

THE INFLUENCE OF FASTING, AFFECT, AND BODY DISSATISFACTION ON SET
SHIFTING ABILITY

Megan Beth Harney

A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in
partial fulfillment of the requirements for the degree of Doctor of Philosophy in the
Department of Psychology

Chapel Hill
2012

Approved by:

Anna Bardone-Cone, PhD

Cynthia Bulik, PhD

Donald Baucom, PhD

Kelly Giovanello, PhD

Keith Payne, PhD

ABSTRACT

MEGAN BETH HARNEY: The Influence of Fasting, Affect, and Body Dissatisfaction on Set Shifting Ability
(Under the direction of Dr. Anna Bardone-Cone)

Set shifting, or the ability to shift back and forth between multiple tasks, operations, or mental sets (Miyake et al., 2000), is a neurocognitive construct characterized by a rigid thinking style. It has been shown to be impaired in individuals with anorexia nervosa (AN) (Roberts et al., 2007) and may impede treatment progress (Vitousek & Manke, 1994). Given the lack of effective treatments for AN (Steinhausen, 2002), examining how set shifting may be exacerbated or ameliorated is worthy of investigation. In Study 1, the effects of acute fasting and emotional experiences, independently and in combination, on set shifting abilities were experimentally explored in undergraduate females. There was no significant interactive effect of fasting and affect on set shifting ability although a trend emerged suggesting those who are fasting and experiencing negative affect may make more perseverative errors on the Wisconsin Card Sorting Task (WCST) relative to other groups. No significant main effects were found. In Study 2, undergraduate females selected for being high or low on body shame were exposed to a body dissatisfaction induction paradigm in order to examine its effects on one's ability to mentally task switch. A significant interaction was found and analyses suggest that those who feel ashamed of their bodies may indeed perform more cognitive errors on the WCST when feeling acutely body dissatisfied compared to those high in body

shame in a neutral condition and those low in body shame in the body dissatisfaction condition.

ACKNOWLEDGEMENTS

Graduate school transformed my life. I entered feeling unsure, hesitant, and unable but left feeling proud, accomplished, and downright happy. My most heartfelt gratitude goes to Anna Bardone-Cone who gave me the encouragement to discover not only what I wanted for my career but also for my self. I could not ask for a more warm, compassionate, and thoughtful advisor and friend. You, Matt, and the boys have treated me like family and I have been truly touched. My fellow graduate student, Christine Maldonado, shared my biggest accomplishments and deepest sorrows with an incredible amount of grace, class, humor, and kindness. You showed me friendship in its truest, rarest, rawest, form and I will be forever changed. Ellen Fitzsimmons-Craft, my companion for the great move from Missouri to North Carolina! Without you and Tim my experience in North Carolina would have felt much less friendly, less stylish, and would have involved fewer Mason jars. And Katherine, because of your insight, genuineness, and wisdom, I was able to discover my own strengths and how to share them with the young women that mean so much to me. My sense of self has evolved since entering grad school. Anna, Christine, Ellen, and Katherine: you all helped shape me into the woman I am today.

My tireless team of undergraduates was the driving force behind this dissertation and without their humor, spirit, and dedication I never could have finished running my participants. A special thanks to Kaitlin Doyle - my time chatting and laughing with you will be remembered fondly. I would also like to thank my committee for their helpful feedback and positive encouragement.

I have been so fortunate to always receive the utmost support from my mom and dad who know how to balance my independence while understanding that sometimes a girl just needs her parents. Mom and Dad, thank you for trusting that I knew my own path (it sure wasn't dental school).

And finally, Sam. You came into my life during the last leg of this journey and rounded out my graduate school education by teaching me the difference between a loblolly and a shortleaf pine. I am so happy. I love you.

TABLE OF CONTENTS

LIST OF TABLES	viii
LIST OF FIGURES	ix
Chapter	
I. INTRODUCTION	1
Set Shifting and Anorexia Nervosa.....	4
Fasting and Set Shifting	7
Affect and Set Shifting.....	9
Study 1: Fasting, Affect, and Set Shifting	12
Body Dissatisfaction and Set Shifting	14
Study 2: Body Dissatisfaction and Set Shifting.....	15
Limitations of Existing Literature.....	17
II. METHODS STUDY 1	19
Participants.....	19
Measures	19
Procedure	23
III. ANALYSES: STUDY 1.....	25
IV. RESULTS: STUDY 1	27
Demographic Data	27
Manipulation Check.....	27

	Hypothesis 1: Fasting, Affect, and Set Shifting.....	28
	Hypothesis 2: Blood Glucose and Set Shifting.....	29
	Hypothesis 3: Perfectionism and Set Shifting	29
	Hypothesis 4: Disordered Eating and Set Shifting.....	29
V.	DISCUSSION: STUDY 1	31
VI.	METHODS: STUDY 2	37
	Participants.....	37
	Measures	37
	Procedure	41
VII.	ANALYSES: STUDY 2.....	43
VIII.	RESULTS: STUDY 2	45
	Demographic Data	45
	Manipulation Check.....	45
	Hypothesis 1: Body Shame, Body Dissatisfaction, and Set Shifting.....	46
	Hypothesis 2: Cognitive Flexibility Scale (CFS) and the Wisconsin Card Sort Test.....	46
	Hypothesis 3: Body Dissatisfaction Induction and Body Rumination	49
IX.	DISCUSSION: STUDY 2	50
X.	GENERAL DISCUSSION.....	56
	Strengths	56
	Limitations	57
	Future Research	59
	Clinical Implications.....	60

Conclusion	62
REFERENCES	76

LIST OF TABLES

Table

1. Study 1: Demographic Data	64
2. Study 1: Means, Standard Deviation, and Range of Perseverative Errors for Hypothesis 1 Interaction Effects.....	65
3. Study 1: Correlation Table for Set Shifting and Perfectionism Measures	66
4. Study 1: Mean and Standard Deviations Before and After the Body Dissatisfaction Induction for Those High in Body Shame and Low in Body Shame.....	67
5. Study 2: Demographic Data	68
6. Study 2: Means, Standard Deviations, and Range of Perseverative Errors for Hypothesis 1 Interaction Effects.....	69

LIST OF FIGURES

Figures

1. Pictorial Representation of Wisconsin Card Sort Test	70
2. Representation of Study 1	71
3. Interaction Graph for Study 1, Hypothesis 1	72
4. Representation of Study 2.....	73
5. Interaction Graph for Study 2, Hypothesis 1	74
6. Interaction Graph for Study 2, Hypothesis 1 Excluding Two Outliers in the Low Body Shame Condition.....	75

INTRODUCTION

Cognitions have long held importance in theories regarding anorexia nervosa (AN). The cognitive theory of AN, first developed by Garner and Bemis (1982) and based on Beck's model of emotional disorders (Beck, 1976) suggests that maladaptive beliefs attached to the importance and meaning of weight and shape contribute to the development and maintenance of AN. Cognitive theories for eating disorders have garnered much empirical evidence; individuals with AN do indeed endorse and engage in maladaptive thought processes as well as construct inflexible cognitive schemas regarding food and weight (Cooper, 1997; Cooper, 2005; Vitousek & Hollon, 1990). However, although components of cognitive theories are empirically supported, the therapeutic treatments for AN stemming directly from the theory are not. Cognitive behavioral therapy (CBT) has yet to be demonstrated effective for the treatment of AN (Bulik, Reba, Siega-Riz, & Reichborn-Kjennerud, 2005; Murphy, Straebl, & Fairburn, 2010; Steinhausen, 2002; Steinhausen, 2003; Zipfel, Lowe, Reas, Deter, Herzog, 2000) although some have suggested using CBT transdiagnostically. Given the historically poor treatment prognosis and high mortality rate among individuals diagnosed with AN, a priority for researchers is to better understand this concerning limitation in our field and to repair the gap between cognitive theories and treatment for AN (Steinhausen, 2002).

Some researchers have suggested that existing cognitive theories focus too narrowly on "specific psychopathology" such as food and weight issues and that researchers need to broaden their conceptualization of cognition in eating disorders so that theory and empirical

tests consider the neuropsychological deficits underlying the maladaptive thinking such as cognitive inflexibility (Vanderlinden, 2008). However, there are fewer neuropsychological studies of eating disorders than of any other major psychiatric disorder, undermining our understanding of AN and likely contributing to inconsistencies within the literature (Tchanturia, Campbell, Morris, & Treasure, 2005). While some studies suggest neuropsychological performance is not related to eating disorder symptoms (Mikos et al., 2008), others posit that, at minimum, subtle cognitive impairments are apparent in women with AN (Bosanac, et al., 2007; De Hamsher, Halmi, & Benton, 1981; Fowler et al., 2006, Green, Elliman, Wakeling, & Rogers, 1996). A number of studies indicate that individuals with AN may experience cognitive deficits in the domains of set-shifting, attention, visual-spatial ability, memory, verbal functioning, and learning before the onset of AN, during the disorder, and after remission with the most severe deficits during the acute illness (see Lean, Fiocco, & Leyenaar (2004) for a review; Braun & Chouinard, 1992; Chui et al., 2008; Gillberg, Råstam, Wentz, & Gillberg, 2007).

However, establishing the link between cognitive impairments and the dysfunctional cognitions associated with AN is largely absent in current treatment theories regarding AN. Considering the potentially ubiquitous nature of cognitive deficits in AN and evidence that impaired cognition is associated with poorer treatment outcome in individuals with AN (Hatch et al, 2009; Small, Madero, Teagno, & Ebert, 1983), treating overt symptoms (e.g., restrictive eating) rather than the underlying problem (i.e., cognitive deficits) may explain high relapse rates among individuals with eating disorders. Indeed, a recent study suggests the decline of eating disorder cognitions, rather than eating disorder behaviors, denotes a turning point from partial to full recovery status (Bardone-Cone et al., 2010). These eating

disorder cognitions, however, do not diminish readily. Clinicians often bemoan the rigidity and inflexibility of eating and weight cognitions of clients with AN, making AN one of the most difficult disorders to treat (Vitousek, Watson, & Wilson, 1998).

A neurocognitive trait that is significantly impaired in individuals with AN and may underlie this cognitive rigidity is set shifting, or the ability to shift back and forth between mental sets (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007). The ability to shift cognitive set has been in part traced to biological underpinnings. Generally speaking, set shifting impairment on the Wisconsin Card Sorting Task (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993), a widely used measure of set shifting performance, can be used to distinguish those with dysfunction in the prefrontal cortex, the region of the brain related to executive functioning (Konishi et al., 1998; Rogers, Andrews, Grasby, Brooks, & Robbins, 2000). Specifically within an AN sample, Zastrow et al. (2009) found that compared to healthy controls, women with AN show more errors on a behavioral set shifting task and concurrent functional magnetic resonance imaging (fMRI) readings showed increased activation in the prefrontal and parietal regions, indicative of effortful cognitive control during the task performance. Another study found that decreased leptin, a hormone secreted by fat cells and notably suppressed in malnourished AN patients, and its associated appetite-regulating agouti-related protein (AGRP) may be related to set shifting difficulties in adolescent AN patients (Sarrar, et al., 2011). Within a community sample, elevated cortisol, a hormone related to the experience of stress, was related to increased set shifting impairment for women, but not for men (McCormick, Lewis, Salamy, & Kahan, 2007). Together, these studies indicate that impaired set shifting may be

related to specific differences in brain activity, particularly in the prefrontal region, as well as differences in hormone levels.

A rigid, inflexible cognitive style resulting in an inability to “shift set” from thoughts surrounding food, eating, weight, and shape can hamper treatment and may even be considered a “sticking point” in treatment progress. Characteristics of AN noted by clinicians, such as cognitive rigidity, perfectionism, obsessional thinking, and inability to alter cognitions even if motivated to do so, provide clinical face validity for the set shifting difficulties empirically observed in this population (Vitousek & Manke, 1994). Indeed, a critical component of therapy, namely, insight, seems to be partially dependent on mental flexibility (Konstantakopoulos, Tchanturia, Surguladze, & David, 2010). A better understanding of cognitive deficits such as set shifting that may contribute to the rigidity of food/weight-related cognitions is warranted.

The primary goal of the current research is to examine how set shifting, a cognitive construct impaired in individuals with AN and characterized by a rigid thinking style, may be exacerbated or ameliorated. In Study 1, the effects of acute fasting and emotional experiences, independently and in combination, on set shifting abilities were experimentally explored in undergraduate females. In Study 2, undergraduate females selected for being high or low on body shame were exposed to a body dissatisfaction induction paradigm in order to examine its effects on one’s ability to mentally task switch. Set shifting ability was investigated using the Wisconsin Card Sorting Task (WCST; Computerized Version IV; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) a widely-used measure of set shifting ability.

Set Shifting and Anorexia Nervosa

Set shifting is an important aspect of executive control involving the ability to shift back and forth between multiple tasks, operations, or mental sets requiring an individual to not only disengage from an irrelevant task and actively engage in the subsequent relevant task, but also to perform this new task in light of interference and priming from the previous task (Miyake, et al., 2000). In the literature, although “cognitive flexibility” is occasionally used interchangeably with “set shifting,” the term “cognitive flexibility” often refers to a broader construct relating to creativity in general rather than switching mental sets specifically. Thus, this manuscript will refer to “cognitive flexibility” as a more general, loosely defined construct defined by one’s ability to think creatively and assessed by a wide variety of measures, whereas “set shifting” refers to a more specific construct in which one has the ability to switch to a different thought or mental set while inhibiting competing responses according to changes in a situation (Wang & Guo, 2008).

Although few in number and largely limited to one lab, the studies that have investigated set shifting in AN are intriguing (Holliday, Tchanturia, Landau, Collier, & Treasure, 2005; Tchanturia et al., 2004; Tchanturia et al., 2005; Tchanturia, Morris, Surguladze, & Treasure, 2002; Tchanturia, Serpell, Troop, & Treasure, 2001). Using a perceptual set shifting task in which participants were asked to evaluate the relative mass of wooden spheres placed in their hands, individuals with AN were more likely to be influenced by previous sphere masses and respond more rigidly (i.e., gave the same incorrect response repeatedly) than either healthy controls or individuals with bulimia nervosa (Tchanturia, et al., 2001). To further investigate the persistence of impaired set shifting, the same research group examined perceptual, along with cognitive, set shifting tasks in individuals with active AN and those weight-recovered from AN. The authors found that individuals with active AN

and, to a lesser degree, individuals with a history of AN performed more poorly on perceptual and cognitive set shifting tasks than healthy controls, indicative of set shifting as a trait rather than state marker of AN (Tchanturia, et al., 2002). Other research groups have uncovered similar trait-like findings using a variety of set shifting tasks (Fassino, Piero, Daga, Leombruni, Mortara, & Rovera, 2002; Nakazato et al., 2009; Steinglass, Walsh, & Stern, 2006; Zastrow et al., 2011).

Evidence has also emerged to suggest that set shifting impairments not only specifically persist after recovery but are also evident in first-degree non-AN relatives. Given the trait-like quality and potential heritability of impaired set shifting, this cognitive deficit could represent not only a vulnerability factor for AN, but may also represent an endophenotype of AN (Holliday, et al., 2005; Nakazato, et al., 2009; Tchanturia et al., 2004). In a meta-analysis investigating set shifting ability in individuals with eating disorders, Roberts and colleagues (2007) examined 15 studies that administered at least one neurocognitive measure of set shifting ability in both eating disorder and healthy control groups. The authors concluded that studies of set shifting in individuals with AN show consistent set shifting impairment across stages of AN. To further corroborate previous findings suggesting the trait-like features of set shifting, Roberts, Tchanturia, & Treasure (2010) recently investigated set shifting in women with current AN and bulimia nervosa (BN), women recovered from AN, and unaffected sisters of the AN and BN probands. Using an assessment battery of four neurocognitive tasks, the authors concluded that poor set shifting is a transdiagnostic feature particularly related to the active eating disorder stage, but may also be present in those recovered from AN and in unaffected sisters of both AN and BN.

In sum, evidence from the eating disorder literature points toward a relation between one's ability switch task sets and AN. Although this cognitive inflexibility is evident to therapists and researchers in the field, it has gone largely unaddressed in cognitive theories and treatments regarding AN. Incorporating a broader view of the disorder to include cognitive impairments such as set shifting may generate new treatment approaches for AN.

Fasting and Set Shifting

Multiple studies demonstrate that during the active illness stage of AN when individuals are fasting, or at least subsisting on an extremely restrictive diet, there are evident impairments in executive functioning and that upon improved nutrition, cognitive functioning may improve (Hatch, et al., 1996; Kingston, Szmulker, Andrews & Tress, 1996; Lauer, Gorzewski, Gerlinghoff, Backmund, & Zihl, 1999). Interestingly, despite these studies suggesting that poor cognitive functioning is related to malnutrition, there is little support for *low BMI* being specifically related to cognitive impairment (Green et al. 1996; Moser et al., 2002). Similar findings emerge when evaluating the relation between BMI and set shifting in particular (Mathias, 1998; Roberts et al., 2010). Although low BMI may not in itself directly contribute to poorer cognitive functioning (i.e., exacerbate any trait set shifting impairments) in individuals with AN, the above research suggests that other correlates of malnutrition may indeed play a role in cognitive impairment. Taken together, the literature suggests that although more pronounced set shifting deficits are evident in the active stage of AN, biological correlates of malnutrition rather than low weight itself may be in part responsible.

A component of nutritional status of specific interest in this proposal is hypoglycemia, or low blood glucose levels. Lowered blood glucose levels can affect glucose supply to the brain that may in turn result in loss of brain function and decreased cognitive

performance (Green & Rogers, 1995). One mode by which blood glucose levels are altered is through fasting, a practice commonly seen in individuals with AN (Gaudiani, Sabel, Mascolo, & Mehler, 2010). Mathias and colleagues (1998) reported that low blood glucose has often been found to impair cognitive functioning in a variety of populations. For instance, Benton and Sargent (1992) found that breakfast consumption and blood glucose levels were positively correlated with performance on verbal and spatial memory tests in undergraduate students. In contrast, following a 12-16 hour fast (i.e., low blood glucose levels), healthy individuals consistently show impairment in a variety of cognitive domains including information processing speed, problem solving, verbal naming, verbal and nonverbal memory, attention, and visual spatial skills and working memory (Doniger, Simon, & Zivotofsky, 2006; Green & Rogers, 1998). Studies investigating dieters versus nondieters suggest that food restriction may play a role in cognitive performance (Green & Rogers, 1995; Rogers & Green, 1993). However there is also some research reporting null findings; Green and colleagues (1995; 1997) found no significant detrimental effect of missing a meal or blood glucose level on memory tasks and an attention task. Finally, in tandem with studies investigating restricted glucose levels, various studies indicate that increases in glucose appear to temporarily enhance attention and memory abilities (for a review see Rogers & Lloyd, 1994; Benton & Owens, 1993; Gagnon, Greenwood, & Bherer, 2010).

Experimental examination of fasting and glucose levels in relation to set shifting is important to further our understanding of the cognitive processes related to AN. However, to date, there is little research investigating the specific relation between fasting (and related blood glucose levels) and set shifting. Landers and colleagues (2001) investigated set shifting in college wrestlers with and without rapid weight loss prior to a meet. Results indicated no

significant differences in cognitive performance between the two groups. However, although this study addressed rapid weight loss, the investigation of fasting was not isolated per se since both groups may have been engaging in fasting practices. Other studies have examined the effects of fasting on set shifting in experimental designs. Piech and colleagues (2009) investigated the effects of hunger and fasting on inflexibility and perseverative errors made on a WCST-like task in a sample of healthy participants. Participants in a 5-hour fast condition made significantly more errors on the task when hunger was made salient with a slideshow of appetitive foods. These results indicate a combination of physiological hunger (i.e., fasting) and psychological hunger (i.e., desire for food) may indeed contribute to the inability to shift sets and adapt to new environmental pressures. Lastly, in examining the relation between fasting for 16 hours and perseverative thinking using a computerized measure of perseveration developed by the authors in a non-clinical sample of females, Bolton, Serpel, Gilbert, and Burgess (2010) found that individuals in the fasting condition were slower on trials requiring a shift in set response and that the effect was even greater in individuals with higher levels of eating disorder psychopathology.

These findings regarding fasting and set-shifting are intriguing but require replication using a widely-used set shifting instrument (e.g., the WCST) and the examination of blood glucose levels along with fasting in an experimental design.

Affect and Set Shifting

Contrary to the mixed findings regarding acute fasting on cognitive abilities in general and the limited findings regarding set shifting specifically, there is a rich literature confirming the role positive affect plays in increasing cognitive flexibility. A variety of models have been proposed to explain the mechanism underlying the relation between affect

and cognitive flexibility. The “cognitive tuning” model states that individuals interpret a situation based on their current affective state (Schwartz, 1990). Negative affect cues the interpretation of a “problematic” situation and an analytic, linear, step-by-step, narrow thinking style is activated. On the other hand, positive affect cues the perception of a “safe” situation; thus, the individual can afford to ponder broader concepts, as well as be playful with and explore new ideas and alternate perspectives (Schwartz, 1994). The “mood-congruent retrieval” view asserts that positive affect signals the retrieval of positive memories and that positive material in memory is encoded in a more extensive and diverse network than negative material. Thus, when an individual experiences positive affect, more fluid, unique, and innovative combinations of ideas are generated relative to the more rigid arrangements activated during a negative affective experience (Isen, Shalcker, Clark, & Karp, 1978; Isen et al., 1985). Finally, there is evidence to support a dopamine theory of affect and cognitive flexibility in that positive affect is associated with increased brain dopamine levels which in turn promote greater cognitive flexibility (Ashby, Isen, & Turken, 1999). Although a thorough review of the above models is outside the scope of this proposal, this brief background highlights the rich theoretical support for the relation between affect and cognitive flexibility.

A large number of studies incorporating diverse methods and measures provides empirical evidence for the influence of affect on cognitive flexibility and set-shifting (see Ashby et al., 1999 for a review; Frederickson, 1998) and a large meta-analysis has recently demonstrated evidence for the link between negative affect and low cognitive flexibility (Baas et al., 2008). As an example of an experimental examination of the link between affect and cognitive flexibility, Hirt, Devers, and McCrea (2008) manipulated affect by showing

positive, negative and neutral film clips to a sample of healthy controls. Over a series of three studies, individuals viewing positive clips consistently demonstrated greater cognitive flexibility. Additional experimental studies corroborate these findings, suggesting that upon affective manipulation individuals with even modest increases in positive affect display increased cognitive flexibility and reduced perseveration compared to neutral and negative affect groups (Bauman et al., 2005; Dreisbach, et al., 2004; Wang & Guo, 2008). Focusing on set shifting, individuals higher in trait anxiety demonstrate inefficiencies in switching mental set (Johnson, 2009), dysphoric undergraduates demonstrate poorer ability to shift set on the WCST relative to their euthymic peers (Channon, 1996), and undergraduate students who experience more perceived stress perform more poorly on the Trail Making Task (another task intended to capture set shifting) (TMT; Reitan, 1958) than undergraduates reporting less stress (Orem et al., 2008). The influence of depressive and anxious symptoms on set shifting ability is present in clinical populations as well. For example, compared to healthy controls, individuals with major depressive disorder demonstrate set shifting deficits when presented with a modified WCST that uses negative stimuli (e.g., images selected to induce feelings of sadness and fear) (Deveney & Deldin, 2006).

In sum, a wide literature has consistently demonstrated that positive affect tends to enhance creativity, facilitate greater originality and fluidity among concepts, and increase set shifting ability in both healthy and clinical populations while negative affect tends to hinder set shifting performance and creativity (Hirt et al., 2008). Put another way, affective states can influence individuals' abilities on a trait-like cognitive construct. However, there is no existing research investigating the impact of affect on set shifting within the context of AN or fasting. Given that set shifting deficits are exacerbated in the active illness stage of AN and

that fasting and negative affect are often inherent components of this stage, investigating their interactive effect may shed light on the increased set shifting impairment evident during acute AN. Importantly, both fasting and negative affect are common in other populations, including undergraduate females (Eisenberg, Gollust, Golbersetine & Hefner, 2007; Lowry et al., 2000); thus, Study 1 not only serves as an analog study for individuals with AN but will also apply to individuals who may commonly engage in dietary restriction and experience negative affect.

Study 1: Fasting, Affect, and Set Shifting

The primary goal of Study 1 was to experimentally investigate under what conditions set shifting abilities might improve (i.e., positive affect) or worsen (i.e., fasting, negative affect). Better understanding state conditions that further impair or alternatively ameliorate a trait deficit has the potential to add to the limited neuropsychological research in the eating disorders field as well as contribute to more informed treatment practices for individuals with AN. A secondary goal of Study 1 was to investigate preliminarily the relation between perfectionism, a characteristic of AN (Lilenfeld, Wonderlich, Riso, Crosby, & Mitchell, 2006; Pike et al., 2008; Wade et al., 2008), and set shifting ability. Investigating perfectionism in the context of set shifting has been suggested as a valuable avenue of research due to the rigid cognitive style often associated with perfectionism (Holliday et al., 2005; Steinglass et al., 2006). However, the connection between set shifting and perfectionism remains unclear; one study has jointly investigated these two variables and results suggest that while retrospective self-report of childhood perfectionism was associated with worse set shifting in adulthood, no association was found with adult levels of perfectionism (Tchanturia et al., 2004). Of note, perfectionism was measured using a

unidimensional scale and many researchers argue that important information is lost when measuring perfectionism as a unidimensional, rather than multidimensional, construct (Bardone-Cone, 2007; Frost, Marten, Lahart & Rosenblate, 1990; Hewitt & Flett, 1991; Hewitt, Flett, Besser, Sherry, & McGee, 2003). In particular, two perfectionism subscales, “concern over mistakes” and “doubts about actions,” seem to be especially related to disordered eating (Bulik, Tozzi, Anderson, Mazzeo, Aggen, & Sullivan, 2003). However, no study has investigated whether these subscales are tied to set shifting difficulty and the current study aims to investigate these particular subscales, among other dimensions of perfectionism, in relation to set shifting. Lastly, a goal of Study 1 was to examine the relation between eating disorder pathology and set shifting ability.

Specifically, Study 1 proposed four hypotheses. Hypothesis 1: Fasting and affect are expected to interact to predict set shifting ability. In particular, the most pronounced set shifting impairments are expected in individuals randomized to both the fasting and negative affect groups. If no significant interactive effects are found, the main effects of fasting on set shifting and affect on set shifting will be explored. If main effects are to be considered, individuals in the fasting condition are expected to perform more poorly on the WCST than non-fasting individuals (Hypothesis 1a) and participants randomly assigned to the negative affect induction are expected to demonstrate worse ability to shift sets on the WCST in relation to individuals randomly assigned to the positive affect induction (Hypothesis 1b). (Individuals randomly assigned to the neutral affect induction are expected to score between the positive and negative affect groups on the set shifting measures.) Hypothesis 2: Blood glucose levels are expected to correlate with set shifting ability, such that lower glucose levels will be associated with poorer performance on the WCST. Hypothesis 3: Perfectionism

is expected to correlate with set shifting ability, such that individuals scoring high on perfectionism measures will more likely demonstrate set shifting deficits relative to individuals scoring low on perfectionism measures. High scores on two perfectionism subscales, “doubts about actions” and “concern over mistakes” are thought to be especially correlated with poor set shifting. Hypothesis 4: Eating disorder psychopathology is expected to correlate with set shifting ability, such that individuals with high levels of eating disorder pathology will be more likely to demonstrate set shifting deficits relative to individuals with low levels of eating disorder pathology.

Body Dissatisfaction and Set Shifting

Although there is an extensive literature regarding the effects of negative affect on set shifting, no research has examined whether a body-centric type of negative affect (i.e., body dissatisfaction) may have similar, or potentially stronger, influences on set shifting among individuals concerned with their weight and shape. Body dissatisfaction, or a “negative subjective evaluation of one’s physical body” (Stice & Shaw, 2002, p. 985) is a hallmark feature of AN and is a robust factor in the development and maintenance of eating disorders (Garner & Garfinkel, 1980; Stice & Shaw, 2002). Body dissatisfaction is so highly prevalent among women in Western cultures that a culture of “normative discontent” regarding one’s body exists among females (Klemchuck, Hutchinson, & Frank, 1990; Neighbors & Sobal, 2007; Roberts, Cash, Feingold, & Johnson, 2006; Stice & Shaw, 2002).

Given that body dissatisfaction can be conceptualized as a type of body-centric negative affect leads to the question of whether body dissatisfaction affects cognitive flexibility in general and set shifting in particular. One might expect that body dissatisfaction-related cognitions and negative affect may inundate cognitive resources to the

point that effective set shifting is hampered, as would be suggested by cognitive load theory (Sweller, 1988; Sweller & Chandler, 1994), and that this effect may be especially strong among those elevated in body shame. Further, a ruminative thinking style focused on the body (body rumination) where one ruminates on, or thinks deeply about over and over, negative body-related cognitions, may be important to consider in relation to set shifting. Body rumination has been tied to disordered eating (Cowdrey & Park, 2012; Park, Dunn, & Barnard, 2011; Serpell, Treasure, Teasdale, & Sullivan, 1999) and one might expect that an individual engaging in body rumination may be at risk for experiencing a greater sense of body-centric negative affect, especially if she is already predisposed to feel badly about her body, which could interfere with effective set shifting. However, to date, no research has experimentally examined the effect of body dissatisfaction induction on set shifting ability nor the relation between negative body-related rumination patterns and set shifting ability.

Study 2: Body Dissatisfaction and Set Shifting

Study 2 is an experimental study in which participants selected for being high or low on body shame were randomized to view still images in a body dissatisfaction condition, a negative affect non-body-related condition, or a neutral condition in order to investigate the effect of body dissatisfaction induction on set shifting ability (assessed with the WCST) in a population of susceptible (i.e., body shameful) females. This experimental design allowed for testing main effects (i.e., body shame on set shifting and body dissatisfaction induction on set shifting) as well as interactive effects (i.e., does body dissatisfaction induction moderate the relation between body shame and set shifting?). The inclusion of the negative affect group allowed testing whether a body-centric type of negative affect (i.e., body dissatisfaction) would result in differential set shifting consequences relative to more generic negative affect.

Lastly, Study 2 is the first to compare a self-report measure of cognitive rigidity, the Cognitive Flexibility Scale (CFS; Martin & Rubin, 1995), with the WCST and explored the relation between body rumination and set shifting ability.

Specifically, Study 2's key hypothesis focused on an interactive effect. Hypothesis 1: Body shame and induction condition will interact to predict set shifting ability. In particular, the most pronounced set shifting impairments are expected in individuals reporting high body shame who were randomized to the body dissatisfaction induction condition. If no significant interactive effects are found, the main effects of body shame on set shifting and induction on set shifting will be explored. Those high on body shame are expected to perform more poorly on the WCST than those low on body shame (Hypothesis 1a) and participants randomly assigned to either the body dissatisfaction or negative affect inductions are expected to demonstrate impaired ability to shift set on the WCST in relation to individuals randomly assigned to the neutral affect induction (Hypothesis 1b). Hypothesis 2: The Cognitive Flexibility Scale (CFS) is expected to correlate with set shifting ability, such that individuals with high levels of cognitive rigidity will be more likely to demonstrate set shifting deficits on the WCST relative to individuals with low levels of cognitive rigidity on the CFS. Hypothesis 3a: Individuals in the high body shame group that endorse greater levels of body rumination will perform more poorly on the WCST relative to individuals with high body shame that report lower levels of rumination. Hypothesis 3b: In addition, the induction itself is predicted to induce greater body rumination such that those with high body shame randomized to the body dissatisfaction induction condition will endorse higher levels of body rumination post induction relative to those with high body shame in the negative affect or neutral conditions.

Limitations of Existing Literature

Although there is promising evidence supporting the relation between set shifting and AN, there are limitations to this area of research. First, prior work investigating neurocognitive constructs in the context of AN is limited which necessarily limits the application of these findings to treatment approaches. Given the gap between cognitive theories and cognitive treatment outcomes for AN, incorporating cognitive constructs such as set shifting into the theory of and treatment for AN is potentially valuable. Second, due to a focus on the broader construct of cognitive flexibility in general and the wide variety of non-standardized measures used in the literature to capture set shifting specifically, cross-study comparisons are difficult. Third, little is known about the factors that may influence (exacerbate or ameliorate) set shifting deficits in individuals with AN or individuals with anorexic-like tendencies. Investigating the influence of general and disorder-specific factors may assist in developing effective cognitive therapy strategies. Fourth, to date no research has investigated the interactive effect of fasting and affect on set shifting. Although there is evidence for the influence of affect on set shifting ability, examination of affect within a fasting context is warranted due to the pervasiveness of both fasting and negative affect in AN as well as in non-clinical undergraduate females. Fifth, the research investigating a potential link between perfectionism and set shifting has been limited, in part due to the assessment of perfectionism as unidimensional. Examining the association between set shifting and various dimensions of perfectionism could provide greater insight into these two trait characteristics of AN. Sixth, although body dissatisfaction is a hallmark feature of AN, the impact of inducing body dissatisfaction on cognitive processing, such as set shifting, has been rarely studied. Further, no studies have explored the relation between a body-ruminative

thinking style and set shifting ability. Seventh, although tasks like the WCST, rather than self-report questionnaires, are more commonly used to assess set shifting difficulty and cognitive rigidity, these tasks can be costly and burdensome to administer. Researchers have recently developed a self-report measure of cognitive rigidity but have yet to validate this measure with the WCST.

Study 1 addresses limitations 1 through 5 and extends existing research by employing an experimental design to assess not only the effects of acute fasting on set shifting ability but also the interactive effect of fasting and affect using the WCST, a valid and widely-used measure of set shifting. Study 2 extends existing research by addressing and limitations 1 through 3 and limitations 6 and 7 by experimentally investigating the role of body dissatisfaction induction on set shifting ability using the WCST in a sample of females selected for being high or low on body shame. Ultimately, this research contributes to the burgeoning investigation of cognitive constructs in relation to fasting, affect, and body dissatisfaction with the potential to provide new therapeutic tools to complement cognitive treatments for AN.

METHODS: STUDY 1

Participants

Female undergraduates ($N = 121$) from the University of North Carolina (UNC) participated in this study. The women were recruited from the Introductory Psychology participant research pool and received course credit for their participation. Due to the potential health risks posed by the fasting component of the study in vulnerable populations, individuals with a known history of hypoglycemia, fainting, diabetes, or an eating disorder were not eligible to participate.

Measures

Demographics. A brief demographic questionnaire was administered containing items such as age, year in school, race/ethnicity, and self-reported height and weight. Measured height and weight was gathered by the researcher at the end of the study.

Blood glucose level. Fasting and non-fasting blood glucose levels were assessed with a glucometer, which is a small battery-powered device that determines the concentration of glucose in the blood. Glucometer readings are considered reliable and comparable to laboratory testing of blood glucose levels within populations of physiologically healthy individuals (Baig et al., 2007; Mann, Salinas, Pidocke, Wolf, Holcomb, & Wade, 2008). Given our population of healthy controls, glucometers are predicted to accurately estimate blood glucose level to $\pm 10\%$ of actual blood glucose level when used correctly (Ajala, Oladip, Fasanmade, & Adewole, 2003; Chan et al., 1997). In most individuals, fasting blood

glucose levels are between 70-100 mg/dL with levels below 70 considered “low” blood glucose (American Diabetes Association, 2010).

Affect Induction. Film clips as the method of induction were chosen based on their reliability and effectiveness as a widely-used mood induction technique (Brenner, 2000; Gerrards-Hesse & Spies, 1994; Isen, Daubman, & Nowicki, 1987; Kenealy, 1986; Kim, Kim, Park, & Rice, 2007; Tice, Baumeister, Shmueli, & Muraven, 2007; Westermann, Spies, Stahl, & Hesse, 1996) and because this approach has been used in the disordered eating literature (Cavallo & Pinto, 2001; Macht & Mueller, 2007; Macht, Roth, & Ellgring, 2002; Schotte, Cool, & McNally, 1990; Yeomans & Coughlan, 2009).

For the negative affect induction, a scene from the film “The Champ” (1974) portraying a young boy grieving his father’s death was shown. This clip has been widely used in the literature to effectively induce negative affect (Gross & Levenson, 1995). Positive affect was induced by presenting a series of clips featuring young children, which have been shown to increase positive affect in the laboratory (Dan-Glauser & Scherer, 2011; Gable & Harmon-Jones, 2008; Griskevicius, Shiota, & Neufeld, 2010). Finally, neutral affect was induced by showing a clip from a nature documentary detailing bird migration patterns, which has been previously shown to induce neutral affect (Goldschmidt, Tanofsky-Kraff, & Wilfley, 2011). This approach allowed for a control group (neutral affect) as well as investigation of both negative and positive affect, each of which could influence set shifting differentially. Pilot testing was conducted to confirm the affect induction effectiveness of the positive affect video has not been validated in the literature. Analyses showed that this clip did indeed induce positive affect, with a paired samples t-test indicating that positive affect was higher

after viewing the clip featuring young children ($M = 14.93$, $SD = 4.23$) than before watching the clip ($M = 12.42$, $SD = .77$), $t(13) = 3.19$, $p = .007$.

Set shifting. The Wisconsin Card Sorting Test (computerized version IV, Heaton et al., 2003) has been widely used to assess set shifting ability. This task involves sorting 128 cards that vary in the shape on the card (star, circle, square, cross), the color of the shape (red, yellow, green, blue), and the number of shapes on the card (one, two, three, or four) (see Figure 1). The participant is not given explicit information regarding how to appropriately sort but is asked to sort each card under one of four category cards and is given feedback after each sort regarding the correctness of the sort. After the participant has correctly identified the pattern for a sustained time, the pattern will unpredictably change and the number of perseverative errors made by the participant (i.e., continuing to sort under the former rule) is used as a measure of set shifting ability with greater number of errors reflecting poorer ability to shift sets.

Perfectionism. The Frost Multidimensional Perfectionism Scale (Frost MPS; Frost et al., 1990) and the Perfectionism Cognitions Inventory (PCI; Flett, Hewitt, Blankstein, & Gray, 1998) were administered to assess perfectionistic qualities. The Frost MPS is a 35-item questionnaire composed of 6 subscales: Concern Over Mistakes, Personal Standards, Parental Expectations, Parental Criticism, Doubt About Actions, and Organization. The Frost MPS has demonstrated good reliability (with subscales alphas from .77 to .93) and high correlations with other perfectionism measures in samples of undergraduate women (Frost et al., 1990). In the current study the subscale alphas ranged from .70 to .92 indicating adequate reliability in the sample.

The PCI is a 25-item self-report measure used to assess automatic thoughts regarding perfectionistic themes and beliefs. Respondents are asked to rate how often a given perfectionism thought has occurred to them over the past week on a scale from 0 (*not at all*) to 4 (*all of the time*). This measure of perfectionism cognitions accounts for unique variance above and beyond trait perfectionism and taps into automatic, perfectionistic thoughts as ruminative and obsessive in nature. The PCI is a unidimensional measure with high internal consistency (alpha .95 in a clinical sample) and is correlated with other perfectionism measures, as well as anxiety and depression (Flett, Hewitt, Whelan, & Martin, 2007). The current study demonstrated good reliability with an alpha of .94.

Eating disorder psychopathology. The Eating Attitudes Test-26 (EAT-26; Garner, Olmsted, Bohr, & Garfinkel, 1982) is a widely used 26-item self-report questionnaire intended to capture maladaptive eating disorder-related thoughts, feelings, and behaviors. Respondents rate their agreement with the items on a 6-point scale with higher scores indicating greater levels of pathology. The EAT-26 is scored such that the first three responses (“Never,” “Rarely,” and “Sometimes”) are scored as “0” and the later three responses (“Often,” “Usually,” “Always”) are scored as “1,” “2,” and “3,” respectively. A total score at or above 20 is associated with maladaptive eating behaviors and eating disordered symptomology and can be considered a cut-off for a probable eating disorder diagnosis (Garner et al., 1982; King, 1989, 1991). The EAT-26 has demonstrated adequate internal consistency (alphas range from .80 to .89 in a clinical sample) and has been shown to be highly correlated with other measures of eating pathology (Berland, Thompson, & Linton, 1986; Greenleaf & McGreer, 2006; Henrickson, Crowther, & Harrington, 2010). In the current study, alpha was .81 indicating adequate reliability.

Procedure

The study was advertised on the UNC Sona research participation website. Students expressed interest via the Sona system and were contacted and screened for eligibility via phone. In particular, males, individuals with a known history of hypoglycemia, fainting, diabetes, or an eating disorder were not eligible to participate. Due to lab space logistics, participants that preferred the 11:00am time slot were assigned the fasting condition and participants that preferred the 11:20am time slot were assigned the non-fasting condition. Participants were unaware that their time preference determined their condition assignment.

Fasting participants were instructed to eat a balanced breakfast and lunch but not to consume any food or beverage with the exception of water starting at 8:00pm the day prior to their participation; thus participants engaged in an approximately 15-hour fast. Non-fasting participants were instructed to eat balanced meals the day prior to their study visit as well as a “hearty” breakfast the morning of their participation. All participants were given guidelines, both verbal and via email, that described and provided examples of balanced meals and a “hearty” breakfast. These guidelines were established based on consultations with a nutritionist. Non-fasting participants were also made aware that they would be required to eat the study-provided breakfast (Boost shake and cereal bar) the morning of their participation. Providing breakfast ensures standardization of food intake and timing prior to administering the set-shifting task. During this informational phone call, all participants were also informed of the nature of blood glucose and that blood glucose is measured, in part, to discern adherence to the fasting protocols.

Upon their study visit and after providing informed consent, participants in the non-fasting condition were required to eat a breakfast consisting of the Boost shake and the cereal

bar, while participants in the fasting condition began the experimental protocol immediately. Further, in order for the glucose to be more fully metabolized, non-fasting participants waited 30 minutes between their breakfast consumption and the experimental protocol. During this time, all non-fasting participants were instructed to play solitaire on a computer so that the activities of this waiting period were standardized across participants.

The remainder of the protocol was identical for both fasting and non-fasting participants. First, the researcher measured the participant's blood glucose level by pricking a sanitized finger with the glucometer lancet. After the blood glucose test, the demographic questionnaire was administered via the online survey tool, Qualtrics.

Next, each participant viewed the affect clip for the affect induction condition she was randomly assigned to (positive, negative, or neutral). The clips were viewed full-screen on a Bardone-Cone lab computer monitor and each clip lasted approximately four minutes. Due to the transient nature of affect inductions, (Martin, 1990) participants were administered the WCST immediately after viewing the film clip.

Following the experimental protocol (i.e., affect clip and WCST) individuals completed a series of questionnaires via Qualtrics. These questionnaires assessed perfectionism and eating pathology. Finally, after completing the questionnaires, participants were debriefed about the nature of the study. For individuals in the fasting condition, a granola bar was provided to the participant before leaving. The non-fasting group completed the study in approximately 75 minutes (which included the 30-minute period for glucose metabolism) while the fasting group completed the study in approximately 45 minutes. See Figure 2 for a depiction of the Study 1 layout.

ANALYSES: STUDY 1

In order to determine the independent and combined effects of fasting and affect on set shifting ability (Hypothesis 1), a 2 (fasting, non-fasting) x 3 (negative, positive, neutral affect) ANOVA was performed. A significant interaction was followed up with pairwise comparisons using Tukey HSD tests. This allowed for testing main effects (e.g., fasting on set shifting) as well as the interactive effect of fasting and affect on set shifting, which is of central interest. Main effects were only interpreted if the interaction was not significant. The dependent variable, set shifting ability, was determined by calculating “perseverative errors” on the WCST (i.e., when a participant continues sorting response cards according to a matching rule after it has been changed). The relations between set shifting ability and blood glucose level (Hypothesis 2), perfectionism (Hypothesis 3), and eating pathology (Hypothesis 4) were examined via correlation analyses.

Due to the factors (i.e., fasting and affect) potentially differentially influencing the outcome variable (i.e., set shifting), the correlation analyses for Hypotheses 2, 3, and 4 were first performed within certain cells followed by correlations using the entire sample. For example, the relation between glucose level and set shifting was initially examined across fasting and non-fasting conditions but limited to the neutral affect condition. The relation between set shifting and perfectionism was initially examined in individuals in the “control” group (i.e., non-fasting, neutral affect). Perfectionism was investigated as an overall construct (MPS, PCI) and as a multidimensional construct (the six subscales of the MPS); correlation

strengths involving the varying dimensions of perfectionism and set shifting were statistically compared (Meng, Rosenthal, & Rubin, 1992). Eating pathology was initially examined in the "control" group. Of note, for those in the fasting condition, blood glucose levels were analyzed for protocol adherence so that individuals with fasting blood glucose levels above 100 mg/dl could be considered as possibly noncompliant and potentially removed from analyses. All analyses were done in SPSS.

RESULTS: STUDY 1

Demographic Data

The participants' mean age and BMI by fasting group are presented in Table 1. Independent samples t-tests determined that there were no differences between the fasting and non-fasting groups in age, $t(119) = -.40, p = .688$ or BMI, $t(119) = -1.08, p = .282$. Although the majority of participants were Caucasian non-Hispanic ($N = 90; 74.4\%$), a variety of ethnic and racial backgrounds were represented in this study: African American ($N = 12; 9.9\%$), Hispanic ($N = 9; 7.4\%$), Asian ($N = 8; 6.6\%$), and Middle Eastern ($N = 2; 1.7\%$).

Manipulation check

Regarding obtaining confirmation of adherence to the fasting condition, an independent samples t-test revealed that the fasting and non-fasting groups differed in their blood glucose levels, $t(69) = -11.70, p < .001$ with lower blood glucose levels in the fasting group ($M = 91.2$ mg/dL, $SD = 7.52$) compared to the non-fasting group ($M = 125.92$ mg/dL, $SD = 20.94$). Further, participants in the fasting condition with blood glucose levels above 100 mg/dl, the typical upper bound for fasting blood glucose levels, were considered for removal from analyses based on potential non-adherence. In total there were 6 participants with blood glucose levels over 100mg/dL ranging from 101-112mg/dL. Consultation with a nutritionist determined that these levels were not high enough to dictate exclusion from the analyses given normal individual variance in glucose levels and error rates of the glucometer.

No manipulation check was performed regarding the ability of the clips to induce the expected affect. This is because of the transient nature of the inductions which required administering the WCST immediately after the induction in order to adequately capture the effect of the induction on set shifting ability. Affect was assessed with the PANAS after the WCST; however, given the approximately 12-minute time lag between the induction and the PANAS, the scores on the PANAS likely do not reflect the affective experience caused by the induction. Earlier pilot data provided adequate evidence for using the selected clips.

Hypothesis 1: Fasting, Affect, and Set Shifting

A 2 (fasting, non-fasting) x 3 (positive, negative, neutral affect) ANOVA was conducted on the total number of WCST perseverative errors. There was no significant interaction effect between fasting and affect on set shifting, $F(2, 114) = 2.18, p = .118$, partial eta squared = .04. This indicates that the fasting and non-fasting conditions were not differentially affected by affect (negative, neutral, or positive affect inductions) in terms of set shifting ability. See Table 2 for the perseverative error means and standard deviations and Figure 3 for a graphical display of this pattern.

Despite the non-significant omnibus F, individuals randomized to the negative affect group demonstrated the greatest difference in perseverative errors between the fasting and non-fasting groups. Of note, the group with the most perseverative errors (fasting and negative affect induction) was the group predicted to perform most poorly on the WCST. Due to a non-significant interaction effect, main effects were then investigated. There was a non-significant main effect of fasting on set shifting ability, $F(1, 114) = 1.58, p = .212$, partial eta squared = .01, suggesting that regardless of eating balanced meals ($M = 6.70; SD = .54$) or fasting for 15 hours ($M = 7.64; SD = .52$), the number of perseverative errors on the

WCST remained statistically similar. Finally, there was a non-significant main effect of affect on set shifting ability, $F(2, 114) = .47$, $p = .628$, partial eta squared = .01, indicating that the negative ($M = 7.66$; $SD = .67$), neutral ($M = 6.77$; $SD = .66$), and positive ($M = 7.08$; $SD = .62$) affect induction groups also performed similarly on the WCST.

Hypothesis 2: Blood Glucose and Set Shifting

Given the non-significant effect of affect on set shifting, the relation between blood glucose level and set shifting was examined within the full sample rather than confining the analysis to neutral affect only. Pearson correlation analyses revealed that blood glucose level was not significantly related to how many perseverative errors were made on the WCST, $r = -.12$, $p = .227$.

Hypothesis 3: Perfectionism and Set Shifting

Again, given the non-significant effects of fasting and affect on set shifting, the relation between perfectionism and set shifting was explored within the entire sample rather than just the non-fasting, neutral subsample. Table 3 presents Pearson correlation analyses of the relation between the number of perseverative errors and various perfectionism measures such as the Frost Multidimensional Perfectionism Scale (Frost MPS; Frost et al., 1990) and the Perfectionism Cognitions Inventory (PCI; Flett et al., 1998). Of note, there were no significant correlations between the number of perseverative errors and any of the various perfectionism scales indicating that perfectionism is not related to set shifting ability in this sample.

Hypothesis 4: Disordered Eating and Set Shifting

Finally, there was no significant correlation between the Eating Attitudes Test -26 and the number of perseverative errors made on the WCST, $r = .17$, $p = .099$ suggesting that level of disordered eating pathology did not relate to set shifting ability.

DISCUSSION: STUDY 1

Study 1 experimentally investigated the role of fasting and affect on set shifting ability among undergraduate women. Although the primary hypotheses were not supported, notable patterns emerged and the findings highlight the complex quality of set shifting.

First, Study 1 found that there was no significant interaction between fasting and affect when examining set shifting. In other words, individuals who fasted for approximately 15 hours and individuals who ate balanced meals prior to the set shifting task were not differentially affected by affect (negative, neutral, or positive) in terms of set shifting ability on the WCST. Given the significance level of the interaction term ($p = .118$), it is possible that the study was underpowered although attempts were made to increase sample size. Power analyses determined that the power to detect a medium effect size given the present sample size ($N = 121$) and alpha of .05 was .68; the power to detect a small effect size was .11. Thus, we cannot completely rule out that there was a small or medium effect size in the current study.

The non-significant results do suggest, however, that those who are fasting and in a negative affective state perform statistically similarly on the WCST as individuals who consumed balanced meals and are in a positive affective state. The fasting/negative affect group was expected to perform more poorly on the WCST given that negative mood has been shown to impair set shifting in general and that when fasting, this negative mood was expected to become more pronounced due to the emotional dysregulation and negative mood that tend to co-occur with fasting (Kaye, Fudge, & Paulus, 2009; Wells, Read, Laugharne, &

Ahluwalia, 1998). In other words, the fasting/negative affect group was expected to feel particularly badly after viewing the induction clip, thus decreasing their ability to shift cognitive set. However, there is also a body of literature that recognizes increased alertness and mood enhancement during periods of deliberate fasting that are often associated with a cultural or religious undertone (Michalsen, 2010; Ponice, Albacht, & Leplow, 2005).

Although most connections of positive mood and fasting are concerned with prolonged fasting, there may be parallels to short-term fasting as well and future work will want to continue establishing the relation among fasting, malnutrition, and cognitive impairments.

Of note, a pattern emerged among the data such that those in the fasting and negative affect condition made more perseverative errors than those in any other interactive condition although the overall interaction term was non-significant. Further research may investigate this fasting/affect combination among a more severe population (i.e., individuals that are in fact malnourished and perhaps experiencing a more intense, prolonged negative affective state such as major depressive disorder). Of note, depressive symptoms (Harvey et al., 2004; Michopoulos, et al., 2006) and long-term stress (Nikiforuk & Popik, 2011; Orem, Petrac, & Bedwell, 2008) appear to create some set shifting impairment which suggests that a more prolonged, intense negative affective experience may play a role in set shifting ability.

Although evidence suggests that negative affect may reduce cognitive flexibility and the film clips from the current study have been shown to induce negative affect, the results from the current study indicate no significant main effect of affect on set shifting ability. In other words, collapsing data across fasting conditions, individuals that were exposed to the negative, neutral, and positive affect all performed similarly on the WCST. This contradictory finding may be due to several reasons. First, the WCST has been rarely used in

prior studies investigating affect and set shifting and a different pattern of findings may emerge (i.e., affect may not influence set shifting as strongly) when using a stringent measure of set shifting such as the WCST. Along these lines, the WCST may be capturing an aspect of set shifting that is dissimilar to the findings related to affect and the construct of cognitive rigidity most often reported in the literature. Second, the relative strengths of the three affect inductions were not investigated; as such, it is possible that the inductions were overall too weak and not differentiated enough to manifest as difficulty on the WCST. Third, an academic population of undergraduate women from a prestigious university may be driven to perform well on a task such as the WCST, thus overriding their affective experience.

There was also no significant main effect of fasting on set shifting ability. The literature includes mixed findings on the effects of fasting on cognitive rigidity and this study supports some previous findings that short-term fasting has limited, if any, effects on cognitive functioning in general (Euser et al., 2010; Green, Elliman, & Rogers, 2005). Care was taken within the current study to ensure an appropriately long fasting period (i.e., 15-hour fast), to consult with a nutritionist and be explicit with participants about what constituted appropriate food intake for their given condition, and to assess glucose levels to confirm blood sugar differences between the fasting and non-fasting groups. Interestingly, data have emerged from recent studies to suggest that malnutrition may not play a clear role in the set shifting deficits seen in AN (Roberts, Tchanturia, & Treasure, 2010). This parallels the current study's non-significant main effect of fasting on set shifting ability. However, evidence still suggests that set shifting ability is more impaired during the active stage of the disorder than during recovery stages when nutrition is restored. Given the current study's findings and recent findings that malnutrition may not play a role in set shifting deficits,

more work should investigate what brings about these impairments during the active phase if not low body weight or malnutrition. Other physiological correlates of the active eating disorder as well as psychological correlates of the active eating disorders (e.g., intense fear of gaining weight) may play a role in driving the set shifting difficulties noted during this stage of the eating disorder.

Together, the non-significant main effects of fasting and affect on set shifting ability speak to the notion that set shifting may have strong trait-like components and that temporary states (such as acute fasting and momentary affect changes) are not typically able to influence the way one is able to shift cognitive set.

Although perfectionism was examined as both a multidimensional and unidimensional construct in this study and was hypothesized to be a positive correlate of set shifting deficits, no significant correlation was found between set shifting ability and perfectionistic thoughts, attitudes or behaviors as measured by two different perfectionism questionnaires. Given the cognitive rigidity associated with both set shifting and perfectionistic tendencies, these results are surprising. However, one prior study relating perfectionism and set shifting found similar results using a unidimensional measure of perfectionism (Tchanturia et al., 2004). Perhaps, akin to multiple dimensions of perfectionism, there are multiple dimensions of set shifting ability and a cognitive task such as the WCST may capture a different mode of rigidity than a self-report perfectionism questionnaire. Indeed, there is evidence for at least two dimensions of set shifting (perceptual versus cognitive) (Tchanturia et al., 2004) and the WCST is likely to tap into the cognitive domain rather than the perceptual domain, which traditionally incorporates physiological sensations. It is interesting to consider multiple domains within cognitive set shifting as well,

although little research has fully explored this within the context of AN. Alternatively, there may be a discrepancy between one's insight of her perfectionistic rigidity as measured by a self-report measure and her rigidity as measured by an actual cognitive task. An interesting avenue of research may be to develop a task that captures dimensions of perfectionism, and to use that rather than a self-report questionnaire in relation to performance on this task to other cognitive tasks such as the WCST. Such a task might capture elements of perfectionism that are not elicited within self-report measures. Finally, although those with perfectionistic tendencies may exhibit a type of rigid thinking style, this rigidity is also purported to serve as a driving force behind success in areas such as academics. As such, individuals with perfectionism may be more invested and driven to perform well on a task such as the WCST. This focused, performance-driven rigidity may have allowed those high in perfectionism to make a similar number of perseverative errors on the WCST compared to their more cognitively relaxed, less rigid peers, explaining the near-zero correlation between the perfectionism measures and perseverative errors.

The final hypothesis proposed by Study 1, that eating disorder pathology and set shifting ability would be positively correlated, was also not supported. This finding does not corroborate prior literature which suggests that eating disorder severity and set shifting ability are related (Tchanturia, 2004). Interestingly, however, one study found that within an outpatient sample of females with anorexic symptoms, set-shifting performance on the WCST was not related to eating disorder symptom severity (Swanson, 2009). Further, Tchanturia et al. (2011) recently found that length of illness and BMI, two correlates of clinical severity, were not related to increased set shifting ability. The authors suggest that these findings highlight the trait nature of set shifting deficits in people with AN. It is

important to note that this sample of healthy control undergraduate women exhibited a narrow range of eating disorder pathology. For example, a score at or greater than 20 on the EAT-26 indicates problematic disordered eating behaviors and thoughts and only 2 participants in the current sample reported a score in this range with the average EAT-26 score much lower ($M=5.97$, $SD =6.00$) and 74% of participants clustered in the EAT-26 score range from 0-8. Given the limited range of pathology it is not necessarily surprising that a correlation did not emerge. Finally, a recent study found that adults with AN had significantly greater set shifting impairment relative to controls but that adolescents with AN did not differ in set shifting ability compared to matched healthy controls. This finding not only suggests that set shifting may be less pronounced in adolescents with AN, but also that within a sample of young females (such as the current undergraduate sample) set shifting deficits associated with patterns of disordered eating may not emerge until later adulthood after the illness has persisted (Shott et al., 2012).

METHODS: STUDY 2

Participants

Female undergraduates ($N = 146$) from the University of North Carolina participated in this study. The women were recruited from the Introductory Psychology participant research pool and received course credit for their participation. The Body Shame subscale of the Objectified Body Consciousness Scale (OBCS-BS; McKinley & Hyde, 1996) was administered to the participant pool via a mass online screening, in order to select individuals high and low in body shame for participation, since prior pilot work with undergraduate females that body shame emerged as a strong predictor of Time 2 body dissatisfaction ($\beta = .226$, $t(249) = 4.84$, $p = .000$) relative to other predictors such as perfectionism, thin ideal internalization, and body surveillance. See Table 4 for body dissatisfaction means before and after the induction for both the low body shame and high body shame groups. Based on pilot data and modifications due to distribution of scores for women in the introductory psychology classes, scores of 3.0 and lower captured the lowest quartile and scores of 4.0 and higher captured the highest quartile.

Measures

Body Shame. The Body Shame subscale of the Objectified Body Consciousness Scale (OBCS-BS; McKinley & Hyde, 1996) reflects the degree to which the pursuit of unattainable internalized standards of beauty results in feelings of shame about one's body. The eight items are assessed using a 1 (*strongly disagree*) to 7 (*strongly agree*) scale. The OBCS-BS has demonstrated good internal consistency ($\alpha = .75-.84$ for undergraduate

women), adequate test-retest reliability ($r = .79$), and adequate construct validity via correlations with measures of body esteem and appearance control (McKinley & Hyde, 1996). This measure was administered as part of the mass online screening for introductory psychology students, and participants were recruited for participation based on their scores (see ‘Participants’ section).

Demographics. A brief demographic questionnaire was administered containing items such as age, year in school, race/ethnicity, and self-reported height and weight.

Inductions. For the body dissatisfaction induction condition, a series of images portraying thin/athletic females was shown. Other researchers have used similar body dissatisfaction paradigms (Groesz, Levine, & Murnen, 2002; Wade, George & Atkinson, 2009) and this slideshow of images was shown to induce body dissatisfaction in females scoring high on body shame in pilot work (see Table 4).

To induce negative affect, a series of images selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) depicting a town devastated by a recent tornado were shown. These images were also pilot tested as a collective slideshow and produced appropriate levels of negative affect. T-tests revealed that the slideshow of IAPS images depicting storm damage led to a significant increase in negative affect, $t(12) = 4.86, p < .000$ with participants rating their pre-manipulation levels of negative affect ($M = 13.77, SD = 3.44$) lower than after viewing the images ($M = 18.08, SD = 5.42$). In addition, the images in the IAPS are well-validated for use in affect induction paradigms. Normed valence scores have been validated for each image with scores ranging from 1 to 10 with higher scores indicating more positive valence. The rankings of the tornado scene negative IAPS images for the current study ranged from 1.95 to 6.47 with an overall average ranking of 3.50

indicating a generally negative set of images. Additionally, the prompt at the beginning of the slideshow attempted to further bring the individual images together within a negative affect framework and possibly decrease the affective rating: “Every year, violent weather events such as tornadoes can wreck havoc on the lives of unsuspecting Americans. People suffer the loss of their belongings, homes, and even lives. The emotional aftermath of a tornado can be one of distress, sadness, and loss. The following images portray a tornado and the devastation it can inflict. The images will advance by themselves. Please attend to the images.”

Neutral images from the IAPS were selected to induce neutral affect. The images in the IAPS are well-validated for use in affect induction paradigms. Normed valence scores have been validated for each image with scores ranging from 1 to 10 with higher scores indicating more positive valence. The rankings of the neutral IAPS images for the current study ranged from 4.52 to 5.52 with an overall average ranking of 4.95 indicating a neutral set of images.

Body Dissatisfaction. Two items from Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994) were used to measure dissatisfaction with weight and shape. “How dissatisfied are you with your weight?” and “How dissatisfied are you with your shape?” with higher scores indicating higher dissatisfaction. Prior work has used these two items to assess body dissatisfaction (Heinberg & Thompson, 1995). In addition, two visual analogue scales (VAS) were used to measure dissatisfaction with weight and shape in the online survey: “Please slide the bar to indicate how dissatisfied you feel about your body *weight* right now” and “Please slide the bar to indicate how dissatisfied you feel about your body *shape* right now” with higher scores indicating higher satisfaction. In the current study, the EDE-Q and VAS item pairs were each averaged to develop an overall dissatisfaction

score. The two EDE-Q items demonstrated a strong correlation, $r = .614$, $p < .001$, as did the two VAS items, $r = .632$, $p < .001$.

Affect Ratings. The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) measured the affect experienced by participants. This 20-item scale comprises a positive affect and a negative affect mood scale. For each item participants report on how they feel “at this moment” using a response scale from 1 (*very slightly or not at all*) to 5 (*extremely*). Good reliability has been demonstrated (Positive Affect Scale, alphas ranging from .86-.90; Negative Affect Scale alphas ranging from .84-.87). In the current study the Positive Affect Scale had an alpha of .83 and the Negative Affect Scale an alpha of .73.

Self-reported Cognitive Flexibility. The Cognitive Flexibility Scale (CFS, Martin & Rubin, 1995) was designed to capture neurocognitive functioning in a less time consuming, more accessible modality than traditional neurocognitive tasks. This 12-item self-report questionnaire consists of statements that deal with beliefs and feelings about one’s own behavior (e.g., “I am willing to listen and consider alternatives for handling problems”) using a response scale from 1 (*Strongly Disagree*) to 6 (*Strongly Agree*) such that higher scores indicate higher cognitive flexibility. Within a college sample, the CFS has demonstrated adequate test-retest reliability over a one-week period ($r = .83$). The reliability in the current sample was fair, alpha = .63.

Body Rumination. The Body Rumination Scale was developed within the Bardone-Cone Lab for the purposes of this study. This 12-item scale is intended to capture ruminative thoughts specifically related to one’s weight and shape. Respondents are asked to rate the extent to which they agree “in the moment” to items such as, “My attention is focused on the

way my body looks,” using a response scale from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). In the current study, excellent reliability was demonstrated, $\alpha = .91$.

Set Shifting. As in Study 1, the perseverative error score on the Wisconsin Card Sorting Test (WCST; Heaton et al., 2003) was used to measure set shifting.

Disordered Eating. As in Study 1, the Eating Attitudes Test-26 (EAT-26; Garner et al., 1982) was used to assess level of disordered eating. The EAT-26 again demonstrated good reliability with an alpha of .86.

Procedure

Eligible participants (i.e., female undergraduates scoring in the upper and lower quartiles on the body shame measure based on pilot study cut-offs and modifications due to the distribution of scores in this sample) were invited to participate in Study 2 via email recruitment. After providing informed consent in the laboratory, participants were administered a demographic questionnaire via an online survey.

Next, each participant viewed the slideshow of images for the induction condition she was randomly assigned to (body dissatisfaction, negative, or neutral). The images were viewed full-screen on a computer monitor and each condition contained 15 images with the entire show lasting approximately four minutes. Due to the transient nature of inductions (Martin, 1990), participants were administered the WCST immediately after viewing the images.

Following the experimental protocol (i.e., body-related, negative affect, or neutral images and WCST) individuals were administered a body dissatisfaction VAS, the two body dissatisfaction items from the EDE-Q (Fairburn & Beglin, 1994), the Body Rumination Scale, the PANAS, the EAT-26 (Garner et al., 1982), and the CFS (Martin & Rubin, 1995)

via an online survey. Finally, after completing the questionnaires, participants were debriefed about the nature of the study and given the opportunity to ask questions regarding the study. Due to the presentation of thin/athletic female images to women high in body shame, care was taken to provide a thorough debriefing including information regarding referral sources and media literacy. Each study visit lasted approximately 40 minutes for all individuals. See Figure 4 for a depiction of the Study 2 layout.

ANALYSES: STUDY 2

In order to determine the independent and combined effects of body shame and induction (Hypothesis 1) a 2 (low body shame, high body shame) x 3 (body dissatisfaction, negative affect, neutral affect) ANOVA was performed along with follow-up Tukey tests given a significant interaction finding. This allowed for testing main effects (e.g., body shame on set shifting) as well as the interactive effect of body shame and induction on set shifting, which is of central interest. Main effects were only interpreted if the interaction was not significant. As in Study 1, the number of “perseverative errors” on the WCST was used as the key dependent variable.

Correlation analyses were performed to investigate the relation between the Cognitive Flexibility Scale and set shifting (Hypothesis 2). Due to the factors (i.e., level of body shame and induction) potentially differentially influencing the outcome variable (i.e., set shifting), the correlation analyses for Hypotheses 2 first focused on the correlations within certain control cells (i.e., low body shame/neutral affect) followed by correlations using the entire sample.

To test the Hypothesis 3a regarding comparing the high body shame/high rumination group and high body shame/low rumination group on set shifting, a median split separated women high in body shame into either low or high body rumination and a t-test was performed to investigate if these two groups differed in number of perseverative errors. Finally, one-way ANOVA was performed with follow-up Tukey tests to determine if those in the high body shame group randomized to the body dissatisfaction induction would endorse

higher levels of body rumination post induction relative to those with high body shame in the negative affect or neutral conditions (Hypothesis 3b).

RESULTS: STUDY 2

Demographic Data

The participants' mean age and BMI by body shame condition are presented in Table 5. Independent samples t-tests determined that there were no differences between the high body shame and low body shame groups in age $t(143) = -.74, p = .458$. However, the groups did differ in BMI $t(143) = -2.27, p = .025$ with individuals in the high body shame group reporting a higher average BMI than those in the low body shame group, although both BMIs were in a healthy range. Although the majority of participants were Caucasian non-Hispanic ($N = 96; 65.8\%$), a variety of ethnic and racial backgrounds were represented in this study: African American ($N = 20; 13.7\%$), Hispanic ($N = 11; 7.5\%$), Asian ($N = 9; 6.2\%$), multi-racial ($N = 7; 4.8\%$), Native American ($N = 1; 0.7\%$), and Eastern European ($N = 1; 0.7\%$), and Middle Eastern ($N = 1; 0.7\%$).

Manipulation Check

To confirm that the OBCS Body Shame scale differentiated the high and low body shame groups as women with distinct perceptions regarding the appearance of their bodies, independent t-tests were performed in the current sample. These t-tests indicate that women in the high body shame group were more dissatisfied with their weight and shape on both the VAS items, $t(144) = 5.63, p < .001$ and the EDE-Q items, $t(144) = -6.122, p < .001$ with women in the body shame group feeling more dissatisfied on the VAS ($M = 4.68, SD = 1.88$) and EDE-Q items ($M = 4.02, SD = 1.36$) relative to women with low body shame on the VAS ($M = 6.39, SD = 1.73$) and EDE-Q items ($M = 2.75, SD = 1.10$). Of note, higher scores on the

VAS indicate higher body satisfaction and higher scores on the EDE-Q indicate lower body dissatisfaction. In addition, there were significant differences in the EAT-26, $t(127) = -5.97$, $p < .001$ where women in the high body shame group endorsed significantly higher levels of eating pathology ($M = 11.37$, $SD = 3.69$) than those in the low body shame group ($M = 3.69$, $SD = 3.57$). These findings increase our confidence of the validity of the high and low body shame groups.

Hypothesis 1: Body Shame, Body Dissatisfaction, and Set Shifting

A 2 (high body shame, low body shame) x 3 (body dissatisfaction, negative affect, neutral affect) ANOVA was conducted on the total number of WCST perseverative errors. There was a significant interaction effect between body shame and induction on set shifting, $F(2, 140) = 6.49$, $p = .002$, partial $\eta^2 = .09$. This indicates that the two levels of body shame (high and low) were differentially affected by the inductions (body dissatisfaction, negative, or neutral) in terms of set shifting ability. See Figure 5 and Table 6 for a visual depiction of the interaction from Study 2 Hypothesis 1 and for the perseverative error means and standard deviations.

To further explore group differences of this interaction effect a Tukey's honestly significant difference (HSD) post-hoc test was performed. The HSD critical value was hand computed at 3.75 (Maxwell & Delaney, 2004) meaning that any two cells that have a mean difference in raw perseverative error scores greater than or equal to the HSD critical value are considered significantly different from each other. The largest mean difference was between the high and low body shame conditions within the body dissatisfaction induction group at 3.43 perseverative errors. This largest mean difference between cells did not exceed

the critical value of 3.75 suggesting that none of the groups truly differ in the number of perseverative errors made.

Alternative approaches were then used to explore mean differences in a less statistically stringent fashion but with the aim of generating hypotheses for further research. Separate one-way ANOVAs with Tukey post hoc tests were performed within each level of body shame. Although the risk of Type I error increases when performing multiple statistical analyses, this series of analyses may also shed light on preliminary findings worthy of future exploration. When investigating only those in the low body shame group, there were significant group differences $F(2, 62) = 4.52, p = .015$. Post-hoc Tukey's tests showed that those with low body shame who viewed the neutral images made significantly more perseverative errors ($M = 9.50, SD = 5.79$) than those in the negative affect group ($M = 6.65, SD = 2.83$) as well as the body dissatisfaction group ($M = 6.18, SD = 2.22$). No other group differences emerged within the low body shame group. For those in only the high body shame group, there were also significant group differences $F(2, 78) = 3.46, p = .036$. Post-hoc Tukey's tests showed that those with high body shame who viewed the body dissatisfaction images made significantly more perseverative errors ($M = 9.62, SD = 8.03$) than those in the neutral affect group ($M = 6.23, SD = 2.56$) but not compared to those in the negative affect group ($M = 6.84, SD = 2.70$). No other group differences emerged within the high body shame group. Of note, for those high in body shame, both acute body dissatisfaction and negative affect may have driven more perseverative errors; this pattern did not emerge for individuals low in body shame where only the neutral affect group appeared to make perseverative errors. Due to a significant interaction effect, main effects were not investigated.

Due to the unexpected findings in the neutral affect condition for the low body shame group, additional exploratory analyses were performed. First, two outliers were identified in the low body shame/neutral affect induction combined group upon examination of a normal Q-Q plot; these two participants made 21 and 25 perseverative errors with the remaining participants ranging from 3 to 15 errors with 77% of individual making 8 or fewer perseverative errors. When these two cases were excluded, the 2x3 ANOVA omnibus F-statistic remained significant, $F(2, 138) = 4.47, p = .013$, partial eta = .06. See Figure 6 for a graphical representation of this interaction. However, when running a one-way ANOVA on the low body shame group, group differences became non-significant, $F(2, 60) = 2.05, p = .137$ suggesting that those low in body shame made a similar amount of perseverative errors, regardless of whether they were exposed to the body dissatisfaction, negative affect, or neutral affect inductions.

Hypothesis 2: Cognitive Flexibility Scale (CFS) and the Wisconsin Card Sort Test

The relation between the CFS and the WCST was primarily examined within the low body shame and neutral affect induction group as that group theoretically serves as the control condition. Pearson correlation analyses revealed that scores on the CFS were not significantly related to how many perseverative errors were made on the WCST, $r = -.14, p = .549$ suggesting that this self report measure of cognitive flexibility and the WCST computerized task assessing set shifting ability are not related. However, when investigating the low body shame/neutral affect induction group and excluding the two outlying cases, the Pearson correlation analyses showed that the CFS was indeed significantly related to the WCST, $r = -.56, p = .015$ such that the more cognitive flexibility that was reported via the CFS, the lower number of perseverative performed on the WCST. This interpretation

suggests that the CFS and WCST may indeed capture similar components of the cognitive rigidity-set shifting complex and helps provide validation for the use of such a self-report measure.

Hypothesis 3: Body Dissatisfaction Induction and Body Rumination

To examine whether those with high body shame and high rumination exhibit more perseverative errors than those with high body shame and low rumination, the high body shame group was split into high and low body rumination groups using median splits. An independent t-test revealed that those in the high body rumination group made significantly more perseverative errors ($M = 8.11, SD = 5.89$) than those in the low body rumination group ($M = 5.95, SD = 1.66$), $t(76) = -2.55, p = .013$. This finding suggests that for those who feel shameful about their bodies, higher levels of rumination may reflect a more impaired set shifting ability.

Contrary to the original hypothesis, a one-way ANOVA showed that those with high body shame who viewed the body dissatisfaction induction did not report higher levels of body rumination ($M = 50.92, SD = 8.00$) relative to those with high body shame who viewed the negative affect images ($M = 49.40, SD = 8.40$) or the neutral images ($M = 49.79, SD = 7.36$), $F(2, 77) = .26, p = .773$. This suggests that negative, cognitive rumination regarding one's body may not be particularly activated by a short, acute body dissatisfaction induction.

DISCUSSION: STUDY 2

Study 2 experimentally investigated the combined role of body shame and acute body dissatisfaction or negative affect on set shifting ability among undergraduate women. The patterns of significance suggest that feeling acutely dissatisfied with your body has the potential to reduce one's ability to shift cognitive set in a vulnerable sample as determined by high body shame.

Study 2 found that there was a significant interaction between body shame and induction-type (body dissatisfaction, negative affect, or neutral affect) on set shifting ability. However, a conservative estimate of significant mean difference, Tukey's HSD, was calculated and results showed that none of the groups were significantly different. In other words, regardless of body shame and induction groupings, all performed similarly on the WCST perseverative errors task. This finding contradicts the original hypotheses and there are potential statistical and methodological reasons for these null comparison findings. This result could have emerged because although the omnibus F acts as a single test and does not need to control for multiple comparisons, Tukey's HSD reduces the chance of finding a difference among a pair of groups by chance by controlling for multiple comparisons. Methodologically, given the analogous, exploratory nature of the study, perhaps the body dissatisfaction and negative affect inductions felt too contrived or sterile for participants. For example, actively comparing one's self to an appearance-admired peer or celebrity may generate greater dissatisfaction and negative affect surrounding one's body than viewing images of thin women in the lab with the real-life comparisons promoting greater difficulty

in set shifting. Although the experimental design was rigorously enacted, the internal validity of the study likely reduced external validity.

However, upon investigation of less stringent statistical comparisons, post-hoc tests revealed that those in the high body shame group who viewed the body dissatisfaction images made more perseverative errors than those in the high body shame group who viewed neutral images. Statistically, in the high body shame condition, poorer set shifting performance when acutely body dissatisfied may be linked to the experience of negative affect so much so that body dissatisfaction does not contribute to set shifting difficulties above and beyond negative affect. Negative affect is related to increased cognitive rigidity (Ashby et al., 1999; Bass et al., 2008; Frederickson, 1998;) and body dissatisfaction is most often understood as containing elements of negative affective experiences (Stice & Shaw, 2002). The general experience of negative affect may be just as powerful in inducing a type of cognitive derailment as acute body dissatisfaction in women high in body shame.

That said, it is important to note that inspection of the mean perseverative error findings indicates that those in the high body shame/body dissatisfaction group make more perseverative errors than those in the high body shame/negative affect group (see Table 6). In other words, although not statistically significant in the current study, the direction of the effects suggests that body dissatisfaction may induce cognitive rigidity above and beyond negative affect alone. This would make theoretical sense given the value and import often placed upon appearance by women that are particularly ashamed of their weight and shape. When such a specific, vulnerable component of self (i.e., appearance) is negatively targeted, the emotional-cognitive impact is more likely greater than the impact created by a broader target (general sadness) and is an area worthy of future study.

In addition, the current study found that women high in body shame with high rumination levels made more perseverative errors than women high in body shame with lower levels of body rumination. This suggests that thinking about one's body over and over again in a negative, unforgiving fashion may contribute to or reflect cognitive impairment. One can imagine that unrelenting negative thoughts about one's appearance may override cognitive resources to the point that shifting mental set becomes more difficult. Conversely, one can imagine that these unrelenting ruminative thoughts about one's body reflect the underlying construct of set shifting impairment (i.e., unable to shift cognitive set from such thoughts). Future research may want to further explore the directionality between rumination and set shifting difficulties. Together, the findings that negative affect, body dissatisfaction, and body rumination may play a role in the increased perseverative errors seen in those high in body shame lends credence to the idea that body dissatisfaction is indeed a complex, cognitive-affective construct and that both affective and cognitive elements may contribute to declines in cognitive performance.

In sum, although no group differences emerged in the original Tukey HSD post-hoc analyses, further exploration of one-way ANOVAs suggest that those high in body shame who are acutely body dissatisfied may make more perseverative errors than those in a neutral affect condition. However, the body dissatisfaction condition did not differ from the negative affect condition suggesting that body dissatisfaction and negative affect may contribute similarly to set shifting impairment. In contrast, the finding of higher perseverative error mean scores within the high body shame/body dissatisfaction group relative to the high body shame/negative affect group, albeit non-significant, may suggest that body dissatisfaction delivers a stronger blow to set shifting ability than negative affect among women that are

ashamed of their bodies. Finally, ruminating about one's body in a negative fashion is related to increased perseverative errors in women high in body shame relative to women high in body shame that ruminate less.

Another pattern of results worthy of discussion involves those in the low body shame group that viewed the neutral images. The one-way ANOVA with Tukey follow-up comparison tests showed that this group performed worse on the WCST compared to those in both the negative affect group and body dissatisfaction group, which did not differ. Although the neutral affect induction was intended to affect the low and high body shame groups similarly such that both groups made low perseverative errors on the WCST, perhaps the low body shame group was affected in a different way due to methodological issues with the induction paradigm. Indeed, the neutral affect induction was not pilot tested although the images did come from a normed database (the IAPS).

One theoretical posit for this differential experience for the high and low body shame groups may be that those low in body shame were bored while viewing the neutral images while those high in body shame may have experienced a type of relief or escape from feeling body dissatisfied. As such, this specific type of negative affect, boredom, experienced by those with low body shame while viewing the neutral affect clip may have contributed to poorer set shifting ability on the WCST. However, post-hoc investigations found that the low body shame group reported statistically similar levels of positive and negative affect after viewing the neutral images and taking the WCST as the high body shame group. Further, item-level investigation showed that the low and high body shame groups randomized to the neutral affect condition reported statistically similar levels of boredom. As such, we may conclude that the differential effect of the neutral induction across these two groups may not

have been due to different affective experiences. However, the PANAS was administered after both the induction and the WCST when the effects of the induction on affect will have likely dampened or disappeared.

Study 2 also investigated the ability of a self-report measure of cognitive flexibility to parallel findings on a computerized set-shifting task. Given the financial and time expenditure to administer the WCST, identifying and validating a self-report measure to capture set shifting difficulties is important. Initial results showed that within the low body shame/neutral affect group, no correlation emerged between the self-report CFS measure and the WCST cognitive task. Methodologically, a smaller relation is expected when comparing two different modalities (i.e., a task and a self-report measure of a similar construct will correlate to a lesser extent than two self-report measures of a similar construct). However, it is worthy of note that a self-report measure of cognitive flexibility and a cognitive task that assesses set shifting were unrelated. This may have implications for study designs that choose to use one modality of assessment in lieu of other measures. This nonsignificant correlation may be due to individuals not having the insight to evaluate their own cognitive rigidity; diminishing the validity of self-report. Further, the CFS and the WCST may be targeting distinct aspects of cognitive rigidity such that any relation is diluted. Interestingly, when two outlying cases were considered and excluded, the data suggest that the CFS and WCST may indeed tap into a similar construct. Future research should continue investigating how self-report and task-oriented measures of rigidity and set shifting align and if such measures can be used independently or if there is incremental validity of using such measures in tandem. Finally, a recent self-report measure that attempts to capture cognitive rigidity/set shifting has been created, the Detail and Flexibility Questionnaire (DFlex; Roberts, Barthel,

Lopez, Tchanturia, & Treasure, 2011). This new measure of cognitive rigidity has been validated with some set shifting tasks but has yet to be compared to the WCST.

GENERAL DISCUSSION

The current pair of studies investigated ways in which set shifting, a cognitive style often impaired in individuals with anorexia nervosa, may become more impaired or, alternatively, ameliorated. Hypotheses pertaining to set shifting ability were explored within a population of undergraduate women. Results from Study 1 indicated that the combined and independent effects of fasting and affect (positive, negative, and neutral) did not appear to worsen or improve set shifting ability. The findings from Study 2 preliminarily suggest that for women who endorse high body shame, feelings of acute body dissatisfaction may indeed impair set shifting.

Strengths

The study of neurocognitive constructs is limited in the field of eating disorders and few experimental designs with this focus have been implemented; as such, this set of studies contributes to a young body of literature examining cognitive constructs and disordered eating. Further, no study has investigated what factors may exacerbate or ameliorate set shifting as related to eating disorders and the current study set out to explore three factors independently and in tandem: fasting, affect, and body dissatisfaction testing both interactions and main effects. The rigorous experimental design is also a strength of the studies.

Additional factors beyond the experimental variables, such as dimensions of perfectionism, ruminative thought styles, and self-report measures of cognitive rigidity were explored. The examination of these factors in relation to set shifting has been rarely, if ever,

explored. Many of the studies that have investigated set shifting in relation to disordered eating populations have used a variety of set shifting measures. However, the use of the WCST has been limited. Incorporating a stringent, validated measure of set shifting, the WCST, expands our knowledge and interpretation of set shifting among this population.

Finally, although disadvantageous in some respects, the use of undergraduate women allows for more generalized results across a larger population than investigating set shifting only among those with disordered eating. Acute fasting, body dissatisfaction, and negative affect are not uncommon in college women; thus the variables investigated in the current studies not only act as analogous to a disordered eating population, but are also relevant to a wider class of individuals. In addition, few studies investigating set shifting in the context of disordered eating have used general samples as analogue samples. In addition,

Limitations

The use of an undergraduate sample can also be seen as a limitation. Given the strong interest in the relation between set shifting and factors associated with disordered eating, investigation of these hypotheses within a clinical sample may have yielded different results. The experimental designs attempted to induce physical, cognitive and affective experiences that parallel the experiences of individuals with disordered eating yet the studies acted as analogues rather than reflective of true experiences (e.g., prolonged, severe caloric restriction or chronic depressed mood). In addition, this undergraduate sample was largely homogenous in terms of race/ethnicity, and educational experiences.

An important limitation to note within both Studies 1 and 2 is the limited range of negative affect elicited by the induction paradigms. Both “The Champ” and the tornado images generally tapped into sadness-related negative affect. However, negative affect can be

induced in a variety of more specific fashions (e.g., anger, frustration, embarrassment, boredom, etc.) which were not investigated.

Additional limitations include the lack of manipulation checks for the induction paradigms in the current studies. Since inductions (affective or body-oriented) typically do not endure for more than a few minutes, the WCST was administered immediately after the induction rather than testing affect or body dissatisfaction immediately after the induction. Although many of the inductions were piloted, more rigorous pilot testing may have improved not only the potency of the inductions but also ensure consistent strength across inductions. Further, although comparing the CFS with the WCST is novel and adds to the literature, the study could have also incorporated a newly published measure of cognitive flexibility, the Detail and Flexibility Questionnaire (DFlex; Roberts et al., 2011). Investigation of this more recent self-report measure may have been more relevant to the current body of set shifting literature. Finally, although the WCST provides multiple scales and interpretations, given the theoretical emphasis on set shifting, the most valued variable in the current study was perseverative errors. Due to the experimental design and theoretical foundation, there were limited outcome variables to explore. Given these limitations, certain aspects of the study could be retrospectively improved, such as incorporating more stringent pilot testing of induction paradigms, incorporating additional self-report measures of cognitive flexibility (e.g., the DFlex), and inclusion of additional outcome measures.

Finally, it is important to consider the nature of the dependent variable in the current study: the number of perseverative errors made during the WCST. The current sample of healthy undergraduate women made fewer perseverative errors as a whole in both Study 1 ($M = 7.19, SD = 4.08$) and Study 2 ($M = 7.45, SD = 4.70$) than the WCST normative number of

perseverative errors for the same age range ($M = 12.05$, $SD = 7.86$). From a T-score perspective, the average T-score for perseverative errors in the Study 1 was 61.32 which suggests the sample was a full standard deviation above-average (in the 88th percentile) in terms of performance on the WCST. A similar T-score was found for Study 2, also indicating above-average performance on the WCST. This above-average performance may indicate that the current sample is more cognitively oriented to successfully completing tasks such as the WCST. Indeed, there is some evidence that individuals with higher intelligence outperform those with lower or average intelligence on the WCST, including the making of perseverative errors (Arffa, 2007; Arffa, Lovell, Podell, & Goldberg, 1998), although not all studies have found this relation (Boone, Ghaffarian, Lesser, Hill-Gutierrez, & Berman, 1993). Further, one study found that women may outperform men on a variety of WCST subtests, including perseverative errors (Boone et al., 1993). As such, educated, intelligent female undergraduates may be especially adept at sorting cards in the WCST and also more able to cognitively overcome the affective states induced in the current study.

Future Research

The results from the current set of studies incite interesting avenues for future research. One area of interest may be to explore subjective feelings of hunger, rather than fasting, as a potential influencer of set shifting difficulty. The desire to meet basic needs may override one's ability to think flexibly or creatively and such distraction may contribute to poor set shifting. In fact, one experimental study found preliminary evidence for hunger in part contributing to poor cognitive flexibility (Piech, Hampshire, Owen, & Parkinson, 2009). Such experimental designs provide valuable information about causal relations but may be limited in their generalizability. In the current study, body dissatisfaction and affect were

largely investigated within a controlled experimental design, and were thus potentially restricted in their ability to stimulate genuine, sustained feelings of dissatisfaction or sadness. Other experimental designs may improve this limitation, such as employing confederates to induce body dissatisfaction or a type of interpersonal negative affect in the participants. Negative affect stemming from interpersonal discord, such as embarrassment, shame, or guilt, may be an especially powerful induction mechanism particularly among those with high social perfectionism and individuals that engage in high levels of social comparison.

In addition, although not necessarily within an experimental framework, it would be valuable to investigate the relation between depression (prolonged negative affect) and set shifting within a population of individuals with AN (prolonged fasting and more intense body dissatisfaction).

Finally, although Study 1 indicated a limited relation between perfectionism and set shifting it may be worthwhile to more fully examine aspects of set shifting and perfectionism in tandem. Specifically, the “concern over mistakes” perfectionistic presentation may be more strongly heritable than other domains (Tozzi et al., 2004) and given the heritability of set shifting deficits, it would be interesting to explore any common genetic pathway shared by “concern over mistakes” and set shifting difficulty.

Clinical Implications

Clinical reports of cognitive rigidity within AN populations provided a general impetus for the hypotheses proposed in the current studies and although the current study did not investigate an AN population directly, various clinical implications are still worthy of note. Results from Study 1 (i.e., that fasting and affect are limited in their influence on set shifting ability) indicate that the combined effect of acute fasting and negative affect may not

impact one's ability to efficiently shift mental set as originally hypothesized. Clinicians may be advised that although certainly problematic, the restricted eating exhibited by individuals with disordered eating and those in the process of recovery may not impair the ability to shift cognitive set and that certain cognitive therapies may work well under such conditions.

However, it is important to note that the current study investigated acute fasting in a sample of healthy undergraduate women. Future research may want to more closely investigate the impact of prolonged restriction associated with low weight and its impact on set shifting ability.

Results from Study 2 speak to the impact of acute body dissatisfaction and negative affect in women high in body shame. Clinically speaking, a client high in body shame who is actively, acutely struggling with body concerns (e.g., has been comparing herself to her thin roommate or is distressed about wearing a swimsuit in public) or experiencing a negative affective state (e.g., is saddened by an interpersonal conflict or feels anxious about an upcoming exam) may have more difficulty shifting set within a therapy session and adopting alternative outlooks on her current cognitions. This rigidity may undermine the basic cognitive-behavioral therapeutic style; as such, alternative approaches such as values-based therapies (e.g., acceptance and commitment therapy (ACT)) or motivational interviewing techniques may improve the therapeutic process and foster a healthier rapport between client and therapist.

Additionally, the use of cognitive remediation therapy (CRT) may benefit those with set shifting difficulties. CRT is designed to improve neurocognitive functioning and has been shown to improve cognitive flexibility in individuals with schizophrenia (Wykes, Reeder, William, Corner, Rice, & Everitt, 2003). In a preliminary investigation of CRT for

individuals with AN, participants showed improved set shifting performance after 10 treatment sessions (Tchanturia, Davies, & Campbell, 2007). Implementation of CRT may enhance cognitive flexibility to a level more suitable for the restructuring and challenging of thoughts so vital to CBT success. In other words, carrying out CRT prior to CBT may in fact increase the effectiveness of CBT for AN (i.e., greater ability to actively restructure or challenge thoughts) and provide a much needed bridge from cognitive theory to successful treatment (Money, Davies, & Tchanturia, 2011). A major tenet of CRT is to increase cognitive awareness in individuals. This upsurge in meta-cognition is thought to enhance awareness of one's own strengths and shortages and to then apply inherent and learned skills to better interact with self, others, and environment.

Conclusion

Given the rigid, narrow cognitions often documented in individuals with AN and the current ineffectiveness of cognitive treatments for AN, better understanding set shifting ability and factors such as fasting, affect, and body dissatisfaction that may exacerbate or ameliorate this neurocognitive deficit is warranted. Study 1 found that neither acute fasting nor affect, independently or in combination, appear to influence set shifting ability.

Interestingly, however, the group with the highest perseverative error mean (fasting/negative affect) was indeed the group hypothesized to do the most poorly on the WCST. Further exploration is warranted. Finally, perfectionism and disordered eating severity were not related to set shifting ability. Findings from Study 1 emphasize the persistent, trait-like quality of set shifting.

Study 2 found that there was an interactive effect of body shame and induction-type (body dissatisfaction, negative affect, neutral affect), with some evidence to suggest that

those high in body shame that viewed the body dissatisfaction induction made more perseverative errors than those high in body shame that viewed the neutral induction, but not more so than those that viewed the negative affect induction. This suggests that a vulnerable population (i.e., body shameful) that is acutely body dissatisfied may indeed have difficulty shifting set with negative affect speculated to play a role in this. Thinking style also appears to play a role in set shifting ability for those high in body shame as higher levels of body rumination within this group are related to higher perseverative errors on the WCST relative to a group low in rumination. Together, these findings indicate that activating the cognitive-affective construct of body dissatisfaction may debilitate some individuals' ability to effectively shift set.

Overall, this set of studies investigating factors that may influence set shifting adds to the dearth of data related to set shifting and AN and presents interesting avenues of future research and clinical implications.

Table 1

Study 1: Demographic Data

	Age	BMI
Fasting Group (<i>N</i> = 61)	18.59 (.80)	22.74 (2.72)
Non-fasting Group (<i>N</i> = 60)	18.67 (1.24)	23.63 (4.41)

Table 2

Study 1: Means, Standard Deviation, and Range of Perseverative Errors for Hypothesis 1 Interaction Effects

	Fasting	Non-fasting
Positive Affect	6.79 (.93) Range (4.00-11.00) (N = 19)	7.36 (.81) Range (4.00-21.00) (N = 25)
Negative Affect	9.21 (.93) Range (4.00-27.00) (N = 19)	6.11 (.96) Range (2.00-13.00) (N = 18)
Neutral Affect	6.91 (.85) Range (4.00-20.00) (N = 23)	6.62 (1.01) Range (3.00-14.00) (N = 16)

Table 3

Study 1: Correlation Table for Set Shifting and Perfectionism Measures

	WCST Perseverative Errors
Frost CM	.03
Frost PS	-.02
Frost PE	.07
Frost PC	.01
Frost DA	.06
Frost O	.03
Frost Total	.05
PCI Total	.05

Note. None of the *r* values reached significance.

WCST = Wisconsin Card Sorting Test; CM = Concern Over Mistakes; PS = Personal Standards; PE = Parental Expectations; PC = Parental Criticism; DA = Doubts About Actions; O = Organization; PCI = Perfectionism Cognitions Inventory

Table 4

Study 1: Means and Standard Deviations Before and After the Body Dissatisfaction Induction for Those High in Body Shame and Low in Body Shame.

	Time 1 Body Dissatisfaction		Time 2 Body Dissatisfaction		$\Delta M, T2-T1$	<i>t</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Bottom Quartile (OBCS Body Shame < 2.25)	2.75	1.03	2.82	1.29	.07	.63
Top Quartile (OBCS Body Shame > 4.00)	4.88	1.48	5.45	1.51	.57	3.25**

Note: ** $p < .01$

Table 5

Study 2: Demographic Data

	Age	BMI
Low Body Shame (<i>N</i> = 65)	18.83 (1.11)	21.89 (2.37)
High Body Shame (<i>N</i> = 81)	18.96 (1.07)	23.03 (3.43)

Table 6

Study 2: Means, Standard Deviation, and Range of Perseverative Errors for Hypothesis 1 Interaction Effects

	Low Body Shame	High Body Shame
Body Dissatisfaction	6.18 (2.22) Range (3.00-12.00) (N = 22)	9.62 (8.03) Range (4.00-36.00) (N = 26)
Negative Affect	6.65 (2.83) Range (4.00-15.00) (N = 23)	6.84 (2.70) Range (4.00-15.00) (N = 25)
Neutral Affect	9.50 (5.79) Range (4.00-25.00) (N = 20)	6.23 (2.56) Range (3.00-14.00) (N = 30)

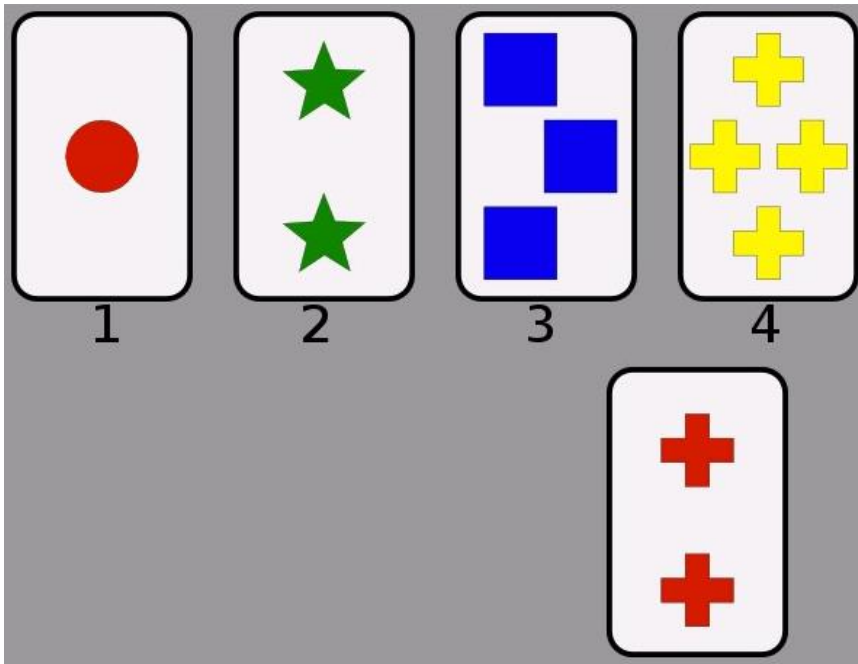


Figure 1: Pictorial representation of Wisconsin Card Sort Test (Heaton et al., 1993). The participant will attempt to correctly match a card from her stack of cards (bottom right) to the appropriate stack (stacks 1, 2, 3, or 4). The correct matching rule will change throughout the test.

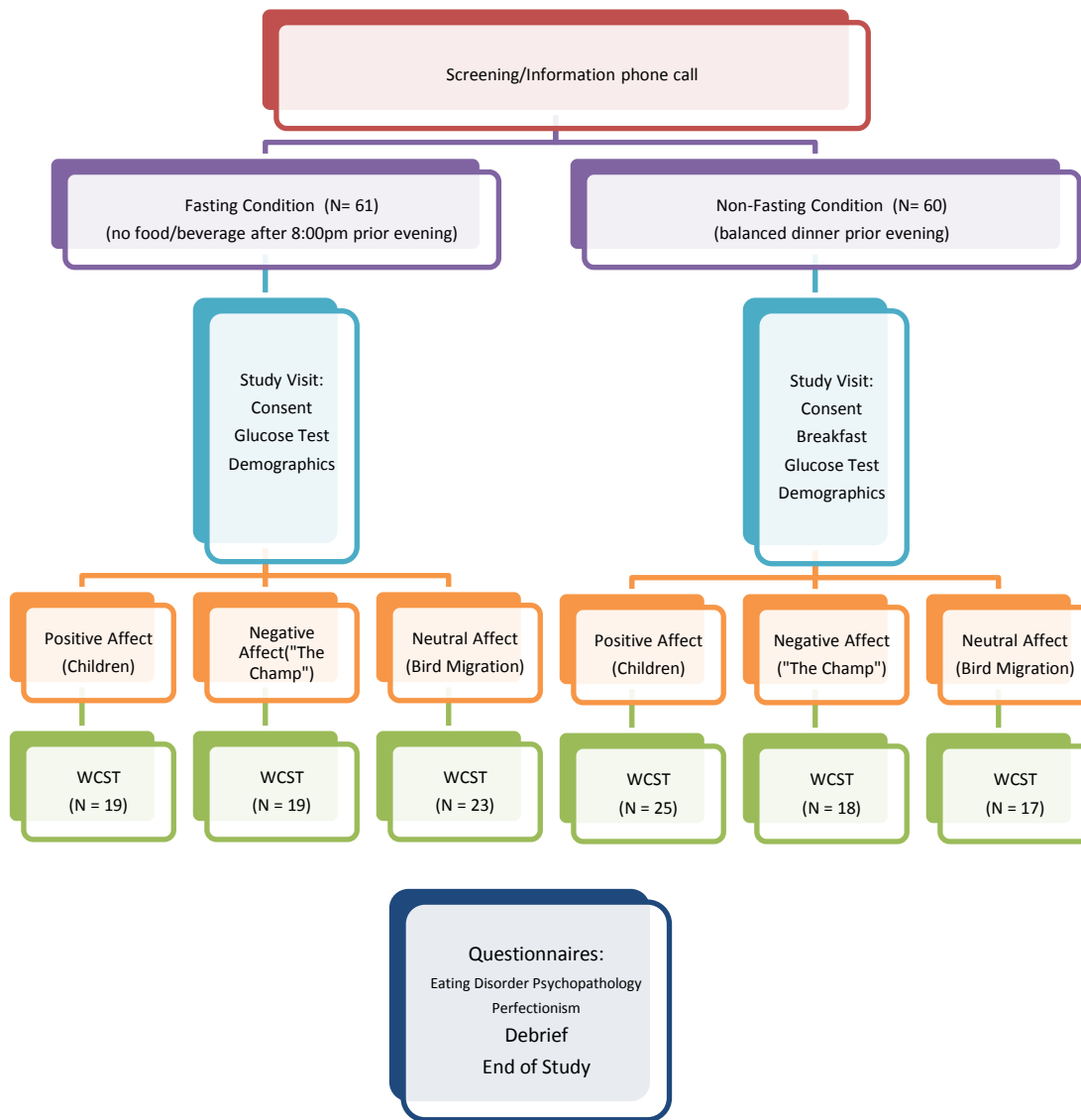


Figure 2: Representation of Study 1

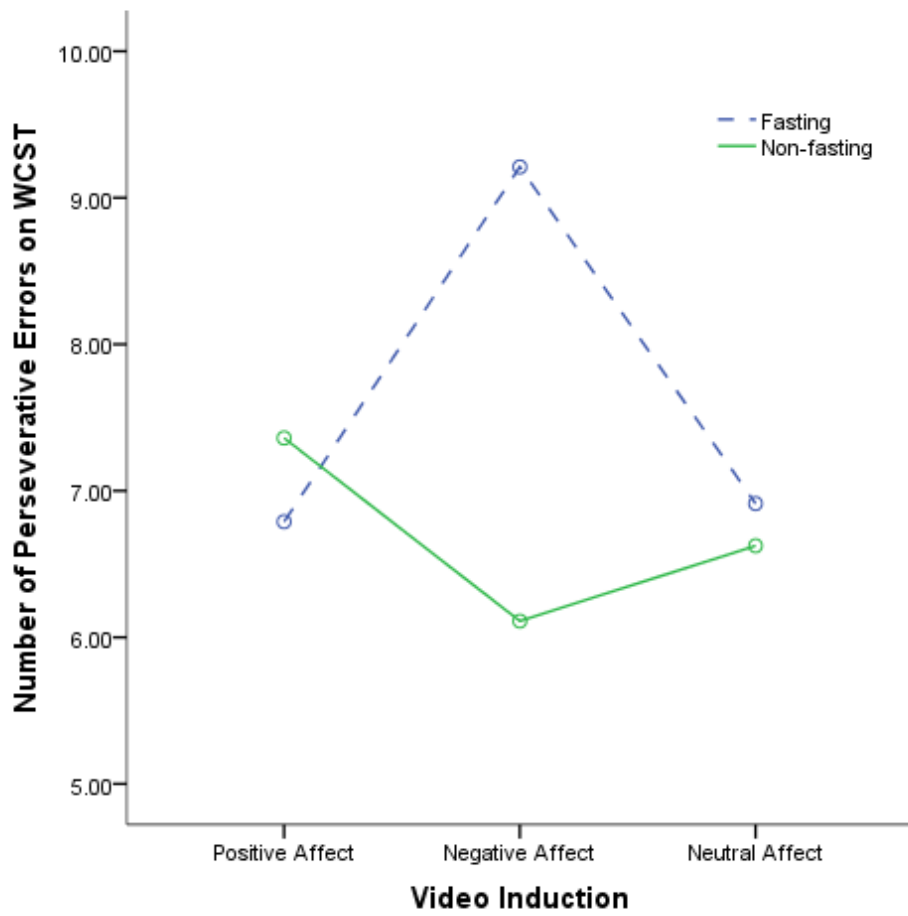


Figure 3: Interaction graph for Study 1, Hypothesis 1: The interaction between fasting and affect on perseverative errors. Of note, the interaction is non-significant.

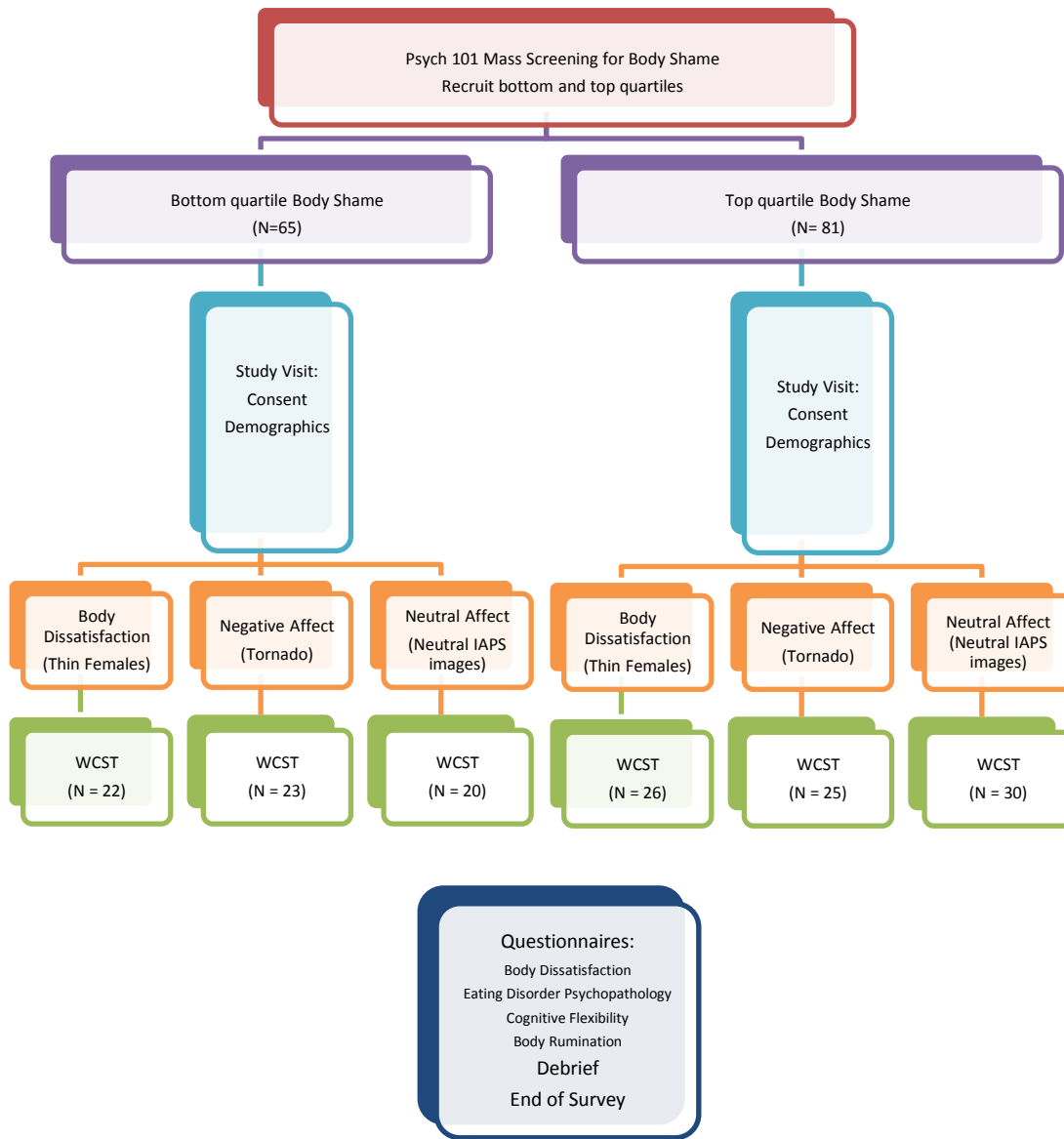


Figure 4: Representation of Study 2

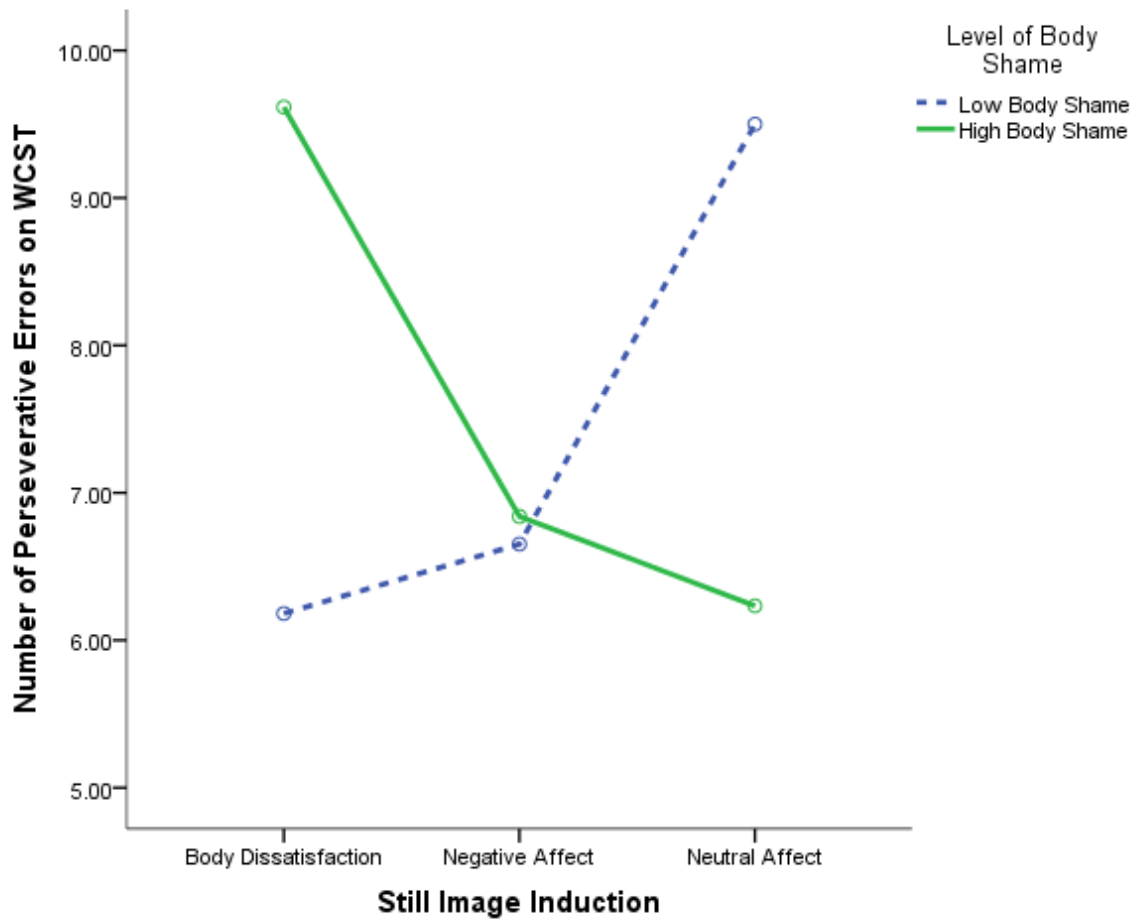


Figure 5: Interaction graph for Study 2, Hypothesis 1: The interaction between body shame and induction type on perseverative errors.

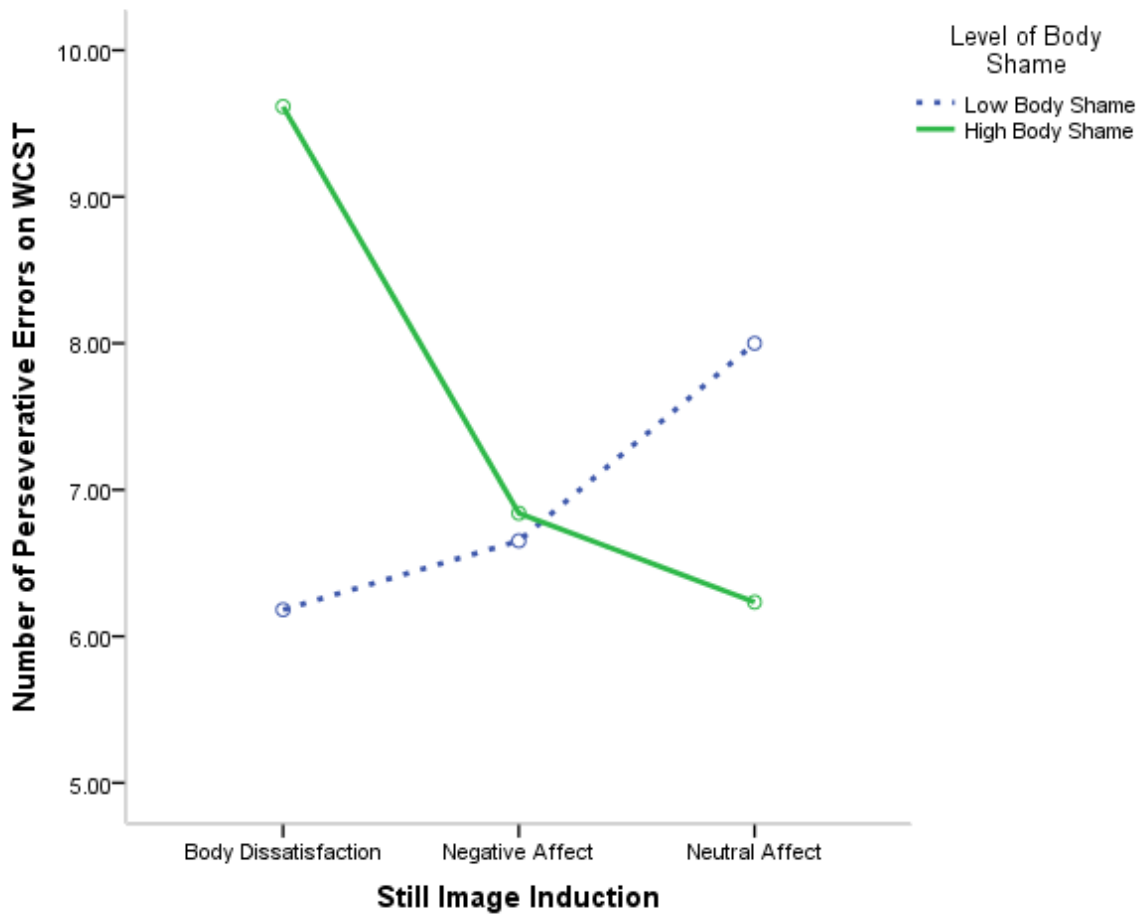


Figure 6: Interaction graph for Study 2, Hypothesis 1, excluding two outliers in the low body shame condition: The interaction between body shame and induction type on perseverative errors.

REFERENCES

- Ajala, M.O., Oladip, O.O., Fasanmade, O., & Adewole, T.A. (2003). Laboratory assessment of three glucometers. *African Journal of Medicine and Medical Sciences*, *32*, 279-282.
- American Diabetes Association (2010). *Ask the Pharmacist Archive*. Retrieved from: <http://www.diabetes.org/living-with-diabetes/treatment-and-care/ask-the-expert/ask-the-pharmacist/archives/index.jsp?page=5>
- Arffa, S. (2007). The relationship of intelligence to executive function and non-executive function measures in a sample of average, above average, and gifted youth. *Archives of Clinical Neuropsychology*, *22*, 969-978.
- Arffa, S., Lovell, M., Podell, K. & Goldberg, E. (1998). Wisconsin Card Sorting Test performance in above average and superior school children: Relationship to intelligence and age. *Archives of Clinical Neuropsychology*, *13*, 713-720.
- Ashby, F. G., Isen, A. M., Turken, & U. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review*, *106*, 529-550.
- Baas, M., De Dreu, C. W., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin*, *134*, 779-806. doi:10.1037/a0012815
- Baig, A., Siddiqui, I., Jabbar, A., Azam, S.I., Sabir, S., Alam, S., & Ghani, F. (2007). Comparison between bed side testing of blood glucose by glucometer vs centralized testing in a tertiary care hospital. *Journal of Ayub Medical College*, *19*, 25.
- Bardone-Cone, A. M. (2007). Self-oriented and socially prescribed perfectionism dimensions and their associations with disordered eating. *Behaviour Research and Therapy*, *45*, 1977-1986.
- Bardone-Cone, A. M., Harney, M. B., Maldonado, C. R., Lawson, M. A., Robinson, D., Smith, R., & Tosh, A. (2010). Defining recovery from an eating disorder: Conceptualization, validation, and examination of psychosocial functioning and psychiatric comorbidity. *Behaviour Research And Therapy*, *48*, 194-202. doi:10.1016/j.brat.2009.11.001
- Baumann, N., & Kuhl, J. (2005). Positive affect and flexibility: Overcoming the precedence of global over local processing of visual information. *Motivation and Emotion*, *29*, 123-134. doi:10.1007/s11031-005-7957-1
- Beck, A. T. (1976). *Cognitive therapy and emotional disorders*. New York: International Universities Press.

- Benton, D., & Owens, D.S. (1993). Blood glucose and human memory. *Psychopharmacology* 113, 83–88.
- Benton, D., & Sargent, J. (1992) Breakfast, blood glucose and memory. *Biological Psychology*, 33, 207–210.
- Berland, N. W., Thompson, J., & Linton, P. H. (1986). Correlation between the EAT-26 and the EAT-40, the Eating Disorders Inventory, and the Restrained Eating Inventory. *International Journal of Eating Disorders*, 5, 569-574. doi:10.1002/1098-108X(198603)5:3<569::AID-EAT2260050314>3.0.CO;2-
- Bolton, H., Serpell, L., Gilbert, S.J., & Burgess, P.W. (2010, October). *Findings from computerized study of perseverative task performance under fasting and non-fasting conditions*. Talk presented at the annual meeting of the Eating Disorders Research Society, Boston, MA.
- Boone, K.B., Ghaffarian, S., Lesser, I.M., & Hill-Gutierrez, E. (1993). Wisconsin Card Sorting Test performance in healthy, older adults: Relationship to age, sex, education, and IQ. *Journal of Clinical Psychology*, 49, 54-60.
- Bosanac, P., Kurlender, S., Stojanovska, L., Hallam, K., Norman, T., McGrath, C., Burrows, Graham., et al. (2007). Neuropsychological study of underweight and “weight-recovered” anorexia nervosa compared to bulimia nervosa and controls. *International Journal of Eating Disorders*, 40, 613-621.
- Braun, C. M., & Chouinard, M.-J. (1992). Is anorexia nervosa a neuropsychological disease? *Neuropsychology Review*, 3, 171-212.
- Brenner, E. (2000). Mood induction in children: Methodological issues and clinical implications. *Review of General Psychology*, 4, 264-283.
- Buchner, A., Erdfelder, E., & Faul, F. (1997). How to Use G*Power [WWW document]. URL http://www.psych.uni-duesseldorf.de/aap/projects/gpower/how_to_use_gpower.html
- Bulik, C. M., Reba, L., Siega-Riz, A. M., & Reichborn-Kjennerud, T. (2005). Anorexia nervosa: Definition, epidemiology, and cycle of risk. *International Journal of Eating Disorders*, 37, S2-S9.
- Bulik, C. M., Tozzi, F., Anderson, C., Mazzeo, S. E., Aggen, S., & Sullivan, P. F. (2003). The relation between eating disorders and components of perfectionism. *The American Journal Of Psychiatry*, 160, 366-368. doi:10.1176/appi.ajp.160.2.366
- Cavallo, D. A., & Pinto, A. (2001). Effects of mood induction on eating behavior and cigarette craving in dietary restrainers. *Eating Behaviors*, 2, 113-127.

- Chan, J.C.N., Wong, R. Y., Cheung, C.K., Lam, P., Chow, C.C., Yeung, V.T., Kan, E.C., Mong, M.Y., & Cockram, C.S. (1997). Accuracy, precision, and user-acceptability of self blood glucose monitoring machines. *Diabetes Research and Clinical Practice*, *36*, 91-104.
- Channon, S. (1996). Executive dysfunction in depression: The Wisconsin Card Sorting Test. *Journal of Affective Disorders*, *39*, 107-114. doi:10.1016/0165-0327(96)00027-4
- Chui, H. T., Christensen, B. K., Zipursky, R. B., Richards, B. A., Hanratty, M. K., Kabani, N. J., et al. (2008). Cognitive function and brain structure in females with a history of adolescent-onset anorexia nervosa. *Pediatrics*, *122*, e426-437.
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*, 155-159.
- Compton, D.M., Bachman, L.D., Brand, D., & Avet, T.L. (2000). Age-associated changes in cognitive function in highly educated adults: Emerging myths and realities. *International Journal of Geriatric Psychiatry*, *15*, 75-85.
- Cooper, M. (1997). Cognitive theory in Anorexia Nervosa and Bulimia Nervosa: A Review. *Behavioural and Cognitive Psychotherapy*, *25*, 113-145.
- Cooper, M. J. (2005). Cognitive theory in anorexia nervosa and bulimia nervosa: Progress, development and future directions. *Clinical Psychology Review*, *25*, 511-531.
- Cowdrey, F. A., & Park, R. J. (2012). The role of experiential avoidance, rumination and mindfulness in eating disorders. *Eating Behaviors*, doi:10.1016/j.eatbeh.2012.01.001
- Dan-Glauser, E.S. & Scherer, K.R. (2011). The Geneva affective picture database (GAPED): A new 730-picture database focusing on valence and normative significance. *Behavioral Research Methods*, *43*, 468-477.
- De Hamsher, K. S., Halmi, K. A., & Benton, A. L. (1981). Prediction of outcome in anorexia nervosa from neuropsychological status. *Psychiatry Research*, *4*, 79-88.
- Deal, J.A., Carlson, M.C., Xue, Q., Fried, A.P., & Chaves, P.H.M. (2009). Anemia and 9-year domain-specific cognitive decline in community-dwelling older women: The Women's Health and Aging Study II. *Journal of the American Geriatrics Society*, *57*, 1604-1611.
- Deveney, C. M., & Deldin, P. J. (2006). A preliminary investigation of cognitive flexibility for emotional information in major depressive disorder and non-psychiatric controls. *Emotion*, *6*, 429-437.
- Doniger, G. M., Simon, E. S., & Zivotofsky, A. Z. (2006). Comprehensive computerized assessment of cognitive sequelae of a complete 12-16 hour fast. *Behavioral*

- Neuroscience*, 120, 804-816. doi:10.1037/0735-7044.120.4.804
- Dreisbach, G., & Goschke, T. (2004). How positive affect modulates cognitive control: Reduced perseveration at the cost of increased distractibility. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 30, 343-353. doi:10.1037/0278-7393.30.2.343
- Eisenberg, D., Gollust, S.E., Golberstein, E., & Hefner, J. (2007). Prevalence and correlates of depression, anxiety, and suicidality among university students. *American Journal of Orthopsychiatry*, 77, 534-542.
- Euser, S.M., Sattar, N., Wittman, J.C., Bollen, E.L., Sijbrands, E.J., Hofman, A., Perry, I.J., Breteler, M.M., & Westendorp, R.G. (2010). A prospective analysis of elevated fasting glucose levels and cognitive function in older people: Results from PROSPER and the Rotterdam Study. *Diabetes*, 59, 1601-1607.
- Fairburn, C. G. (2008). *Cognitive behavior therapy and eating disorders*. New York, NY US: Guilford Press.
- Fairburn, C. G., & Beglin, S. J. (1994). Assessment of eating disorders: Interview or self-report questionnaire? *International Journal of Eating Disorders*, 16(4), 363-370.
- Fairburn, C. G., & Cooper, Z. (1993). The Eating Disorder Examination (12th edition). In C. G. Fairburn & G. T. Wilson (Eds.), *Binge eating: Nature, assessment, and treatment*. (pp. 317-360). New York, NY: Guilford Press.
- Fassino, S., Pieró, A., Daga, G. A., Leombruni, P., Mortara, P., & Rovera, G. G. (2002). Attentional biases and frontal functioning in anorexia nervosa. *International Journal of Eating Disorders*, 31, 274-283.
- Flett, G. L., Hewitt, P. L., Whelan, T., & Martin, T. R. (2007). The Perfectionism Cognitions Inventory: Psychometric properties and associations with distress and deficits in cognitive self-management. *Journal of Rational-Emotive & Cognitive Behavior Therapy*, 25, 255-277. doi:10.1007/s10942-007-0055-4
- Flett, G.L., Hewitt, P.L., Blankstein, K.R., & Gray, L. (1998). Psychological distress and the frequency of perfectionistic thinking. *Journal of Personality and Social Psychology*, 75, 1363-1381. PMID:9866193
- Fowler, L., Blackwell, A., Jaffa, A., Palmer, R., Robbins, T. W., Sahakian, B. J., et al. (2006). Profile of neurocognitive impairments associated with female in-patients with anorexia nervosa. *Psychological Medicine*, 36, 517-527.
- Frederickson, B. L. (1998). What good are positive emotions? *Review of General Psychology*, 2, 300-319.

- Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research, 14*, 449-468.
- Gable, P.A. & Harmon-Jones, E. (2008). Approach-motivated positive affect reduces breadth of attention. *Psychological Science, 19*, 476-482.
- Gagnon, C., Greenwood, C. E., & Bherer, L. (2010). The acute effects of glucose ingestion on attentional control in fasting healthy older adults. *Psychopharmacology, 211*, 337-346. doi:10.1007/s00213-010-1905-9
- Garner, D. M., & Bemis, K. M. (1982). A cognitive-behavioral approach to anorexia nervosa. *Cognitive Therapy and Research, 6*, 123-150.
- Garner D. & Garfinkel P. (1980). Socio-cultural factors in the development of anorexia nervosa. *Psychological Medicine: A Journal of Research in Psychiatry and the Allied Sciences, 10*, 647-656.
- Garner, D., Olmstead, M., Bohr, Y., & Garfinkel, P. (1982). The Eating Attitudes Test: Psychometric features and clinical correlates. *Psychological Medicine, 12*, 871-878.
- Gaudiani, J. L., Sabel, A. L., Mascolo, M. & Mehler, P. S. (2010). Severe anorexia nervosa: Outcomes from a medical stabilization unit. *International Journal of Eating Disorders, 45*, 85-92. doi: 10.1002/eat.20889
- Gerrards-Hesse, A., & Spies, K. (1994). Experimental inductions of emotional states and their effectiveness: A review. *British Journal of Psychology, 85*, 55.
- Gillberg, I. C., Råstam, M., Wentz, E., & Gillberg, C. (2007). Cognitive and executive functions in anorexia nervosa ten years after onset of eating disorder. *Journal of Clinical & Experimental Neuropsychology, 29*, 170-178.
- Goldschmidt, A.B., Tanofsky-Kraff, M., & Wilfley, D.E. (2011). A laboratory-based study of mood and binge eating behavior in overweight children. *Eating Behaviors, 12*, 37-43.
- Goss, K., Gilbert, P., & Allan, S. (1994). An exploration of shame measures: The other as shamer scale. *Personality and Individual Differences, 17*, 713-717.
- Green, M. W., & Rogers, P. J. (1995). Impaired cognitive functioning during spontaneous dieting. *Psychological Medicine: A Journal of Research in Psychiatry and the Allied Sciences, 25*, 1003-1010. doi:10.1017/S0033291700037491
- Green, M. W., & Rogers, P. J. (1998). Impairments in working memory associated with spontaneous dieting behaviour. *Psychological Medicine: A Journal of Research in Psychiatry and the Allied Sciences, 28*, 1063-1070. doi:10.1017/S0033291798007016

- Green, M. W., Elliman, N. A., & Rogers, P. J. (1995). Lack of effect of short-term fasting on cognitive function. *Journal of Psychiatric Research*, *29*, 245-253. doi:10.1016/0022-3956(95)00009-T
- Green, M. W., Elliman, N. A., & Rogers, P. J. (1997). The effects of food deprivation and incentive motivation on blood glucose levels and cognitive function. *Psychopharmacology*, *134*, 88-94. doi:10.1007/s002130050429
- Green, M.W., Elliman N.A., Wakeling A., Rogers P.J. (1996). Cognitive functioning, weight change and therapy in anorexia nervosa. *Psychiatry Research*, *30*, 401-410.
- Greenleaf, C., & McGreer, R. (2006). Disordered eating attitudes and self-objectification among physically active and sedentary female college students. *Journal of Psychology: Interdisciplinary and Applied*, *140*, 187-198. doi:10.3200/JRLP.140.3.187-198
- Griskevicius, V., Shiota, M.N., & Neufeld, S.L. (2010). Influence of different positive emotions on persuasion processing: A functional evolutionary approach. *Emotion*, *10*, 190-206.
- Groesz, L. M., Levine, M. P., & Murnen, S. K. (2002). The effect of experimental presentation of thin media images on body satisfaction: A meta-analytic review. *International Journal of Eating Disorders*, *31*, 1-16. doi:10.1002/eat.10005
- Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition & Emotion*, *9*, 87-108.
- Harvey, P. O., Le Bastard, G. G., Pochon, J. B., Levy, R. R., Allilaire, J. F., Dubois, B. B., & Fossati, P. P. (2004). Executive functions and updating of the contents of working memory in unipolar depressions. *Journal Of Psychiatric Research*, *38*, 567-576. doi:10.1016/j.jpsychires.2004.03.003
- Hatch, A., Madden, S., Kohn, M.R., Clarke, S., Touyz, S., Gordon, E., Williams, L.M. (2009). In first presentation adolescent anorexia nervosa, do cognitive markers of underweight status change with weight gain following a refeeding intervention? *International Journal of Eating Disorders*, *43*, 295-306.
- Heaton, R. K., Chelune, G. J., Talley, J., Kay, G. G., & Curtiss, G. (1993). *Wisconsin Card Sorting Test Manual - Revised and Expanded*. Odessa, FL: Psychological Assessment Resources.
- Heinberg, L. J., & Thompson, J. (1995). Body image and televised images of thinness and attractiveness: A controlled laboratory investigation. *Journal of Social and Clinical Psychology*, *14*, 325-338.

- Henrickson, H. C., Crowther, J. H., & Harrington, E. F. (2010). Ethnic identity and maladaptive eating: Expectancies about eating and thinness in African American women. *Cultural Diversity and Ethnic Minority Psychology, 16*, 87-93. doi:10.1037/a0013455
- Hernandez, M. (2002, January). The relationship between internalized shame and body dissatisfaction in women. *Dissertation Abstracts International, 63*, Retrieved from EBSCOhost
- Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualization, assessment, and association with psychopathology. *Journal of Personality and Social Psychology, 60*, 456-470.
- Hewitt, P. L., Flett, G. L., Besser, A., Sherry, S. B., & McGee, B. (2003). Perfectionism Is Multidimensional: a reply to Shafran, Cooper, and Fairburn (2002). *Behaviour Research and Therapy, 41*, 1221-1236.
- Hirt, E. R., Devers, E. E., & McCrea, S. M. (2008). I want to be creative: Exploring the role of hedonic contingency theory in the positive mood-cognitive flexibility link. *Journal of Personality and Social Psychology, 94*, 214-230. doi:10.1037/0022-3514.94.2.94.2.214
- Holliday, J., Tchanturia, K., Landau, S., Collier, D., & Treasure, J. (2005). Is impaired set-shifting an endophenotype of anorexia nervosa? *The American Journal of Psychiatry, 162*, 2269-2275.
- Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology, 52*, 1122-1131.
- Isen, A. M., Johnson, M. M., Mertz, E., & Robinson, G. F. (1985). The influence of positive affect on the unusualness of word associations. *Journal of Personality and Social Psychology, 48*, 1413-1426. doi:10.1037/0022-3514.48.6.1413
- Isen, A. M., Shalke, T. E., Clark, M., & Karp, L. (1978). Affect, accessibility of material in memory, and behavior: A cognitive loop?. *Journal of Personality and Social Psychology, 36*, 1-12. doi:10.1037/0022-3514.36.1.1
- Johnson, D. R. (2009). Emotional attention set-shifting and its relationship to anxiety and emotion regulation. *Emotion, 9*, 681-690. doi:10.1037/a0017095
- Kaye, W.H., Fudge, J.L., & Paulus, M. (2009). New insights into symptoms and neurocircuit function of anorexia nervosa. *Nature Reviews Neuroscience, 10*, 573-584.
- Kenealy, P. M. (1986). The Velten Mood Induction Procedure: A methodological review. *Motivation and Emotion, 10*, 315-335. doi:10.1007/BF00992107

- Kim, H., Kim, G.-J., Park, H. W., & Rice, R. E. (2007). Configurations of relationships in different media: FtF, email, instant messenger, mobile phone, and SMS. *Journal of Computer-Mediated Communication*, *12*, 1183-1207.
- King, M. B. (1989). Eating disorders in general practice population: Prevalence, characteristics and follow-up at 12 to 18 months. *Psychological Medicine, Monograph Suppl.*, *14*, 1–34. doi:10.1017/S0264180100000515.
- King, M. B. (1991). The natural history of eating pathology in attenders to primary medical care. *International Journal of Eating Disorders*, *10*, 379–387 doi:10.1002/1098-108X (199107)10:4 b 379::AID-EAT2260100402 N 3.0.CO;2-I.
- Kingston, K., Szmukler, G., Andrewes, D., & Tress, B. (1996). Neuropsychological and structural brain changes in anorexia nervosa before and after refeeding. *Psychological Medicine*, *26*, 15-28.
- Klemchuk, H. P., Hutchinson, C. B., & Frank, R. I. (1990). Body dissatisfaction and eating-related problems on the college campus: Usefulness of the Eating Disorder Inventory with a nonclinical population. *Journal of Counseling Psychology*, *37*, 297-305. doi:10.1037/0022-0167.37.3.297
- Konishi, S., Nakajima, K., Uchida, I., Kameyama, M., Nakahara, K., Sekihara, K., & Miyashita, Y. (1998). Transient activation of inferior prefrontal cortex during cognitive set shifting. *Nature Neuroscience*, *1*, 80-84.
- Konstantakopoulos, G. G., Tchanturia, K. K., Surguladze, S. A., & David, A. S. (2011). Insight in eating disorders: Clinical and cognitive correlates. *Psychological Medicine: A Journal Of Research In Psychiatry And The Allied Sciences*, *41*, 1951-1961.
- Landers, D. M., Arent, S. M., & Lutz, R. S. (2001). Affect and cognitive performance in high school wrestlers undergoing rapid weight loss. *Journal of Sport & Exercise Psychology*, *23*, 307-316.
- Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. University of Florida, Gainesville, FL.
- Lauer, C.J., Gorzewski, B., Gerlinghoff, M., Backmund, H., & Zihl, J. (1999). Neuropsychological assessments before and after treatment in patients with anorexia nervosa and bulimia nervosa. *Journal of Psychiatry Research*, *33*, 129-138.
- Lilenfeld, L. R. R., Wonderlich, S., Riso, L. P., Crosby, R., & Mitchell, J. (2006). Eating disorders and personality: A methodological and empirical review. *Clinical Psychology Review*, *26*, 299-320.

- Lowry, R., Galuska, D.A., Fulton, J.E., Wechsler, H., Kann, L., & Collins, J. (2000). Physical activity, food choice, and weight management practices among U.S. college students. *American Journal of Preventative Medicine*, *18*, 18-27.
- Macht, M., & Mueller, J. (2007). Immediate effects of chocolate on experimentally induced mood states. *Appetite*, *49*, 667-674.
- Macht, M., Roth, S., & Ellgring, H. (2002). Chocolate eating in healthy men during experimentally induced sadness and joy. *Appetite*, *39*, 147-158.
- Mann, E.A., Salinas, J., Pidcoke, H.F., Wolf, S.E., Holcomb, J.B., & Wade, C.E. (2007). Error rates resulting from anemia can be corrected in multiple commonly used point-of-care glucometers. *The Journal of Trauma: Injury, Infection, and Critical Care*, *64*, 15-21.
- Martin, M. (1990). On the induction of mood. *Clinical Psychology Review*, *6*, 669-697.
- Martin, M.M. & Rubin, R.B. (1995). A new measure of cognitive flexibility. *Psychological Reports*, *76*, 623-626.
- Mathias, J.L. & Kent, P.S. (1998). Neuropsychological consequences of extreme weight loss and dietary restriction in patients with anorexia nervosa. *Journal of Clinical and Experimental Neuropsychology*, *20*, 548-564.
- Maxwell, S.E. & Delaney, H.D. (2004). *Designing Experiments and Analyzing Data*. New Jersey US: Lawrence Erlbaum Associates.
- McKinley, N., & Hyde, J. (1996). The Objectified Body Consciousness Scale: Development and validation. *Psychology of Women Quarterly*, *20*, 181-215. doi:10.1111/j.1471-6402.1996.tb00467.x
- Meng, X., Rosenthal, R., & Rubin D.B. (1992). Comparing correlated correlation coefficients. *Psychological Bulletin*, *111*, 172-175.
- Michalsen, A. (2010). Prolonged fasting as a method of mood enhancement in chronic pain syndromes: A review of clinical evidence and mechanisms. *Current Pain and Headache Reports*, *14*, 80-87.
- Michopoulos, I. I., Zervas, I. M., Papakosta, V. M., Tsaltas, E. E., Papageorgiou, C. C.,
- Manessi, T. T., & Soldatos, C. R. (2006). Set shifting deficits in melancholic vs. non-melancholic depression: Preliminary findings. *European Psychiatry*, *21*, 361-363. doi:10.1016/j.eurpsy.2006.03.008

- Mikos, A. E., McDowell, B. D., Moser, D. J., Bayless, J. D., Bowers, W. A., Andersen, A. E., et al. (2008). Stability of neuropsychological performance in anorexia nervosa. *Annals of Clinical Psychiatry, 20*, 9-13.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex 'frontal lobe' tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49-100.
- Money, C., Davies, H., & Tchanturia, K. (2011). A case study introducing cognitive remediation and emotion skills training for anorexia nervosa inpatient care. *Clinical Case Studies, 10*, 110-121. doi:10.1177/1534650110396545
- Moser, D.J., Benjamin, M.I., Bayless, J.D., McDowell, B.D., Paulsen, J.S., Bowers W.A., et al. (2003). Neuropsychological functioning pretreatment and posttreatment in an inpatient eating disorders program. *International Journal of Eating Disorders, 33*, 64-70.
- Murphy, R., Straebler, S., & Fairburn, C.G. (2010) Cognitive behavioral therapy for eating disorders. *Psychiatry Clinics of North America, 33*, 611-627.
- Nakazato, M., Tchanturia, K., Schmidt, U., Campbell, I. C., Treasure, J., Collier, D. A., et al. (2009). Brain-derived neurotrophic factor (BDNF) and set-shifting in currently ill and recovered anorexia nervosa (AN) patients. *Psychological Medicine, 39*, 1029-1035.
- Neighbors, L. A., & Sobal, J. (2007). Prevalence and magnitude of body weight and shape dissatisfaction among university students. *Eating Behaviors, 8*, 429-439. doi:10.1016/j.eatbeh.2007.03.003
- Nikiforuk, A., & Popik, P. (2011). Long-lasting cognitive deficit induced by stress is alleviated by acute administration of antidepressants. *Psychoneuroendocrinology, 36*, 28-39. doi:10.1016/j.psyneuen.2010.06.001
- Orem, D. M., Petrac, D. C., & Bedwell, J. S. (2008). Chronic self-perceived stress and set-shifting performance in undergraduate students. *Stress: The International Journal on the Biology of Stress, 11*, 73-78. doi:10.1080/10253890701535103
- Osher, Y., Bersudsky, Y., Silver, H., Sela, B., & Belmaker, R.H. (2008). Neuropsychological correlates of homocysteine levels in euthymic bipolar patients. *Journal of Affective Disorders, 105*, 229-233. doi: 10.1016/j.jad.2007.04.005
- Park, R., Dunn, B., & Barnard, P., 2011. Schematic models and modes of mind in anorexia nervosa: A novel process account. *International Journal of Cognitive Therapy, 4*, 415-437.
- Paxton, S.J., Neumark-Sztainer, D., Hannan, P.J., & Eisenberg, M. (2006). Body dissatisfaction prospectively predicts depressive symptoms and low self esteem in

- adolescent girls and boys. *Journal of Clinical Child and Adolescent Psychology*, 35, 539–549.
- Piech, R. M., Hampshire, A., Owen, A. M., & Parkinson, J. A. (2009). Modulation of cognitive flexibility by hunger and desire. *Cognition and Emotion*, 23, 528-540. doi:10.1080/02699930802012153
- Pike, K. M., Hilbert, A., Wilfley, D. E., Fairburn, C. G., Dohm, F. A., Walsh, B. T., et al. (2008). Toward an understanding of risk factors for anorexia nervosa: A case-control study. *Psychological Medicine*, 38, 1443-1453.
- Ponicke, J., Albacht, B., & Leplow, B. (2005). Cognitive changes during fasting.
- Reitan, R.M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. *Perceptual and Motor Skills*, 1958, 8, 271-276.
- Roberts, A., Cash, T. F., Feingold, A., & Johnson, B. T. (2006). Are black-white differences in females' body dissatisfaction decreasing? A meta-analytic review. *Journal of Consulting and Clinical Psychology*, 74, 1121-1131. doi:10.1037/0022-006X.74.6.1121
- Roberts, M.E., Barthel, F.M., Lopez, C., Tchanturia, K., & Treasure, J.L. (2011). Development and validation of the Detail and Flexibility Questionnaire (DFlex) in eating disorders. *Eating Behaviors*, 12, 168-174.
- Roberts, M.E., Tchanturia, K., Stahl, D., Southgate, L., & Treasure, J. (2007). A systematic review and meta-analysis of set-shifting ability in eating disorders. *Psychological Medicine*, 37, 1075-1084.
- Roberts, M. E., Tchanturia, K., & Treasure, J. L. (2010). Exploring the neurocognitive signature of poor set-shifting in anorexia and bulimia nervosa. *Journal of Psychiatric Research*, 44, 964-970. doi:10.1016/j.jpsychires.2010.03.001
- Rogers, R.D., Andrews, T.C., Grasby, P.M., Brooks, D.J., & Robbins, T.W. (2000). Contrasting cortical and subcortical activations produced by attentional-set shifting and reversal learning in humans. *Journal of Cognitive Neuroscience*, 12, 142-162.
- Rogers, P. J., & Green, M. W. (1993). Dieting, dietary restraint and cognitive performance. *British Journal of Clinical Psychology*, 32, 113-116.
- Rogers, P.J., & Lloyd, H.M. (1994). Nutrition and mental performance. *Proceedings of the Nutrition Society*, 53, 443-456.
- Sanftner, J. L., Barlow, D., Marschall, D. E., & Tangney, J. (1995). The relation of shame and guilt to eating disorder symptomatology. *Journal of Social and Clinical Psychology*, 14, 315-324.

- Sanftner, J. L., Barlow, D., Marschall, D. E., & Tangney, J. (1995). The relation of shame and guilt to eating disorder symptomatology. *Journal of Social and Clinical Psychology, 14*, 315-324.
- Sarrar, L., Ehrlich, S., Merle, J., Pfeiffer, E., Lehmkuhl, U., & Schneider, N. (2011). Cognitive flexibility and Agouti-related protein in adolescent patients with anorexia nervosa. *Psychoneuroendocrinology, 36*, 1396-1406.
doi:10.1016/j.psyneuen.2011.03.014
- Schotte, D. E., Cools, J., & McNally, R. J. (1990). Film-induced negative affect triggers overeating in restrained eaters. *Journal of Abnormal Psychology, 99*, 317-320.
- Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In R. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 527–561). New York: Guilford Press.
- Schwarz, N. (1994). Judgment in a social context: Biases, shortcomings, and the logic of conversation. *Advances in Experimental Social Psychology, 26*, 123–162.
- Serpell, L., Treasure, J., Teasdale, J., & Sullivan, V. (1999). Anorexia nervosa: Friend or foe? *International Journal of Eating Disorders, 25*, 177–186.
- Serpell, L., Waller, G., Fearon, P., & Meyer, C. (2009). The roles of persistence and perseveration in psychopathology. *Behavior Therapy, 40*, 260-271.
doi:10.1016/j.beth.2008.07.001
- Shott, M.E., Filoteo, J.V., Bhatnagar, K.A.C., Peak, N.J., Hagman, J.O., Rockwell, R., Kaye, W.H., & Frank, G.K.W. (2012). Cognitive set shifting in anorexia nervosa. *European Eating Disorders Review*, early online publication.
- Small, A., Madero, J., Teagno, L., & Ebert, M. (1983). Prediction of outcome in anorexia nervosa from neuropsychological status. *Journal of Clinical Psychology, 39*, 780-782.
- Smith, E. & Rieger, E. (2010), An investigation of the effect of body dissatisfaction on selective attention toward negative shape and weight-related information. *International Journal of Eating Disorders, 43*, 358–364. doi: 10.1002/eat.20703
- Steinglass, J. E., Walsh, B. T., & Stern, Y. (2006). Set shifting deficit in anorexia nervosa. *Journal of the International Neuropsychological Society, 12*, 431-435.
- Steinhausen, H. (2002). The outcome of anorexia nervosa in the 20th century. *American Journal of Psychiatry, 159*, 1284-1293.

- Steinhausen, H. C., Boyadjieva, S., Griogotoiu-Serbanescu, M., & Neumarker, K. J. (2003). The outcome of adolescent eating disorders: Findings from an international collaborative study. *European Child & Adolescent Psychiatry, 12*(Supplement 1), 91-98.
- Stice, E. & Bearman, S.K. (2001). Body image and eating disturbances prospectively predict growth in depressive symptoms in adolescent girls: a growth curve analysis. *Developmental Psychology, 37*, 597-607.
- Stice, E., & Shaw, H. E. (2002). Role of body dissatisfaction in the onset and maintenance of eating pathology: A synthesis of research findings. *Journal of Psychosomatic Research, 53*, 985-993. doi:10.1016/S0022-3999(02)00488-9
- Swanson, H. (2009). Set shifting impairments in an outpatient eating disorder sample. *Dissertation Abstracts*.
- Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*, 257-285.
- Sweller, J., & Chandler, P. (1994). Why some material is difficult to learn. *Cognition and Instruction, 12*, 185-233. doi:10.1207/s1532690xci1203_1
- Tchanturia, K., Anderluh, M. B., Morris, R. G., Rabe-Hesketh, S., Collier, D. A., Sanchez, P., et al. (2004). Cognitive flexibility in anorexia nervosa and bulimia nervosa. *Journal of the International Neuropsychological Society, 10*, 513-520.
- Tchanturia, K., Campbell, I. C., Morris, R., & Treasure, J. (2005). Neuropsychological Studies in Anorexia Nervosa. [Article]. *International Journal of Eating Disorders, 37*, 72-76.
- Tchanturia, K., Davies, H., & Campbell, I. C. (2007). Cognitive remediation therapy for patients with anorexia nervosa: Preliminary findings. *Annals of General Psychiatry, 6*.
- Tchanturia, K., Harrison, A., Davies, H., Roberts, M., Oldershaw, A., Nakazato, M., Stahl, D., Morris, R., Schmidt, U., & Treasure, J. (2011). Cognitive flexibility and clinical severity in eating disorders. *PLoS ONE, 6*, 20462. doi:10.1371/journal.pone.0020462
- Tchanturia, K., Morris, R. G., Anderluh, M. B., Collier, D. A., Nikolaou, V., & Treasure, J. (2004). Set shifting in anorexia nervosa: An examination before and after weight gain, in full recovery and relationship to childhood and adult OCPD traits. *Journal of Psychiatric Research, 38*, 545-552.
- Tchanturia, K., Morris, R. G., Surguladze, S., & Treasure, J. (2002). An examination of perceptual and cognitive set shifting tasks in acute anorexic nervosa and following recovery. *Eating and Weight Disorders, 7*, 312-315.

- Tchanturia, K., Serpell, L., Troop, N., & Treasure, J. (2001). Perceptual illusions in eating disorders: Rigid and fluctuating styles. *Journal of Behavior Therapy and Experimental Psychiatry*, *32*, 107-115.
- Thompson, J.K., Heinberg, L.J., Altabe, M., & Tantleff-Dunn, S. (1999). *Exacting beauty: theory, assessment, and treatment of body image disturbance*, American Psychological Association, Washington, DC (1999).
- Tice, D. M., Baumeister, R. F., Shmueli, D., & Muraven, M. (2007). Restoring the self: Positive affect helps improve self-regulation following ego depletion. *Journal of Experimental Social Psychology*, *43*, 379-384.
- Tozzi, F., Aggen, S. H., Neale, B. M., Anderson, C. B., Mazzeo, S. E., Neale, M. C., & Bulik, C. M. (2004). The structure of perfectionism: A twin study. *Behavior Genetics*, *34*, 483-494. doi:10.1023/B:BEGE.0000038486.47219.76
- Vanderlinden, J. (2008). Many roads lead to Rome: Why does cognitive behavioral therapy remain unsuccessful for many eating disorder patients? *European Eating Disorders Review*, *16*, 329-333.
- Vitousek, K. B., & Hollon, S. D. (1990). The investigation of schematic content and processing in eating disorders. *Cognitive Therapy and Research*, *14*, 191-214.
- Vitousek, K. & Manke, F. (1994). Personality variables and disorders in anorexia nervosa and bulimia nervosa. *Journal of Abnormal Psychology*, *103*, 137-47.
- Vitousek, K., Watson, S., & Wilson, G. T. (1998). Enhancing motivation for change in treatment-resistant eating disorders. *Clinical Psychology Review*, *18*, 391-420.
- Wade, T., George, W., & Atkinson, M. (2009). A randomized controlled trial of brief interventions for body dissatisfaction. *Journal of Consulting and Clinical Psychology*, *77*, 845-854. doi:10.1037/a0016879
- Wade, T. D., Tiggemann, M., Bulik, C. M., Fairburn, C. G., Wray, N. R., & Martin, N. G. (2008). Shared temperament risk factors for anorexia nervosa: A twin study. *Psychosomatic Medicine*, *70*, 239-244.
- Wahlin, T.R., Wahlin, A., Winblad, B., & Backman, L. (2001). The influence of serum vitamin B12 and folate status on cognitive functioning in very old age. *Biological Psychology*, *56*, 247-265.
- Wang, Y., & Guo, D. (2008). The effects of positive emotions on task switching. *Acta Psychologica Sinica*, *40*, 301-306. doi:10.3724/SP.J.1041.2008.00301

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063-1070. doi:10.1037/0022-3514.54.6.1063

Wells, A.S., Read, N.W., Laugharne, J.D., & Ahluwalia, N.S. (1998). Alterations in mood after changing to a low-fat diet. *The British Journal of Nutrition*, *79*, 23-30.

Westermann, R., Spies, K., Stahl, G., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: a meta- analysis. *European Journal of Social Psychology*, *26*, 557-580

Wykes, T., Reeder, C., Williams, C., Corner, J., Rice, C., & Everitt, B. (2003). Are the effects of cognitive remediation therapy (CRT) durable? Results from an exploratory trial in schizophrenia. *Schizophrenia Research*, *61*, 163-174.

Yeomans, M. R., & Coughlan, E. (2009). Mood-induced eating. Interactive effects of restraint and tendency to overeat. *Appetite*, *52*, 290-298.

Zipfel, S., Lowe, B., Reas, D. L., Deter, H.-C., & Herzog, W. (2000). Long-term prognosis in anorexia nervosa: Lessons from a 21-year follow-up study. *Lancet*, *355*, 721-722.