things when I was growing up", "I grew up in a relatively wealthy neighborhood" and, "I felt relatively wealthy compared to the other kids in my school." The scores from the three questions were averaged to identify whether the participant's childhood SES was low, medium or high. Current SES was assessed in a similar manner. The questions asked to determine current SES included (α =.83), "I have enough money to buy things I want," "I don't need to worry too much about paying my bills," and "I don't think I'll have to worry about money too much in the future."

4.3.3.3 Current level of life stress. Finally, to determine how stressful the participant's current life is they were asked, "how stressful is your life?" Ratings were recorded using a 5-point scale (anchored with the descriptors 1= very low stress and 5= very high stress).

4.4 Analysis

In order to examine how stress mediates the relationship between gender, childhood SES and food desirability, I conducted a path analysis, which is the conventional statistical method for testing the mediation in multiple observed variables. All the analyses were conducted using Mplus 7 (Muthén & Muthén, 1998-2015). First, descriptive analyses such as means, variances, and correlations among the variables were examined. Then, a path analysis was conducted to examine the relationship between the variables. The model was estimated using robust maximum likelihood in Mplus 7 to correct for any violations of normality in the data set (Muthén, & Muthén, 1998-2015). In assessing the models' overall fit, I considered the root mean square error of approximation (RMSEA) < .08 (Browne & Cudeck, 1993), standardized root mean square residual (SRMR) < .08, (Hu & Bentler, 1998), comparative fit index (CFI) > .90 (Bentler & Bonett, 1980), and Chi-Square p-value. Bias corrected bootstrap confidence interval (MacKinnon, 2008) was used to evaluate the significance of indirect effect.

4.5 Results

Before I conducted a path analysis, I ran a primary analysis to calculate variable correlations, means and variance. These results are presented in Table 4.1.

Table 4.1 Correlations among model constructs

Variable	1	2	3	4	5	6
1. Stress level	–					
2. Desire for low energy dense food	-0.158**	–				
3. Desire for high energy dense food	-0.046	0.661**	–			
4. Trait appetite	0.238**	0.074	0.311**	–		
5. Past childhood SES	-0.124*	0.170**	0.157**	0.086	–	
6. Current adult SES	-0.459**	0.083	0.041	-0.079	0.268**	–
Mean	2.761	4.371	4.841	2.88	3.53	4.003
Variance	1.476	0.98	0.958	1.697	1.945	2.635

* Significant at 0.05, **Significant at 0.01

In order to examine the relationship between the variables of interests, I conducted a path analysis. The conceptual diagram is shown in Figure 4.1. The model fitted the data very well: Chi-squared=12.283, df=9, p=.20; RMSEA=.035; CFI=.989; and SRMR=.045. In Figure 4.1, all the coefficients are statistically significant with exception of the link from trait appetite to desire for low energy dense food. This non-significant path is included in Figure 4.1 because it is related to the hypothesis which predicted that trait appetite would mediate the relationship between childhood SES and the desire for low and high energy dense foods. There are several pathways in the model, and I will discuss each of the statistical significant pathways in the following sections.

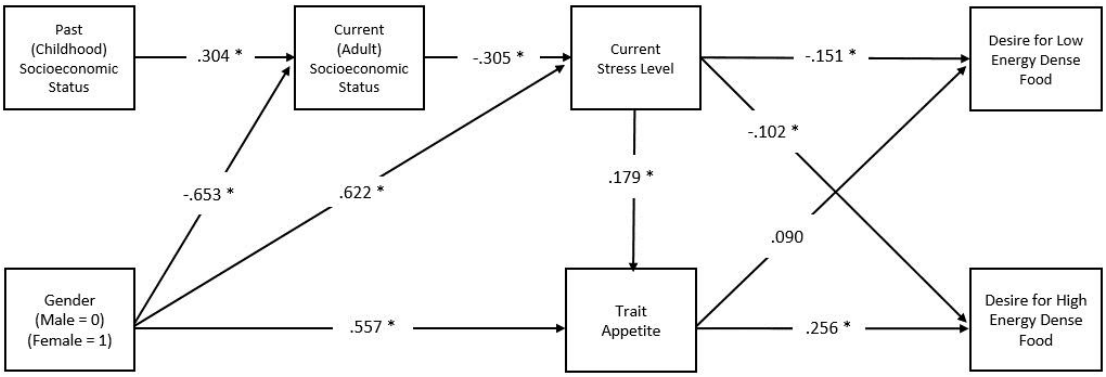

Figure 4.1. Path analysis for low and high energy dense food preferences. *Denotes path is significant.

Footnote: Path Coefficients" are partial regression coefficients. Partial regression coefficients remove the effects of correlated influences (or the effect of two independent variables on a dependent variables). For example, stress (IV), gender (IV), low SES (IV) are all correlated with obesity (DV). Each of the IV's are called 'partial' coefficients because they remove the effect of the additional IV variables.

Table 4.2 Significant path summaries.

	Paths found to be significant in this model										Bootstrap CI
1a.	Past SES	→	Current SES	→	Stress		→		Desire for LEDF		.004, .030
2a.	Past SES	→	Current SES	→	Stress		→		Desire for HEDF		.002, .022
2b.	Past SES	→	Current SES	→	Stress	→	Trait Appetite	→	Desire for HEDF		-.010, -001
3a.	Gender	→	Current SES	→	Stress		→		Desire for LEDF		-.067, -.010
3b.	Gender		→		Stress		→		Desire for LEDF		-.184, -.033
4a.	Gender	→	Current SES	→	Stress		→		Desire for HEDF		-.053, -.004
4b.	Gender	→	Current SES	→	Stress	→	Trait Appetite	→	Desire for HEDF		.003, .021
4c.	Gender		→		Stress		→		Desire for HEDF		-.141, -.010
4d.	Gender		→		Stress	→	Trait Appetite	→	Desire for HEDF		.007-.062
4e.	Gender			→			Trait Appetite	→	Desire for HEDF		.066, .255

LEDF = Low energy dense foods, HEDF = High energy dense foods.

4.5.1 The relationship between past childhood SES and the desire for low energy dense foods

The first pathway (1a, table 4.2) examined the indirect effect of past (childhood) SES on low energy dense food desirability mediated by current adult SES and current stress level. First, past (childhood) SES positively and significantly predicted current (adult) SES (.304). Current adult SES then negatively and significantly predicted current stress level (-.305), which negatively and significantly predicted preference for low energy dense food (-.151). Thus, there was an overall positive indirect effect from past SES to preference for low energy dense food. The indirect effect was tested using bias corrected bootstrap confidence interval, and the result was significant (95% CI = .004, .030). In other words, if a participant had high childhood SES, adult participants were more likely to have high desire for low energy dense food whereas those who were from a low childhood SES environment were less likely to desire low energy dense food. This pathway is shown in Table 4.2 -1a.

4.5.2 The relationship between past childhood SES and the desire for high energy dense foods

The second analysis examined the indirect effect of past (childhood) SES on the desire for high energy dense food. This analysis shows there are two paths. In the first path (i.e., path 2a in Table 4.2), past childhood SES positively and significantly predicted the desire for high energy dense food whereas the second path (2b), shows an opposite effect whereby past (childhood) SES had a significant negative effect on the desire for high energy dense food.

In path 2a, past (childhood) SES positively and significantly predicted current (adult) SES (.304). Current adult SES then negatively and significantly predicted current stress level (-.305), which negatively and significantly predicted the desire for high energy dense food (-.102). Thus, there was an overall positive indirect effect from past SES to preference for high energy dense food. The indirect effect was tested using bias corrected bootstrap confidence interval, and the result was significant (95% CI = .002, .022). In other words, if a participant had high childhood SES, adult participants were more likely to have high preference for high energy dense food.

The next pathway (2b) contained the same variables as pathway 2a except it included trait appetite as a mediating variable. The overall indirect effect of past (childhood) SES on the desire for high energy dense food, when mediated by adult SES, stress level and trait appetite was negative. The indirect effect was tested using bias corrected bootstrap confidence interval, and the result was significant (95% CI = -.010, -001). Simply stated, if a participant had high childhood SES, they were more likely to have low trait appetite and low desire for high energy dense food. Whereas, if participant had low childhood SES they were more likely to have high trait appetite and high desire for high energy dense foods.

4.5.3 The relationship between gender and the desire for low energy dense foods

The third analysis examined the indirect effect of gender on the desire for low energy dense food mediated by current (adult) SES (path 3a) and stress

(path 3a and 3b). In both paths gender negatively and significantly predicted a decrease in desire for low energy dense food. In path 3a, gender negatively and significantly predicted adult SES (-.653) and current adult SES negatively and significant predicted current stress level (-.305). Next, current stress level negatively and significantly predicted the desire for low energy dense food (-.151). In other words, adult females were more likely than males to have low SES (mean difference = -.653 after controlling for past SES) and as a result, females were also more likely to report higher levels of stress (mean difference =.557 after controlling the effect of stress). As stress levels increased, the desire for low energy dense food decreased. The overall negative indirect effect was significant (-.067, -.010).

In path 3b, current stress level was the only mediating variable between gender and the desire for low energy dense food. In this path, female gender positively and significantly predicted current stress level (.622) and current stress level significantly and negatively predicted desire for low energy dense food. Thus, as in path 3a, females were more likely to have higher stress levels which decreased the desire for low energy dense food. Overall, there was a significant negative indirect effect (bias corrected bootstrap confidence interval = -.184, -.033) of gender on the desire for low energy dense food.

4.5.4 The relationship between gender and the desire for high energy dense foods

The fourth set of analyses involved examining the indirect effect of gender on the desire for high energy dense foods. Before I describe each path in detail, I will point out the two paths (4a and 4c) show a negative indirect effect of gender on the desire for high energy dense foods and three paths (4b, 4d, 4e), show gender has a positive indirect effect on the desire for high energy dense foods. A common mediating variable in all of the three positive paths is the variable of trait appetite. In all paths discussed the path coefficients are significant.

Starting with the two paths that show gender can have a negative indirect effect, in path 4a, gender negatively and significantly predicted current adult SES (-.653). Current SES then negatively and significantly predicted current stress level (-.305) which in turn negatively and significantly predicted the desire for high energy dense food (-.102). In path 4c, there was only one mediating variable; current stress level. In path 4c gender positively and significantly predicted current stress level (.622). Current stress level then negatively and significantly predicted the desire for high energy dense food. In other words, when I look at both path 4a and 4c together, adult females are more likely to live in a lower SES environment and have higher stress levels. These higher stress levels then predict a decrease in desire for high energy dense foods.

The next three paths (4b, 4d, 4e), show when a person has high trait appetite there is a positive indirect effect of gender on the desire for high energy dense foods. Beginning with path 4b, gender positively predicted current adult SES (-.653) and current adult SES negatively predicted current stress level (-.305). Next, current stress level positively predicted trait appetite (.179) which in turn positively predicted the desire for high energy dense foods (.256).

Path 4d shows that gender has a positive indirect effect on the desirability even when current SES is removed as a mediating variable. In this path, gender positively predicted current stress level (.622). As previously noted, stress level predicts trait appetite (.179) and trait appetite predicts the desire for high energy dense food (.256). In other words, females are more likely to have higher stress levels which leads to high desire for high energy dense foods.

The final analysis (path 4e) shows a positive indirect effect on the desire for high energy dense foods when mediated by trait appetite. In this path gender positively predicted trait appetite (.557) and trait appetite positively predicted the desire for high energy dense foods (.256). In other words, females were more likely than males to have high trait appetite. This overall indirect effect was tested using bias corrected bootstrap confidence interval, and the result was significant (95% CI = .066, .255). The path model presented in Figure 2 explained 27.2% variance of stress, 3.8% variance of preference of low energy dense food, 11.2% variance of preference for high energy dense food, 9.6% variance of trait appetite, and 11.1% of current SES. The results

showed that the path model is more efficient at predicting participants' preferences for high energy dense food than participants' preferences for low energy dense food.

4.6 Discussion

This study was designed to explore whether stress and trait appetite mediate the relationship between childhood SES and the desire for low and high energy dense foods. Through a path analysis, it was discovered that both stress and trait appetite are indeed mediators. Furthermore, I found that trait appetite also mediates the relationship between stress and the desire for high energy dense foods. Specifically, elevated stress only increases the desire for high energy dense foods through trait appetite; whereas, if trait appetite is held constant, stress has a negative impact on desire for high energy dense food. I also confirmed that stress and trait appetite mediate the relationship between gender and the desire to eat high energy dense foods.

There are two dominant theories as to why stress triggers the desire to eat. The first theory is the insurance hypothesis. The insurance hypothesis postulates that humans have an instinctive drive to overconsume food to put on excess fat stores to buffer the impact of a future famine. It is believed that as environmental conditions become harsh, a sense of resource scarcity is felt which creates a sense of stress. To reduce stress, humans are driven to acquire and consume excess food (Nettle et al., 2016).

A second reason stress can increase the desire for high energy dense foods is because stress signals to the body that it needs to prepare for a fight or flight response. As Sapolsky (2004) states, stress is an outcome of the body being knocked out of a state of homeostasis. When this happens, stress triggers a number of physiological responses that produce a drive to restore the body to a homeostatic state. At the most fundamental level, the purpose of the stress response is to prepare our bodies for a fight or flight response. To fuel this response the muscles need to mobilize stored glucose and fats as quickly as possible (Sapolsky, 2004).

While both theories have merit they do not fully explain why under stress, some people experience an increase in appetite whereas others experience a decrease. One possible reason is that different types of environmental stressors have a different effect on appetite.

A second reason stress may increase or decrease the desire for high energy dense foods may be due to some environments having different stressor intensities. As previously mentioned, low level chronic stress tends to increase appetite (Sinha & Jastreboff, 2013; Torres & Nowson, 2007), whereas acute high intensity stress tends to decrease appetite (Manister & Gigliotti, 2016; Born et al. 2010; Dagher, 2010; Torres & Nowson, 2007).

Two limitations of this study should be noted. As discussed earlier, there are both subjective and objective measures of past SES, current SES and level of stress. The study design assessed general stress levels as stated by the

participants, rather than specific types of stressors. The findings also imply that women report higher levels of stress than men. An analysis that examines different types of stressors may provide a deeper understanding of the relationships between gender, stress and food preference. It would also be beneficial to control for the intensity of the stressors so that it can be determined whether the stressor is perceived to be chronic (low intensity) or acute (high intensity).

While it is recognized that there are different types of environmental stressors affect appetite and food choice, little is known about how appetite and food choice vary based on age, gender and personality. Also, high trait appetite seems to be associated more with participants who were raised in lower childhood SES environments. It would be valuable to gain a deeper understanding why lower childhood SES environments lead to the development of high trait appetite.

4.7 Conclusion

In conclusion, this study shows the complexity of the relationship between psychosocial variables and eating behaviour. It also shows that by themselves SES level and stress are insufficient in explaining food consumption patterns. Being stressed is both a psychological and physiological state that can be triggered by different environmental conditions. Furthermore, how an adult responds to environmental stressors is influenced by the socioeconomic conditions that were experienced during childhood.

Chapter 5

Environmental harshness influences the desire for signalling products used during sexual competition

5.1 Abstract

Prior research has shown that as environmental harshness increases, consumers invest greater effort and financial resources into mate acquisition initiatives. These initiatives include the purchase and conspicuous display of products that either intimidate same-sex rivals or attract members of the opposite sex. In this study, we examined how the desire for signalling products change depending on the type of environmental harshness; that is, when exposed to either safe or harsh social, economic or physical safety conditions. The results showed that under harsh economic conditions, product desire generally decreased. However, there was significant differences in the amount of decrease between product categories in different environmental conditions. Under harsh economic conditions, women tended to express a greater decrease in desire for financial signalling products than beautifying products. In contrast, in harsh economic conditions men tended to prefer physical power products more than financial power products. In addition, in harsh physical safety conditions, women did not express a significant preference between beautifying and financial power products, whereas men demonstrated an increase in desire for products that signalled physical power but not financial power. It is also found that when exposed to harsh social conditions there was no change in product desire. Our findings are important in helping understand

how environmental conditions unconsciously influence the conspicuous display of products for the purposes of intimidating same sex rivals and mate attraction.

Key words: Conspicuous consumption, life history theory, sexual competition, product signalling, environmental harshness.

5.2 Introduction

It has been said that people buy products they don't really need, with money they don't really have, to impress people they don't really like (Ramsey, 2013). Consumers often purchase products for their symbolic value and, as a means to signal or communicate a message to others (Trigg, 2001; Kassim, Bogari, Salamah, & Zain, 2016; Arbore, Soscia, & Bagozzi, 2014; Berger & Ward, 2010). On the surface, it may appear that buying products for signalling purposes may be wasteful, but when these purchases are examined from an evolutionary perspective these consumer behaviours may be seen as adaptive as they can play a communicative function during sexual competitions (Sundie et al., 2011; Saad 2007; Miller, 2000).

5.2.1 Sexual Competition and Product Signalling

The conspicuous display of products can be used to signal social class (Berger & Heath, 2007; Kempen, 2003) and which social groups one wants to be known to affiliate with (White, Argo, & Sengupta, 2012; Han, Nunes, & Drèze, 2010; Kempen, 2003). Products can also communicate a desired social identity such as, that one is brave, sexually attractive or possesses physical or

financial power (Saad, 2007). These messages can play an important role in both intra- and intersexual competition.

Intrasexual competition refers to any direct or indirect form of competition between members of the same sex. Intrasexual competition establishes a dominance hierarchy among rivals, which provides higher ranking individuals the first opportunity to approach the opposite sex and express their mating interests. Wang and Griskevicius (2014) state that products used for self-promotion communicate something about the owner with the intent to intimidate same-sex rivals. To be effective as a means of intimidation, these products must be displayed conspicuously to potential rivals (Miller, 2009).

While both women and men use products to intimidate same-sex rivals, the message objective may be different. Women who have a partner may display luxury products to communicate their mate is devoted to them and therefore, rival women need not waste their time attempting to poach their mate (Hudders, Backer, Fisher & Vyncke, 2014). Women may also compete with same-sex rivals by using products such as lipstick and other cosmetics to enhance their physical appearance (Hill, Rodeheffer, Griskevicius, Durante, & White, 2012). If a woman feels relatively less attractive she may back-down, thus giving her competitor first opportunity to approach potential mates. In contrast, men more often use products to intimidate rivals by signalling they are brave and possess strength and physical power. In so doing, they provide cues of their likelihood of winning a physical altercation if their status is challenged. Miller (2000) states that men may also signal they have power by displaying

positional goods. Positional goods are expensive luxury products that are used to signal that a man has wealth and financial power. Men who have fewer financial resources may feel intimidated and therefore choose to withdraw.

Products are used to signal during intersexual competition. The goal of an intersexual competition is to attract a mate. Hudders et al. (2014) state that men frequently spend large amounts of money on luxury goods to signal their mate-value to women. The message implied is that the products the man possesses will be shared with the woman if she chooses him as her mate. Women however, are less likely to use financial power products to attract a mate compared to men. Women are more likely to use products such as lipstick, hair dye, teeth whitening, and skin creams to augment their physical attractiveness by appearing healthy and youthful (Hudders et al. 2014; Wang & Griskevicius, 2014; Hill et al. 2012). Women may also buy fashion products such as high-heels and revealing clothing to accentuate physical features and communicate sexual attractiveness (Morris, White, Morrison, & Fisher, 2013; Smith, 1999).

Consistent with this line of reasoning, the products that men use to attract a mate are based on augmenting their perceived mate value in line with what women value (Buss, 2003). Prior research has shown that women value dominant men who have power, high status and wealth (Buss, 2008). The opposite is also true: the traits that men value in partners are frequently associated with physical features that are associated with high fertility; this includes feminine facial features, healthy skin, an optimal body weight and hip-

to-waist ratio (Saad, 2007; Singh, 1993). Accordingly, the products that women often purchase augment these traits.

5.2.2 Life history theory, sexual competition and product signalling

Prior research has also shown that adult consumer behaviour varies depending on an individual's socio-economic status (SES) (Solomon, 2015; Schiffman, Lazar, Kanuk & Das, 2006). The concept of SES include the dimensions of income, and non-financial assets such as social and cultural capital. *Social capital* refers to a person's acquaintances and the social networks one belongs to, whereas *cultural capital* refers to assets such as cultural knowledge and one's level of education (Jones, 2016). Understanding these concepts is important to interpreting how SES affects the physical environment one lives in, consumer needs, and the product choices one selects to signal to potential rivals and mates.

The existing literature on the relationship between SES and consumer behaviour is largely descriptive. That is, it describes what low and high SES consumers buy. What the current literature does not do is explain why low and high SES consumers prefer the products they do. We propose that by analyzing consumer behaviour from a life history perspective we can develop a deeper understanding of a subset of consumer behaviour, namely the purchases made to signal in intra- and intersexual competition.

Life history theory provides a framework for understanding how organisms, including humans, allocate scarce resources between somatic

growth and reproduction. Somatic growth involves investing personal energy and financial resources into growth and maintenance of one's body and mind, whereas reproduction effort refers to investing personal energy and financial resources into initiatives which increase the probability of mate acquisition and reproductive success. Reproduction efforts include activities associated with intra- and intersexual competition (Mittal & Griskevicius, 2014).

Life history theory posits that the decision to invest effort and financial resources into somatic growth or reproduction is driven by environmental conditions. Environmental conditions can be viewed as being on a continuum anchored with *safe* on one end and *harsh* on the opposite. Individuals raised in a safe environment tend to adopt a slow life history strategy. Characteristics of a slow life history strategy include a focus on somatic development, stable and predictable home conditions, a longer than average lifespan, and greater parental investment in offspring. In contrast, harsh environments are associated with a fast life history strategy. Characteristics of a fast life history strategy include a focus on mate acquisition and reproduction, unstable and unpredictable home conditions, a shorter than average life span and, lower parental investment in offspring (Kruger & Kruger, 2016; Mittal & Griskevicius, 2014).

If fast life history environments are mate acquisition and reproduction focused it would be logical to assume that under harsh conditions, there should be increased levels of intrasexual and intersexual competition and an increase in desire for products used to signal status.

However, to date this assumption remains neither confirmed nor disconfirmed. Nor, has there been any research on the influence of social harshness, economic harshness and concerns for physical safety harshness on consumer behaviour.

Therefore, we conducted an experiment to examine the effects of different types of environmental harshness (i.e., social, economic, and physical) on female and male preference for status-linked products that might be used in intra- and intersexual competition. More specifically, we make the following two hypotheses. First, when exposed to primes of environmental harshness, women will demonstrate an increase in desire for beautifying and financial status signalling products. Second, when exposed to primes of environmental harshness, men will demonstrate an increase in desire for products that signal they possess physical and financial power.

5.3 Methods

5.3.1 Summary of materials used

5.3.1.1 Desktop or laptop computer. In this study, the participants used a personal desktop or laptop computer.

5.3.1.2 Internet connection. As the study was hosted on the Qualtrics server an internet connection was required.

5.3.1.3 Isolated product images. Individual product items were placed on a white background with no other images or patterns on the slide as the product item was being viewed.

5.3.1.4 Sex and age information was collected through drop-down question boxes at the end of the survey.

5.3.1.5 Participant Consent. Once the participants had accessed the Qualtrics site they were presented with background information on who is conducting the experiment, what is being investigated, who can participate, and a description of what participation involves. The participants were also provided an opportunity to consent to participate in the study. The participant consent section of the study was the same process as identified in on page 28, section *2.3.3 Summary of Materials Used* in this thesis.

5.3.1.6 Environmental scenario stories. The scenario stories used in this experiment were the same stories that were used in Chapter 3, study 2. A rationale for the development and use of these particular scenarios is provided on page 28, *3.3.2.1 Summary of Materials Used.*

5.3.2 Participants

This study includes two separate experiments involving product preferences, the concept of sexual competition and slow and fast life history ecologies. The first study investigated female product preference and the second examined male product preference. As women and men use different intra- and intersexual strategies, a between-subjects comparison is unwarranted and therefore each study should be considered independent of the other.

Collectively, 629 participants (315 women, 314 men) were recruited from across Canada through the Qualtrics online survey service (Table 1). Each participant was paid a nominal fee (~$1.25) to participate. As alcohol and leather products were options in this experiment, individuals who were opposed to buying these products were excluded from this study.

Table 5.1 Mean age and sex of participants in each scenario.

		Male		Female	
		Count	Mean Age and s.d.	Count	Mean Age and s.d.
Scenario	Safe Social	51	39 (6)	51	39 (6)
	Harsh Social	52	38 (6)	53	37 (6)
	Safe Economic	53	39 (6)	53	38 (6)
	Harsh Economic	53	39 (6)	53	39 (6)
	Safe Physical	52	39 (6)	52	38 (6)
	Harsh Physical	53	40 (6)	53	39 (6)

5.3.3 Procedure for experiment 1: female product desire

Having provided informed consent, participants were provided with a URL to the online experiment. The women in this study were shown 10 product images; 5 images of products that signalled financial power and 5 images of beautifying products (Fig. 5.1). The non-brand specific images were purchased from stock photography sites and the images with brand name products were taken from the manufacturer's catalogue. Original images are available from the authors on request. The images were presented in a different randomized order for each participant. Participants viewed each image and rated it

according to the following question which was displayed below the image: “How much would you like to buy this product right now?” Ratings were recorded using a 7-point Likert-type scale (anchored with the descriptors 1= extremely undesirable and 7= extremely desirable).

The participants were then randomly assigned to one of six conditions; safe/harsh social support, safe/harsh economic prospects, or safe/harsh physical safety. Next, they were asked to read an accompanying scenario text (see Appendix 2). Each scenario text depicted environmental conditions associated with the condition group to which they were assigned. The scenario text concluded with the sentence, “Pause for a moment and think about the story you just read. How would you feel if this really was your situation?” Once the scenario had been read, the participants were asked to rate the same products for a second time. The product images were presented in a new and fully randomized order. Finally, participants completed a background questionnaire to obtain demographic details.

Figure 5.1. Female product images used in experiment. Images were shown individually and in randomized order. Top row (left to right): Beautifying products - *Crest White Strips (teeth whitener), red nail polish, red nylons, high-heel shoes, *inexpensive necklace. Bottom row: Financial power products – Pandora™ bracelet, leather jacket, Gucci™ shoes, Prada™ sunglasses, Coach™ hand bag.

*= products that did not cluster with either beautifying or financial signalling products and were removed from the final analysis.

5.3.3.1 Analysis for experiment 1

In order to determine whether the products indeed fall into two categories (i.e., beautifying products vs. financial power products), we conducted Exploratory Factor Analyses (EFA). The dependent variables were the participants' ratings for each product. Separate EFAs were conducted for both pre and post treatment product rating. We conducted the EFA using Principal Axis Factoring with direct oblimin as the rotation method, using SPSS 21. The number of factors was determined based on eigenvalues and the scree plots. Products were divided into two categories based on the EFA results. Beautifying products included items that are known to accentuate or draw attention to physical features. For example, red nylons can draw an observers eyes towards ones legs and high-heel shoes can make ones legs look firmer and more attractive. The final items included in the beautifying product set included, nail polish, non-brand name (inexpensive) high-heel shoes, and red nylons.

The second set of female products that signalled financial power included a Coach™ handbag, leather jacket, Gucci™ shoes, Prada™ sunglasses, and a Pandora™ bracelet. While these products may make a female more appealing, they are less likely to make her sexually attractive. Nor, are financial power products likely to be used to accentuate physical features that are desired by men. We can infer that this assumption is correct as the EFA did not include any of the financial power products in the beautifying

products cluster. Next, we performed repeated ANOVAs to test the effects of environmental harshness and product category on participants' preference rating for each scenario separately (i.e., social, economic and physical safety).

5.3.4 Procedure for experiment 2: male product desire

A second factor analysis was conducted on the products purchased by men. The products shown on Fig. 2 were speculated to fit each respective category. However, the biker sunglasses, weights, ring, and Cognac alcohol did not cluster with a single group and therefore were removed from the subsequent analysis. The first distinct cluster included products that are associated with signalling physical power, toughness and bravery. This cluster included mountain climbing equipment, an arm tattoo, and a motorcycle. The second product cluster included expensive products that signal financial power. This cluster included a watch, expensive suit, and a leather jacket (Fig. 2).

Figure 5.2. Male product images used in experiment. Images were shown individually and in randomized order. Top row (left to right): Physical power (toughness and bravery) products – mountain climbing equipment, *biker sunglasses, arm tattoo, *weights, and motorcycle. Bottom row: Financial power products - *ring, brown leather jacket, suit jacket, *Cognac alcohol, expensive watch.

*= products that did not cluster with either physical power or financial

power products and were removed from the final analysis.

5.3.4.1 Analysis for experiment 2

Similar to the female product analysis, we conducted EFAs to determine the number of product categories. We identified two distinct product categories: products that signalled physical power, strength and bravery (tattoo, motor cycle, and climbing equipment) and products that signaled financial power (classy watch, suit, and brown leather jacket). While we did not test if our study participants perceived these products to be associated with physical power and financial power, other studies have. Arm tattoos and motorcycles are more common with the lower socioeconomic classes because they symbolize masculinity and power (Heywood, Patrick, Smith, Simpson, Pitts, Richters, & Shelley, 2012; Giebel, Moran, Schawohl, & Weierstall, 2015). Whereas classy clothing tends be associated with higher socioeconomic classes (Schiffman et al. 2006). Therefore, it is logical to assume that the products are appropriately categorized as physical power and financial power products. Also, it is notable that despite the fact that motorcycles are expensive, the EFA did not cluster the motorcycle with the other expensive products, but rather, it was clustered with the physical power products. Therefore, it is logical to conclude that the participants in this study perceived the motorcycle to symbolize physical power rather than financial power. We used repeated ANOVA to test the effects of environmental harshness and product power type (i.e. physical power vs. financial power) on participants' preference rating for each scenario (i.e., social, economic, and physical safety).

5.4 Results

5.4.1 Experiment 1: female product desire – changes in desire for beautifying and financial power signalling products

We examined whether the environmental condition (safe vs. harsh) and product category (beautifying vs. financial power products) affected participants' change in desire in each scenario (social, economic, physical). We conducted a repeated-measures ANOVA with product category as the within-subject factor and environmental harshness as the between-group factor. This analysis (Fig. 5.3) showed no significant product category x environmental harshness interaction effect in either the social (F(1, 102)=1.070, p=.303) or physical scenarios (F(1, 103)=.013, p=.908), but there was a significant interaction effect in the economic scenario (F(1, 104)=5.505, p=.021). Specifically, in the safe economic scenario, there was no significant difference between the change in desire for beautifying and financial power products (mean difference between financial power and beautifying products = -.053, p=.699). However, in the harsh economic scenario, participants' desire for financial power products decreased significantly more than beautifying products (mean difference between financial power and beautifying products = -.400, p=.004). It is also important to note that in the economic and physical safety scenarios, there were significant main effects of environmental harshness (F(1, 104)=42.728, p<.001 and F(1, 103)=8.891, p=.004 respectively). Participants' desire for both beautifying and financial power products decreased significantly more in the harsh conditions than the safe conditions. In the social scenarios, the main effect of environmental harshness was not significant (F(1,102)=.029, p=.866).

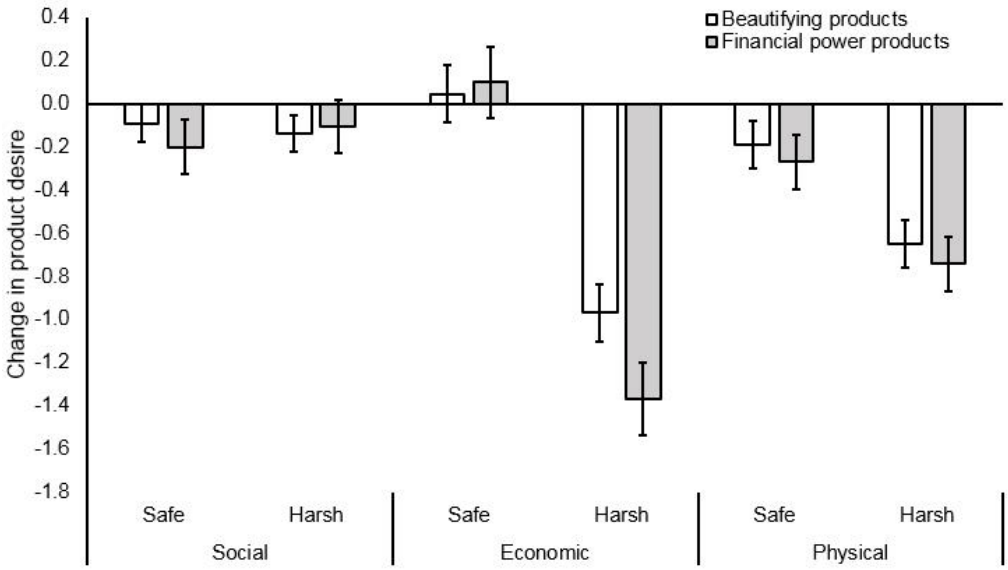

Figure 5.3. Female products: change in mean pre-and post-test product category desirability scores relative to safe and harsh scenarios. Negative numbers indicate a decrease in product category desirability scores whereas a positive score refers to an increase in product category desirability following the scenario manipulation.

5.4.2 Experiment 2: male product desire - changes in desire for physical power and financial power signalling products.

Similar to the female analysis, we used a repeated measure ANOVA to examine the effects of environmental harshness and product category (physical power vs. financial power products) on participants' change in product desire in each scenario. In the social scenarios, no significant effect was found (product category main effect: $F(1,102)=.303$, $p=.583$; harshness main effect: $F(1, 102)=1.492$, $p=.225$; product category harshness interaction: $F(1, 102)=.00$, $p=.992$). In the economic scenarios, there was a significant main effect of environmental harshness ($F(1, 102)=26.913$, $p<.001$). Participants' desire for

both product categories decreased significantly more in the harsh condition than the safe condition. No significant interaction was found between environmental harshness and product category ($F(1, 102)=3.066$, $p=.083$). However, a post hoc analysis showed that participants' desire for physical power products decreased significantly less than their desire for financial power products in the harsh economic scenario (mean difference=.391, $p=.038$). In the physical scenarios, we found a significant interaction between environmental harshness and product category ($F(1, 104)=11.939$, $p=.001$). Specifically, in the safe physical scenario, there was no significant difference in change in product desirability for both product categories (mean difference between financial power products and physical power products = .069, $p=.610$). However, in the harsh physical scenario, participants' desire for physical power products increased, but their desires for financial power products decreased, and this difference was statistically significant (mean difference between financial power product and physical power product = -.591, $p<.001$).

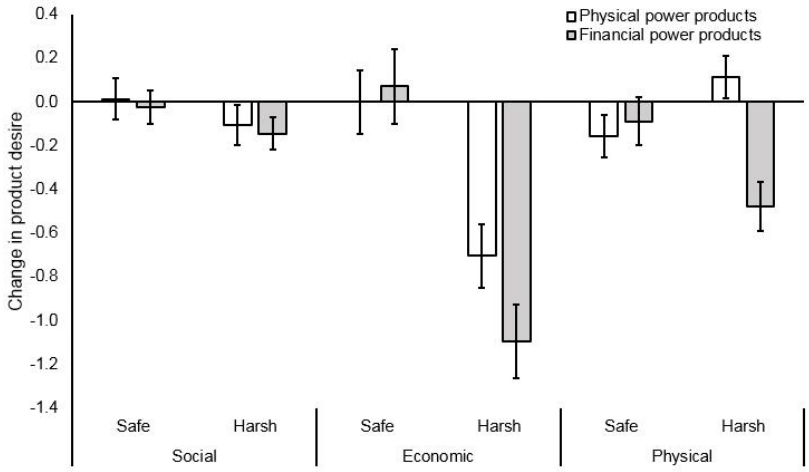

Fig. 5.4 Male products: difference in mean pre-and post-test product category desirability scores relative to safe and harsh scenarios. Negative numbers indicate a decrease in product category desirability scores whereas a positive score refers to an increase in product category desirability, following the scenario manipulation.

5.5 Discussion

The original hypothesis stated that, when exposed to primes of environmental harshness, women will demonstrate an increase in desire for beautifying and financial power signalling products. This hypothesis was indirectly supported by the significant interaction in the economic scenario, which suggests that while participants' desires for products decreased in general due to a lack of economic resources, there was less of a reduction in the desire for beautifying products. As prior research shows that harsh environmental conditions tend to be reproduction focused, it is logical to assume that environmental harshness may stimulate an unconscious drive to find a mate. It is also logical to infer, that the participants felt a higher sense of intersexual competition than intrasexual competition. These relationships are illustrated in Fig.5.5.

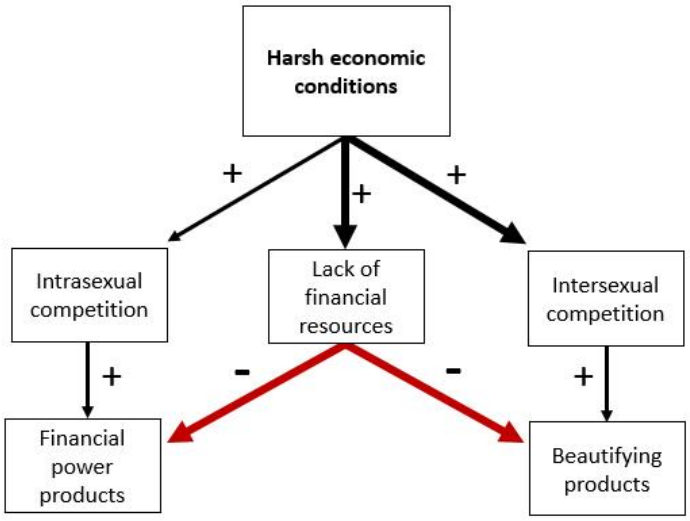

Fig. 5.5. The hypothesized model that explains the difference in desire change between beautifying and financial power products under harsh economic conditions. Thin arrow signifies a weak relationship, thick arrow signifies a strong relationship.

While a lack of financial resources is a component of harsh economic conditions, other psychosocial sub-components likely exist. As shown in Figure 5.3 these subcomponents can both increase and decrease the desire for beautifying and financial power products. While a lack of financial resources is associated with a decrease in one's ability to purchase products, I infer that harsh economic conditions are associated with elevated intra- and especially intersexual competition and the desire for products used to signal in these competitions.

In addition, there are other factors that could have affected the results obtained. Prior research has shown that consumers often respond differently to low and high intensity environmental stressors. For example, low intensity environmental stressors tend to increase appetite (Swaffield & Roberts, 2015) whereas higher intensity stressors decrease appetite (Swaffield & Roberts, 2017). The environmental scenarios used in the current study were the same scenario primes that were used in Swaffield & Roberts (2017) study. In this later study these scenarios were deemed to generate a higher level of stress than in Swaffield & Roberts (2015) study. As a result, a possible explanation for why the data did not support the hypothesis may be due to the scenario primes generating a high level of stress. This reasoning is supported by numerous research studies that have shown that under chronic high stress situations women's sex drive decreases (Hamilton & Meston, 2013; Bodenmann, Atkins, Schär, & Poffet, 2010). Thus, it would be logical to infer that a decrease in sex drive would likely be associated with a decrease in intra- and intersexual competition and subsequently a decrease in desire for beautifying and financial status signalling products.

My theory was that as environmental harshness increases intra- and intersexual competition will also increase. This increase in competition would not be observed directly, but rather it would be evidenced by an associated increase in desire for products that could be used for signalling during sexual competition. Our second hypothesis stated that, when exposed to primes of environmental harshness, men will demonstrate an increase in desire for products that signal they possess physical and financial power. While the results did not directly support the hypothesis, the findings can be interpreted as being consistent with the theory. More specifically, in the harsh economic scenario, participants' desire for physical power products decreased significantly less than their desires for financial power products. In the harsh physical scenario, participants' desire for physical power products increased slightly, while their desires for financial power products decreased. These findings indicated that under harsh economic and physical safely conditions, participants perceived intrasexual competition as more important than intersexual competition.

As mentioned in the previous section, the intensity of the environmental stressor can impact consumer behaviour in different ways. This fact is relevant in the analysis of male product desire too. A second point that is relevant to both the female and male analysis is that signalling one's wealth through products in a harsh environment could increase one's risk of being robbed and physically harmed. Griskevicius, Ackerman & Redden (2012) state humans have a self-protection survival drive. If one does not physically survive, they may not have an opportunity to find a mate and reproduce. Thus, it is logical to assume that in extremely harsh environments the self-protection drive will

supersede the drive to engage in a sexual competition. In addition, under intensely harsh environmental conditions one is likely to avoid displaying financial status products due to the dangers associated with doing so.

The increase in desire for products that signal *physical power* in a physically harsh environment, can be considered adaptive when analyzed from a survival and sexual competition perspectives. First, getting into a physical altercation with another can lead to physical injuries for both parties. Thus, being able to signal one possesses physical power, be it real or a bluff, can serve as a form of protection by intimidating potential aggressors.

From a sexual competition perspective, being perceived to possess physical power can intimidate same sex rivals which leads to the development of a status hierarchy. This in-turn affords higher status men a preferential opportunity to approach potential women. From an intersexual competition perspective, desiring products that signal a man possesses physical power might also be adaptive. Prior research shows that women are attracted to physically dominant men (Giebel, Moran, Schawohl & Weierstall, 2015; Bryan, Webster & Mahaffey, 2011). Buss (2003) states that women have an evolved preference for men who possess physical power. In harsh environments there is often high competition for scarce resources need for survival. A man with physical power is better able to secure resources needed for survival and provide protection for both his female partner and their offspring.

It should be acknowledged that there are four limitations of this study that should be considered when interpreting the study results. First, while it was demonstrated that cues of environmental conditions can influence the desire for

products used in intra- and intersexual competitions, we cannot conclude that the changes in product desire due to harsh environment primes would actually lead to these products being purchased. Second, we do not know if people who are currently in a relationship and those who are single would respond to these environmental scenarios in the same manner. It is possible that intra- and intersexual competition may be more intense among people who are not currently in a relationship. Third, it is possible that the products used to compete in intra- and intersexual competitions may be influenced by the age of the consumer. For example, younger men may choose different products to signal financial and physical power than older men. Lastly, we should be careful to not conclude that the results found in these experiments can be generalizing to both low and high intensity harsh environments.

Therefore, logical next steps for research could include repeating this experiment using milder scenario primes, examining if there are differences between how single people and those who are in a relationship respond, whether there are differences in the products desired for different age groups and, whether these changes in desire translate into actual product purchases.

5.6 Conclusion

In the first part of this paper it was stated, '*people buy products they don't really need, with money they don't really have, to impress people they don't really like*.' By analyzing consumer behaviour from an evolutionary perspective we have provided an explanation for what drives these seemingly irrational consumption behaviours. We have also provided evidence that

supports the perspective that a subset of consumer behaviour is motivated by a sensitivity to perceptions of environmental harshness. In addition, we have shown that conspicuous consumption is not necessarily wasteful, but rather it can be adaptive and can help one survive by deterring potential aggressors and assisting in intra- and intersexual competitions.

Chapter 6

Conclusions and Recommendations for Further Research

Human behaviour is often a product of an interaction between our evolved biology and our environment (Powledge, 2011). This perspective is captured by the adage ‘genes load the gun, the environment pulls the trigger.’ The goal of the research in this thesis has been to develop a deeper understanding of what environmental factors are pulling the trigger that influence appetite and the desire for products used to conspicuously signal messages to others. A second purpose has been to gain a deeper understanding of these behaviours by asking when these behaviours are adaptive and when are they maladaptive?

6.1 Summary of key findings on the effect of environmental harshness on appetite

In the chapters 2, 3 and 4 I examined how environmental harshness affects appetite and why certain foods are selected to satisfy one’s appetite. These studies have advanced the discipline of evolutionary psychology and our understanding of these relationships in the following ways:

1. This research has duplicated other studies that have shown that low intensity stressors tend to increase appetite whereas higher intensity stressors tend to decrease appetite.

2. The included studies have shown environmental stress also affects the desire for low and high energy dense foods differently. Low intensity stress

tends to decrease the desire for low energy dense foods and increase desire for high energy dense foods.

3. Different types of environmental stressors (harsh social, harsh economic and harsh physical safety conditions) impact appetite in different ways. In Chapter 3, *Environmental stress affects appetite: changing desire for high and low energy dense foods depends on the nature of the perceived threat* it was shown that exposure to harsh social and physical safety conditions decrease appetite, whereas economic harshness had no significant effect.

4. Environmental stress affects the desire for the different food categories (vegetables, fruits, dairy, grains, sweets and meats) in different ways. Specifically, the findings in Chapter 3 showed that while the desire for food decreased in the harsh social and physical safety conditions, the desire for sweets showed a mild increase in desire in the harsh social scenario and less of a decrease than other food categories in the harsh physical scenario.

5. I have also shown that there is a strong relationship between childhood and adult socio-economic environments (SES). If one was raised in a low SES environment they are more likely to continue to live in a low SES environment as an adult. They are also more likely to report a higher level of life stress. Although we know that stress is related to appetite it is incorrect to assume that an elevated stress level would directly lead to an increase in desire for high energy dense foods. It was found that stress can both increase and decrease appetite. Elevated stress levels lead to increased appetite only when an individual has high trait appetite.

6.2 Directions for future research on environmental harshness and appetite

While these studies have provided new ways of analyzing the relationship between environmental harshness and appetite a number of experiment modifications could be made that could provide additional insights and deepen our understanding of these relationships. These recommendations are as follows:

6.2.1 Recommendation 1: Create scenario primes (harsh/safe social, harsh/safe economic and harsh/safe physical safety) with three levels of harshness (low, medium and high).

6.2.2 Recommendation 2: Use more than one method to assess stress.

Verbal statements describing ones current stress level may not be sensitive enough to capture lower degrees of stress generated by the scenario stories. Therefore, it may be prudent to measure stress levels generated through biomarkers such saliva cortisol samples. Alternatively rather than using scenario stories to generate a sense of harshness, one could conduct food preference surveys in existing low, medium and high SES environments.

6.2.3 Recommendation 3: Conduct a manipulation check to determine the type of emotion, level and intensity generated by each scenario.

At the time the studies in this thesis were designed, the type of emotion generated by each scenario was not considered. Emotions can be classified as being primary, secondary and tertiary. For example, fear is a primary emotion, nervousness is a secondary sub-emotion of fear and anxiety is a sub-emotion of nervousness (Shaver, Schwartz, Kirson, & Oconnor, 1987). Ashwell (2012) also states that fear is an acute emotion that is experienced when faced with a

dangerous or painful situation. Whereas anxiety, is the anticipation of unpleasant experiences and may be felt over a longer period of time.

It is generally accepted that emotions play many adaptive functions that promote survival. For example, emotions can guide behaviour, help to prioritizing efforts and, help in communicating with others (Tooby and Cosmides, 2008; Pacella, Ponticorvo, Gigliotta, & Miglino, 2017). As it is unknown what emotions each scenario generated future studies should conduct a manipulation check to better understand the emotion type, level and intensity generated by each scenario.

6.3 Summary of key findings on the effect of environmental harshness on the desire for signalling products

In Chapter 5, I explored how harsh environmental conditions affect the desire for products that are used to conspicuously signal messages during sexual competitions. As environments become increasingly harsh people become more reproduction-oriented (Griskevicius et al., 2013). Based on this fact, I hypothesized that there should also be an increase in intra- and intersexual competition and an increase in desire for products that people use to intimidate same sex rivals and to attract members of the opposite sex.

This study has also advanced the discipline of evolutionary psychology and our understanding of consumer behaviour in the following ways:

1. This study has demonstrated that life-history theory, sexual competition and product desire are connected. I have also provided a rationale that argues that many product purchases are not an end in themselves, but rather are a means

to an end that helps in both survival and reproduction initiatives. Therefore, these purchases can be seen as adaptive.

2. While the results obtained from this study did show that environmental harshness does influence consumer behaviour, the results did not provide evidence that supported the hypotheses that the desire for signalling products increases as the environment becomes harsher. This lack of supporting data is not evidence that the theory is wrong. There could be other factors that influenced the results obtained. For example, as stated previously, people respond differently to low versus high stress situations. Similar to the food studies, the harsh environmental primes tend to decrease product desire. The results may have been different if less stressful environmental harshness primes were used.

3. With regard to the female products experiment, the data did show that under harsh economic conditions, females felt a higher sense of intersexual competition than intrasexual competition.

6.4 Directions for future research on environmental harshness and product desire

As with the food studies, it would be beneficial to repeat the experiment with harsh environmental primes that generate low, medium and high levels of stress. It is also important to ensure that the products used in these experiments reflect what people from different age groups value. For example, a younger female (i.e. 18 years old) may value a cosmetic that makes her look closer to the age of optimal fertility, whereas an older women (i.e. 60 years old) may do the same and desire a cosmetic that makes her look younger.

Likewise, a young male may prefer to display ownership of a car rather than an expensive diamond ring to signal financial power.

With regard to the female experiment, it should be noted that beautifying behaviour can be used for both intra- and intersexual competition. Some beautifying products such as expensive high-heel shoes can signal both financial power and sexiness, however, the value of other beautifying products (i.e. cosmetics) does not come from conspicuously displaying the product, but rather how the product makes the women appear to others. It is important to make these distinctions when inferring sexual competition motives.

While this study did look at the role of harsh environments on product desire, a number of inferences were made that linked these concepts to sexual competition. An experiment that primed environmental harshness and exposed participants to potential same sex rivals (real people) or potential opposite sex mates could provide higher quality evidence to support the relationship between environmental harshness, sexual competition and the desire for conspicuous signalling products.

6.5 Possible existence of an online selection bias

When designing a research study that involves humans, researchers often desire a large sample size and, a sample that is representative of the general population. In an effort to obtain a sufficient number of participants non-monetary and monetary incentives are often provided (Trussell, 2004). An example of a non-monetary reward is offering a student extra course credit or

bonus marks for participation.

It is well established that offering incentives increases participation (Chakrapani and Deal, 2005). However, this practice may lead to a self-selection bias. Specifically, a participant who agrees to take part in a study only to receive a reward is known to be extrinsically motivated. In contrast, a person who volunteers to participate in a study with no promise of a reward is intrinsically motivated. Sharp, Pelletier & Lévesque (2006), state that intrinsically motivated people tend to be higher in agreeableness and openness to experience. Sharp et al. (2006) also state that samples that have a poor balance of extrinsically and intrinsically motivated participants are likely to lead to a biased sample which decreases the generalizability of a study to the larger population.

It is possible that people who are motivated to participate in an online study only to earn extra income, may be from a specific SES group. In addition, those from the lower SES may not have access to a computer with an Internet connection thus, creating a self-selection bias (Greenacre, 2016). A second issue is that extrinsically motivated individuals who participate to augment their income may receive multiple survey requests in a single day. If an individual is participating in multiple surveys they may fail to give a sufficient level of attention to any one study which then reduces the confidence in the data obtained.

In all of the studies in this thesis incentives were provided to the participants. Therefore, this should be considered when interpreting the results and conclusions from each study.

6.6 Concluding thoughts

This thesis adds to the body of knowledge on life history theory by showing how human consumption behaviour varies between slow and fast ecologies. Both food desire and conspicuous consumption can increase to a level where the behaviours are maladaptive and thus, become problematic for both the individual and society. For example, obesity has become a world-wide health epidemic (World Health Organization, 2016) and compulsive buying can lead to credit problems and sometimes bankruptcy (Lowrance, (2011).

To date, solutions such as diet advice (Gudzune, Doshi, Mehta, Chaudhry, Jacobs, Vakil,., . . . Clark, 2015) and credit counselling (Cambridge credit counselling corp. (2012) have been largely ineffective at remedying these problems. Wells (2010) underscores this challenge and states that once a trait becomes canalised, it is resistant to the influence of environmental factors and has a 'self-righting' ability. This implies, environmental interventions tend to have a short-term impact on behaviour change. Despite these stated challenges, solutions to issues such as obesity and excessive spending cannot be remedied without having a comprehensive understanding of these phenomena.

A contributing problem to understanding the etiology of these problems is the fact that most consumer behaviour research has focused predominately on identifying proximate variables with little or no understanding of the ultimate causes (Saad, 2007). This thesis provided new insights as to how these proximate variables such as harsh environmental conditions trigger a

behavioural response that enhances ones survival and opportunities for reproduction - which are the ultimate causes of the behaviours being examined.

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Appendices

Appendix 1

Two Scenario Story Write-ups

Scenario 1 - Safe Environment

"Imagine this is your situation. You are single, have a university degree, and do not have any children. Your parents and siblings are supportive and you get along well with them. You live in a neighbourhood that is generally safe, relatively clean, quiet and well maintained. Your neighbours are OK, either friendly or keeping to themselves. You have a stable job; as far as you can tell you will remain employed for the foreseeable future. In general, you are happy at work and get along well with your boss and co-workers. Your job provides you with a steady income that meets your needs satisfactorily. You own your own home and are able to pay your mortgage on time. You have some savings and/or investments and look forward to a reasonably secure future. Imagine how this would make you feel for a few moments."

Scenario 2 - Harsh Environment

"Imagine this is your situation**.** You are single and you have no children. You left school at 16 years of age, which didn't make your parents very happy, but that didn't really matter since you didn't get along with them anyway. In fact, you still don't get along with them and barely get along with your siblings. At best, your family relationships could be described as distant and at worst conflicted. You live in a neighbourhood that is dirty and noisy. The community areas are not well maintained and some areas are even dangerous. Your neighbours are generally unfriendly or keep to themselves but a few are quite nasty and you don't like running in to them, which is sometimes unavoidable. You recently lost your job because of a combination of economic cutbacks as well as conflicts with your boss and coworkers. You only started this job a few months ago, and so are faced with unemployment yet again. From your previous job searches, you know that work is limited and you have no idea when you will be employed again. You rent a home that needs repairs, but the landlord has refused to fix the problems, partly because you owe back rent. And this is not the only bill that has gone unpaid. Imagine how this would make you feel for a few moments."

Appendix 2

Full-text versions of the 6 scenarios

Social Support: Safe condition

You walk down the carpeted hall and turn the doorknob, happy to find that it's not locked because your partner must be home. As you push open the door, savory spices waft from the kitchen—your partner must be cooking. Then suddenly you are gaping at a room full of beautiful smiling faces and greeted by a joyous shout: SURPRISE! And it really IS a surprise. Your jaw drops and you let out a breath as the blood rushes to your face. You feel your smile widening into a huge grin. And they're all there. You knew your partner was getting a lot of phone calls at home lately, but now you know why; they've been setting this up for weeks. Your mum and dad are there, each with an arm round your partner, who can't stop laughing, right there in the middle of everyone. Your two sweet sisters and your brother, who's wearing a little cone birthday party hat, blowing one of those wheezy stretch-whistles and making one of his usual goofy faces. The whole family has gathered from across three provinces to be here for your birthday, and you never had a clue. You suddenly notice your best friend from back home, who must have driven up here with your parents. A tear runs down your old friend's cheek, next to that gigantic smile you remember so well, and have missed so much lately, in spite of all your Facebook conversations. Your own eyes start to moisten and you bite your lip a little to keep the happy-tears back. Two of your closest friends are there from work, and three of your neighbors, including the sweet, hard-of-hearing old lady from down the hall who always brings you cookies. They all seem to have gotten to know one another before you even got here. It's like your family has not only suddenly appeared from out of the blue, but has expanded instantly to include your favorite people from here in the city.

You remember saying goodbye to some of these same folks a few years ago and coming to a city where you didn't know a soul and how lonely that was at first. That feeling has been gone for a long time now, and tonight you feel

connected to everyone here, and connected to this city, your home now. And you feel surrounded by love.

Pause for a moment and think about the story you just read. How would you feel if this really was your situation?

Social Support: Harsh condition

You trudge down the hallway, fish for your key, and your heart sinks. A few months ago that door would have been unlocked, and your partner would be waiting for you. Tonight as you push open the door the air is dead and all you can hear is the low buzzing of a fan. You drop your bag in the hall closet - it makes a thud as it hits the floor. It is quiet and you can hear your footsteps as you cross the kitchen tile. You swing open the fridge and a cold draft hits you. You pull out a small milk carton and set it on the table, then cross to the dishwasher, pull out a cup, set it on the table and fill it. You sit, take a big sip. The milk is cold and makes you shiver. Sadly, you pull yourself up and swing open the fridge again. There's a plastic container with half of yesterday's can of chicken soup in it. On the shelf below there's a foam take-out box with the remains of the beef and rice from the night before. You close the fridge door and sit back down.

Should you get take-out delivered again? Maybe pizza this time. For a special occasion. Some occasion! Why did you come to this city? You may not have liked everybody in your little town, but at least you had your family and a few good friends. And people knew one another, looked out for one another. Despite the fact that you have been in the city for a while now you haven't made one friend. And now your partner's gone, too: couldn't take it. Headed back to that little town. Or maybe couldn't take you. Guess you'll never know, since your ex won't speak to you or even email.

You pull out your phone and turn it on. No messages, not even from anyone in your family. You tug the fridge door open and pull out the beef and rice, pop it in the microwave, and stand waiting for the ping. The microwave

signals it's done and you grab the food and a fork from the dishwasher, then cross into the main room. You drop yourself onto the empty love seat and punch the remote. Canned laughter bleats from the TV. It's a rerun of an old sitcom about a group of friends. You take a bite of beef and your stomach knots. Tears fill your eyes. It's your birthday. And you've never felt so lonely.

Pause for a moment and think about the story you just read. How would you feel if this really was your situation?

Economic prospects: Safe condition

You turn into the parking lot and park your new car, careful not to scratch it on the post. There's a spring in your step as you cross the lot and step through the sliding doors into your bank. You walk up to the Loans and Mortgage desk and pull the original papers out of your bag. The lady behind the desk looks puzzled, but she smiles at you and her eyes sparkle through her glasses.

"Can I help you?" she asks. You realize you're grinning as you pass the mortgage papers to her. "I want to finish paying this off, please" "Oh, well, that's nice. All in one payment?"

"That's correct", you say. She smiles back at you. "Let me pull up your file." She taps away at her keyboard and studies the file for a moment. "Yes, you can do that without penalty under these terms. Did you want me to transfer it from your account?" You grin even harder and nod.

It's taken many years to get to this point, but it's still nowhere near as long as you had once expected. Now everything is happening quickly. It's not as if you haven't worked hard for it, and you'll keep working hard. Well, that's assuming you'll keep working. Maybe you could retire early? You've slowly worked your way up in the company, and you've been responsible and diligent. You're known as a good worker, and your job is secure. Financially you've always been fairly comfortable, and had enough for a bit more than the basics. But you've sometimes had to be careful with your money. Restaurants

not too often, mostly short vacation trips, and you've driven the same car for quite a few years until yesterday.

But thanks to poor Uncle Bill, that's all changed. Last month the inheritance money from your great uncle came through to your account. It's enough to buy a new car, pay down the remaining fifteen years on the home mortgage and still have enough to add to the company pension and saving a good chunk of cash for the future. The money situation has been pretty good in recent years, but now, with the mortgage taken care of, you'll own your own home. As the mortgage and loans lady stamps "Paid" across your mortgage papers, you feel fully financially secure and at ease.

Pause for a moment and think about the story you just read. How would you feel if this really was your situation?

Economic prospects: Harsh condition

You step off the bus and begin the one block walk to your bank that's located in the middle of an old strip mall. As you get close to the mall you walk slowly across a dusty parking lot, rehearsing once again what you'll say. You notice for the first time that the sole on your shoe is splitting off. Maybe you can glue it when you get home. You hope the bank people don't notice. You think to yourself, "How did you ever get into this situation?" You've never been rich, but now you're hitting bottom.

It started when the company went out of business - without any warning. No severance, nobody to sign the employment statement that EI—Employment Insurance Canada--wanted. After weeks of filling out forms and going from one stubborn bureaucrat to another, you finally you got them to accept the pay stubs and the news article about the company's demise as proof. You looked for work but the downturn has made jobs really scarce. Then unemployment insurance ran out and the car was repossessed. And now this.

Your heart beats rapidly as you walk into the bank. You get into the lineup for tellers, and stand there for a few minutes, sweaty hands in your pockets, shuffling along behind some guy in a suit, whose new shoes shine under the fluorescent lights. Your stomach grumbles and you think about one more lunch of Kraft dinner. You then notice there's a different counter that says "Loans and Mortgages". You feel a bit foolish for not noticing it sooner. You cross over and look towards the lady standing behind the counter, but you can't look her in the eye. You reach into your bag and pull out the mortgage papers and the threatening letters you've been getting from the bank for several months. You look at the lady smiling innocently at you. At least this isn't the angry one you had to talk with last month, who kept you waiting for an hour and sneered at you when she had to give you a one-month extension. Your stomach cramps. You're already four months overdue. Why would they give you yet another extension? They'll own the house completely in two days, and you'll be on the street. This time, it feels hopeless. You're not going to make it out of this hole. You really don't know what you're going to do.

Pause for a moment and think about the story that you just read. How would you feel if this really was your situation?

<u>Physical Safety: Safe condition</u>

As you amble along the elm-lined street, a white-haired man raking golden leaves on his lawn smiles and waves. You smile and wave back, then look up at the way the late afternoon sun makes the elm leaves glow above you. You love taking your time on the way home from work—it's a pleasant and relaxing walk and most people here are friendly or at least look completely harmless. Some of them remember you from your childhood or at least know your family. There's hardly any traffic, and the few cars you see are going very slowly. Recently, you managed to get a job transfer back to your home town which made you happy. You don't miss the city at all.

In the city, you used to have to walk through the worst section of town at least twice a day. You looked around constantly to ensure you were safe. But all

that's been behind you now. Today you are feeling safe and breathing a lot easier.

The wonderful thing about this town is the way everyone keeps an eye out for you. Not that the local police are not good at what they do. It's just that they don't have that much to do. Bob, the local cop, seems to spend most of his time at the downtown coffee shop, because there's rarely much need for his services. That's why you feel a bit silly as you come up to your house and pull out your new set of keys. The keys were brought to your office today by the local locksmith. You guess you must have brought your old city mentality with you when you asked him to change the locks and install a new deadbolt on your front door.

The new door handle and locks sparkle brightly in the afternoon sun. You open the lock for the first time. The key slips in snugly and easily. You unlock the handle lock, then the dead bolt, then walk through the door. As you close it behind you and hear a comforting click as the door closes securely behind you. You feel completely, utterly safe.

Pause for a moment and think about the story you just read. How would you feel if this really was your situation?

Harsh Environment: Physical Safety

It's after midnight and you are on the last bus of the night. You reach up and pull the cord to signal your stop - the bell rings. You ride this bus in daylight every day but haven't had to come home so late before. You stand, the brakes squeal and you are thrown forward as the bus pulls up to your stop. You're hesitant to get off, but you'll have a lot further to walk if you don't move quickly. As you step onto the hard pavement you pause, thinking once again about the body that was found in the alley behind the bus stop last month.

The bus hisses and clanks, pulling away in a fog of diesel fumes. You ask yourself, “what got into your head a few years ago when you left the safety of your little town for this dark and dangerous city?”

You take a deep breath and peer into the dark alley - nothing but darkness. You survey the rust-riddled parked cars along the road. Hopefully, no one is lurking behind them. Then you see a guy sitting behind the wheel across the street, his face shadowed. A dog barks and snarls somewhere nearby. You move quickly along the sidewalk, past a row of pawn shops and cash stores, their smudged windows shuttered with steel grating.

You hear the rumble of a big car behind you. It drifts slowly along. It feels like it is following you. You glance back quickly. It’s the car with the shadowy-faced driver you saw on the other side of the street. You see his face this time—a sharp face, smiling weirdly, watching you. You pick up your pace and are breathing hard as you cover the last block. He’s still there, the car crawling along beside you like a wolf following you at the edge of a forest. You turn off on your side street and he drifts by.

The lights along this street are out for some reason. It’s dark but you’re breathing a little easier to see that the car has missed the turn and drifted on past. Then, as you make the corner, you see light swing across the apartments on your left. You look behind and see headlights approaching. They blind you at first. Then, as the car creeps closer and slows down, you see it’s the same car. As it gets closer to you, your heart races and your whole body tightens like a vice.

Pause for a moment and think about the story you just read. How would you feel if this really was your situation?

Appendix 3

The State and Trait Food Cravings Questionnaire

1. Right now at this very moment: - I'm craving tasty food.
2. Right now at this very moment: - I have an urge for tasty food.
3. Right now at this very moment: - I have an intense desire to eat something tasty.
4. Right now at this very moment: - If I ate something, I wouldn't feel so sluggish and lethargic.
5. Right now at this very moment: - Satisfying my appetite would make me feel less grouchy and irritable.
6. Right now at this very moment:- I would feel more alert if I could satisfy my appetite.
7. Right now at this very moment:-If I ate right now, my stomach wouldn't feel as empty.
8. Right now at this very moment:- I am hungry.
9. Right now at this very moment:- I feel weak because of not eating.
10. Right now at this very moment:-My desire to eat something tasty seems overpowering.
11. Right now at this very moment:-I know that I am going to keep on thinking about tasty food until I actually have it.
12. Right now at this very moment:-If I had something tasty to eat, I could not stop eating it.
13. Right now at this very moment:-If I were to eat what I am desiring, I am sure my mood would improve.
14. Right now at this very moment: - Eating something tasty would feel wonderful.
15. Right now at this very moment: - Eating something tasty would make things just perfect.
16. To what degree is each statement generally true for you?-When I crave something, I know I won't be able to stop eating once I start.
17. To what degree is each statement generally true for you? – If I eat what I am craving, I often lose control and eat too much.
18. To what degree is each statement generally true for you? - Food cravings invariably make me think of ways to get what I want to eat.
19. To what degree is each statement generally true for you? - I feel like I have food on my mind all the time.
20. To what degree is each statement generally true for you? - I find myself preoccupied with food.
21. To what degree is each statement generally true for you? - Whenever I have cravings, I find myself making plans to eat.
22. To what degree is each statement generally true for you? - I crave foods when I feel bored, angry, or sad.

23. To what degree is each statement generally true for you? - I have no will power to resist my food crave.
24. To what degree is each statement generally true for you? - Once I start eating, I have trouble stopping.
25. To what degree is each statement generally true for you? - I can't stop thinking about eating no matter how hard I try.
26. To what degree is each statement generally true for you? - If I give into a food craving, all control is lost.
27. To what degree is each statement generally true for you? - Whenever I have a food craving, I keep on thinking about eating until I actually eat the food.
28. To what degree is each statement generally true for you?-If I am craving something, thoughts of eating it consume me.
29. To what degree is each statement generally true for you?-My emotions often make me want to eat.
30. To what degree is each statement generally true for you?-It is hard for me to resist the temptation to eat appetizing foods that are in my reach.