

COGNITIVE PROCESSING of PERSON-REFERENT WORDS IN DEPRESSION AND OBESITY

BY

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## Abstract

The purpose of this study was to investigate differences in the cognitive processing of person-referent words in depression and obesity and identify a cognitive marker of depression vulnerability in obesity. Three groups of participants (obese, non-depressed (OND) (BMI>30); obese, clinically depressed (OD) (BMI>30); healthy weight (HW) (BMI 18.5-24.9), non-depressed) viewed positive, negative, and neutral words while event-related potential (ERP) data was collected. The valenced words were person-referent and described either physical characteristics or non-physical characteristics such as personality and intellect. A repeated measures ANOVA was used to analyze attention allocation to salient stimuli as index by P3 difference wave amplitudes. The ANOVA compared attention to word valence and physicality in these three groups.

The results indicated three main findings: 1) The P3 oddball paradigm with valenced (rare) and neutral (frequent) words produces a reliable P3 ERP component. 2) The magnitude of the P3 is influenced by word valence, with an attention bias towards negative words across groups. 3) Valence impacts the response to the physicality of the words such that there is a greater attentional bias towards negative physical words than positive physical words and a greater attentional bias towards negative physical words than to negative non-physical words across groups. There was also a trend for the OND group to mirror the HW group for positive words and mirror the OD group for negative words, with heightened attention to negative, physical words. This trend towards heightened attention to negative information in the OD group compared to the HW group and the extent to which obese individuals generalize negative self-referent information suggest potential risks for depression vulnerability in obesity. This knowledge may help guide cognitive therapy for obese individuals who are at risk for

depression, emphasizing the importance of reinforcing positive self-attributes and avoiding negative self-focus and ruminative attention.

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## Cognitive Processing of Person-Referent Words in Depression and Obesity

Over the past several decades, there has been a dramatic increase in the rate of obesity in the United States (Mokdad et al., 1999, 2001). In 2009-2010, over 78 million (35%) adults and 12.5 million (16.9%) children and adolescents in the United States were obese (Ogden, Carroll, Kit, & Flegal, 2012). Additionally in 2008, 1.4 billion adults were overweight and over 500 million adults were obese worldwide (World Health Organization, 2013). The toll of this public health epidemic is high. Obesity is not only linked to a number of other diseases, but is also associated with increased healthcare cost and usage (Andreyeva, Sturm, & Ringel, 2004; Eckel, Barouch, & Ershow, 2002; Must et al., 1999)

Compounding the economic and physical health detriments associated with obesity are its implication for mental health. More recently, the field of obesity research has increased its focus on the comorbidity between obesity and depression (de Wit et al., 2010; Faith, Matz, & Jorge, 2002; Luppino et al., 2010; Onyike, Crum, Lee, Lyketsos, & Eaton, 2003; Scott, McGee, Wells, & Oakley Browne, 2008; Simon et al., 2011; Simon et al., 2006). By 2030, depression is predicted to carry the second largest disease burden in the world (Mathers & Loncar, 2006) and 16.6% of the population will experience depression at some point during their life (Kessler et al., 2005). The current literature suggests that the link between these two illnesses may be bidirectional with individuals who are obese carrying a 55% increased risk for developing depression and individuals with depression carrying a 58% increased risk for developing obesity (Luppino et al., 2010; Pan et al., 2012).

Despite the increasing prevalence and costliness of these diseases, little is known about the relationship between depression and obesity. Therefore, the goal of this study is to identify differences in cognitive processing between people who are healthy weight, non-depressed

(HW), people who are obese and not depressed (OND), and people who are obese and depressed (OD). From these differences, I hope to identify a cognitive marker in OND people that indicates a higher vulnerability for developing depression. In order to address this issue, this study will use electroencephalographic event-related potentials (ERP) to examine neural processing of neutral, positive, and negative words that either describe a person's physical appearance (physical) or that describe a person's emotional state, mental characteristics or personality traits (nonphysical). Electroencephalographic ERP uses electrodes placed on the scalp to measure electrical activity in the brain and is thought to reflect small clusters of cortical neurons responding to a particular stimulus. The methodological advantages of ERP is that it is less susceptible to demand characteristics, as it measures cognitive responses rather than behavioral responses and that it has high temporal resolution, allowing for the measurement of real-time responses to stimuli.

Research has demonstrated a strong, negative attentional bias in individuals with depression (e.g., Gotlib, Krasnoperova, Yue, & Joormann, 2004; Iardi, Atchley, Enloe, Kwasny, & Garratt, 2007). However, it remains unknown whether such an attentional bias is present in individuals who are obese and thus at an increased risk for developing depression. To examine the potential role of attention in obesity and depression, this study will use the P3 ERP waveform, which is a reliable marker of attention (Brandeis et al., 2002) and a measure of information salience (Osterhout & Holcomb, 1995) to index attention to emotionally valenced stimuli as discussed by Keil (2002).

Although negative self-thoughts are a hallmark of both depression and obesity, they may manifest themselves differently in these two groups. In depression, there is a global increase in self-focus and attention to negative stimuli, whereas in obesity, there may be a more specific



self-focus and attention to negative body image, rather than a global focus. Furthermore, these differences may be a product of different attribution styles in these two groups. This study aims to further inform our understanding of the relationship between depression and obesity and the processing of information in these two diseases.

### **Ruminative Self-Focus Model in Depression**

Watkins and Teasdale proposed a model for the maladaptive cognitive framework that typifies depression, asserting that depression is associated with a repetitive, ruminative self-focus. This maladaptive strategy leads to overgeneralization and emotional suppression that results in a self-sustaining cycle, engendering avoidance while preventing the development of adaptive, alternative explanations and attributions (Watkins & Teasdale, 2004). Research has demonstrated that the extent to which individuals engage in this negative, perseverative strategy predicts depression vulnerability, duration, and relapse (Beck, 1967; Beck, Rush, Shaw, & Emery, 1979; Ingram, Miranda, & Segal, 1998; Robinson & Alloy, 2003; Nolen-Hoeksema, Morrow, & Fredrickson, 1993). ERP studies have also supported this model, revealing differential cognitive processing in depressed patients compared to healthy participants, specifically showing that depressed individuals display a uniquely amplified P3 response to negative stimuli, reinforcing the link between depression and aberrant, perseverative processing of negatively valenced emotional stimuli (Ilardi et al., 2007).

### **Role of Attribution in Information Processing.**

Weiner's attributional theory of motivation and emotion supports Watkins and Teasdale's model and proposes a mechanism for these cognitive biases in depression, which is useful in considering how OND individuals may be similar to and divergent from OD individuals. Weiner proposed three main influences on people's perception of causality: locus of cause, stability, and

controllability and suggests that globality may also play a role. He argues that individuals' views on these factors will effect their subsequent emotional responses and motivation (Weiner, 1985). OND and OD individuals should still maintain societal ideals of weight and mental/personality characteristics even though they may not feel that they embody these characteristics. According to Watkins and Teasdale's model, depressed people exhibit a strong self-focus. Thus, OD people should attribute their weight and emotional status to internal/personal factors rather than environmental factors and see thinness and happiness as ideals they have failed to meet. This failure will have a greater negative impact on their self-esteem than if they attributed the cause of their weight or mood status to environmental factors.

The rigid, ruminative nature of depresstypic thoughts also helps perpetuate perception of stability of negative events and ideas; Watkins and Teasdale argue that depressed people are unable to move beyond these thoughts and make alternative attributions. Furthermore, people who are dissatisfied with their current weight or emotional status and see it as more stable will experience greater feelings of hopelessness and more susceptible to depression than people who see these statuses as dynamic.

Finally, if people view their failures to maintain an ideal weight or mood status as controllable then they will be more likely to feel shame than if they view these things as out of their control. Weiner then argues that low self-esteem, hopelessness, and shame are the affective responses to these attributions and that they lead to congruent actions such as withdrawal and avoidance, which are consistent with depression (1985).

Later work by Peterson, Seligman, and Vaillant suggests that individuals with a negativistic attributional style who conceptualize bad events as stable (unchanging over time), internal (their own fault), and global (generalizable to multiple domains of their self or world

view) have a greater risk for poor health (1988). This concept of a particular event being seen as global and consistent over time and situations links with Watkins and Teasdale's conceptualization of depressotypic thoughts as being overgeneralizations.

**Ruminative self-focus in depression: ERP studies.** These overgeneralizations of negative thoughts may have implications for attention in depression. One way past research has attempted to measure this is through the P3 ERP component, which can capture emotional arousal. Although depressed individuals have been shown to display an attenuated P300 to various types of auditory sounds (e.g., Ancy, Gangadhar, & Janakiramaiah, 1996), pictures (Kayser, Bruder, Tenke, Stewart, & Quitken, 2000), shapes (Chakroun, 1988), and symbols (Bruder et al., 1991), it seems that negative stimuli uniquely amplify their P300 response. A study performed by Ilardi et al. found a larger P300 to negative depression consistent word stimuli in depressed patients compared to healthy controls (2007). Deitrich et al., who had similar findings, suggests that this effect may be due to the fact that the negative words are more congruent with depressed people's ruminative thoughts (Dietrich et al., 2000). Furthermore, a study by Atchley et al. found depressed patients to be more accurate in judging the valence of negative words than healthy participants when words were presented to the left visual field; controls showed greater accuracy in judging the valence of positive words presented to the left visual field (2007). This finding is of importance because words presented to the left visual field are processed in the right hemisphere, which is thought of as the predominant hemisphere for emotional processing (Canli, Desmond, Zhao, Glover, & Gabrieli, 1998; Davidson 1995), again reinforcing the link between depression and aberrant processing of negatively valenced emotional stimuli.

Recent work by Berman et al. has also shown that depressed individuals tend to hold onto negative information in their short term memory longer than healthy controls. This inability to inhibit negative information may be linked to rumination and impairments in concentration that are features of depression (Berman et al., 2011). Berman et al. found that this inability to clear and inhibit information from short-term memory in depression was specific to negative information and did not hold true for positive information. This would suggest that depressed individuals should have a larger P3 response to negative information, but not positive information as was found in the 2007 study conducted by Ilardi et al.

This line of research has shown that there are cognitive biases in depression towards negative information in general and also specifically towards negative self-referent information. These biases are consistent with the maladaptive negative thought pattern that typifies depression. In the next section, I will discuss how perception may also be biased in individuals who are obese. The bias observed in obesity is again negativistic and self-referent, but is focused on body image rather than a generalized negative self-assessment.

### **Obesity and Body Image**

In behavioral studies, obese people were more likely to overestimate their body size when compared to normal weight controls (Garner, Garfinkel, Stancer, & Moldofsky, 1976). There is also a connection between poor body image and obesity (Friedman & Brownell, 1995). Overweight status has been linked to lower self-esteem in adolescent girls (Ivarsson, Svalander, Litlere, & Nevonen, 2006). Furthermore, studies have linked a higher belief in internal locus of control for weight with lower self-esteem, higher antifat prejudice, and lower psychological well-being in overweight individuals (Crandall, 1994; Quinn & Crocker, 1999; Tiggemann & Rothblum, 1997). However, Quinn and Crocker found no difference in psychological well-being

between normal weight and overweight individuals who believed they had little control over their weight, implying that perception of control plays mediating role in psychological well-being for heavy weight individuals (1999). Quinn and Crocker (1999), Crandall (1994) also propose that this perception of controllability is key for the negative attributions about self in heavy weight individuals. They go further and link perceived controllability to the protestant work ethic engendered in America's individualistic culture, suggesting that heavy individuals who believe in high controllability of their weight hold views that are counter to their self-interest because they see their weight as a failure to work hard or a lack of self-discipline. This in turn leads to negative feelings about themselves.

These finding may elucidate why some obese people are at a higher risk for depression, given that feelings of shame and of self-blame are consistent with depression and why others who do not exhibit this attention bias may not develop depression. In Kim and colleagues' 2011 review of the relationship between shame, guilt and depression, they define shame as a negative evaluation of one's self-identity that is stable, assumes excessive responsibility for uncontrollable events, and global and found that it was strongly associated with depressive symptoms (Kim, Thibodeau, & Jorgensen, 2011). Further, low self-esteem has been linked to increased levels of depression with rumination partially mediating this relationship (Kuster, Orth, & Meier, 2012). As discussed above, rumination may be linked to the aberrant attentional pattern observed in depression. Thus if obese individuals have lower self-esteem, they may be more susceptible to rumination, which has been linked and subsequent depression. Furthermore, obese individuals who see their size as an inability to control their weight and be self-disciplined may experience low self-esteem and shame, which are constructs that have both been tied to depressive symptoms and rumination.

Evidence of the idea that negative attentional biases might be a shared cognitive marker for both depression and obesity comes again from the ERP literature. Differences in processing of valenced body-image words have been found between women who are dissatisfied with their weight compared to a control group. Gao and colleagues found a larger P3 to both positive and negative body-image words than to neutral words in the women who were dissatisfied with their weight (Gao et al., 2011). Women who expressed weight concerns also had slower response times when asked to classify positive words that refer to body image when primed with a self-relevant “I” cue than when primed with an other-relevant cue, which was not the case for the control group. This suggests that weight concerns can cause cognitive interference when processing weight related information that is self-relevant (Chen & Jackson, 2006) and heighten attention to these items.

Attention bias in obesity may not only be about the self, however, other types of attentional bias have been found in obese individuals, which might provide additional challenges. For example, research looking at attention in obesity has examined obese individuals’ responses to food cues and have shown that obese individuals have increased automatic attention to food cues, but not an increased conscious attention bias to food cues (Nijs, Franken, & Muris, 2010; Nijs & Franken, 2012; Nijs, Muris, Euser, & Franken, 2010). While this kind of attentional bias may not lead directly to an increased risk for depression, it likely has a more indirect effect. Hyper attention to food cues is likely to make it harder for individuals to stick to a restrictive diet further engendering a sense of shame and failure for obese individuals, which may lead to a more negative attributional style and the development of depressive symptoms as discussed above. This additional evidence for attention bias will not be directly assessed in the current research,

but it does illustrate the utility of ERP measures for studying attention processes in patients with obesity.

### **The Current Study**

The current study is interested in examining cognitive markers of depression vulnerability in obesity with the specific aim of exploring attentional bias in these diseases. Attentional bias to emotional words and words that vary in degree of physicality were explored in three groups of individuals (depressed, obese individuals; obese, non-depressed individuals; and normal weight, non-depressed individuals) using ERP measures. A norming study was conducted prior to the current study to develop and norm a stimuli set for the current study, which will be discussed in further detail in the stimuli development section. In the current psychophysiological study, responses to neutral, negative physical, negative non-physical, positive physical, and positive non-physical words were measured using the P3 ERP component.

### **Specific Aims**

The three specific aims of this study were: 1) establish that the developed stimuli set produces a P3 in an oddball paradigm 2) examine attention for emotional valence in depression and obesity 3) examine attention for physicality in depression and obesity.

#### **Aim 1: Establish the existence of P3 in response to the newly developed stimuli set.**

This is the first study to use this set of standardized emotionally valenced words that vary in degree of physical and nonphysical traits. Therefore, as a preliminary analysis, it is important to establish that this set of word stimuli is capable of evoking attention bias in a classic P3 oddball paradigm. In accordance with the literature on the P3, all groups should exhibit greater attention to rarely presented target stimuli (ie: valenced physical and nonphysical words), when compared to frequently presented non-target stimuli (ie: neutral words). This peak in attention is captured

by a positive peak in ERP response between 500-600ms known as the P3. I hypothesized that there should be a difference in the amplitude between the rare, valenced words and the frequent, neutral words, with the rare, valenced words evoking a more positive peak. This result would indicate that participants attended more to the rare, target stimuli than the frequent, non-target stimuli and that participants attended more to the valence words than the neutral ones.

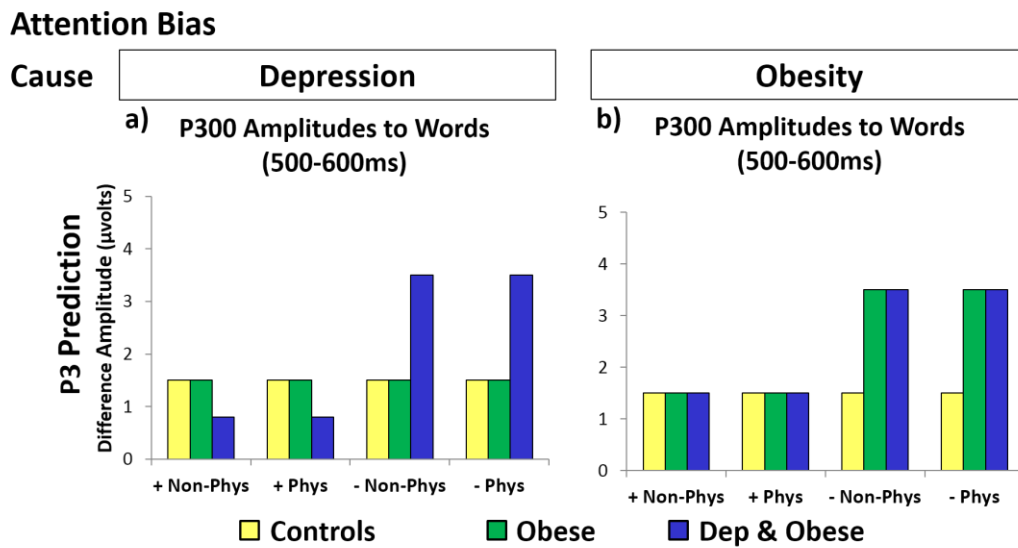
**Aim 2: Examine attention for emotional valence in depression and obesity.** Past research suggests that people have an attentional bias to negative information and that this negative attention bias is exacerbated in depression (Gotlib & Neubauer, 2000; Ilardi et al., 2007). The current study presented positive, negative, and neutral words. Therefore, I predicted that overall, negative words should produce a larger P3 than positive words in all groups. I would also expect an interaction between group and word valence such that the depressed obese group should have a larger P3 response to the negative words than the control group. If this negative attention bias observed in depression is also present in the obese non-depressed group and not in the control group, this would suggest that this negative attention bias may be a risk factor for developing depression in currently obese non-depressed individuals. However, if the obese non-depressed and control groups have similar responses, then this would indicate that the obese non-depressed participants do not exhibit such a cognitive bias despite being at a higher risk for depression than the healthy weight control group.

**Aim 3: Examine attention for physicality in depression and obesity.** While research has examined the effects of word valence on attention, this is the first study to investigate the effect of physicality in depression and obesity. People tend to have a greater attentional bias to personally salient or relevant information, which results in an elevated P3 to personally relevant information (Gray, Ambady, Lowenthal, & Deldin, 2004). Therefore, I would predict that



depressed, obese individuals should have a larger P3 to both negative physical and nonphysical words compared to the control group. This prediction is consistent with the depression literature that suggests that depressed individuals exhibit a generalized negative bias.

There are three possible ways to conceptualize potential findings on attentional bias related to valence and physicality. One possible explanation would be that the negative attention bias is specific to depression. Previous research has demonstrated a negative attention bias in depressed individuals relative to non-depressed individuals. However, second possible explanation is that the attentional bias is not specific to depression, but rather to obesity. Finally, there could be an interaction between depression and obesity in attention bias.



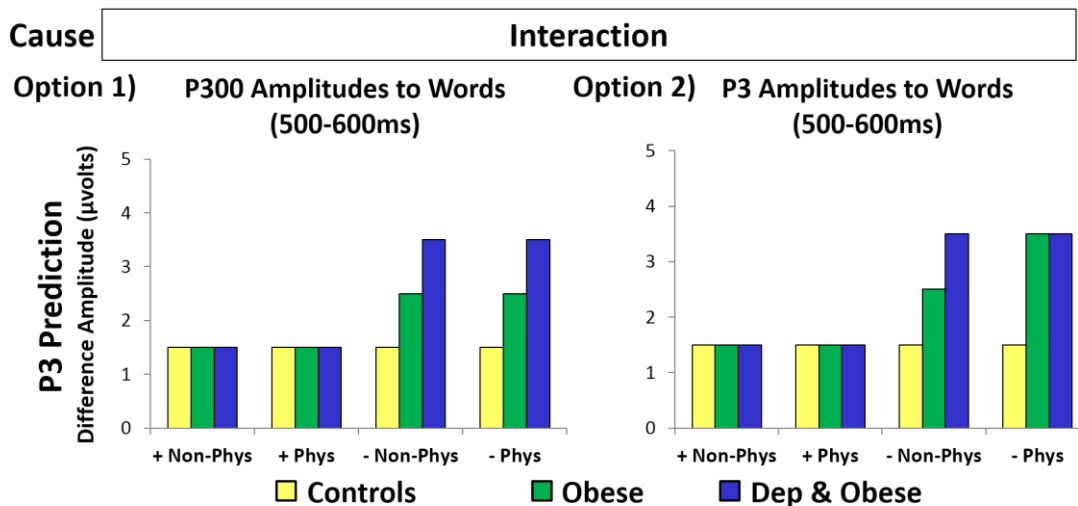
*Figure 1.* Predicted P3 difference amplitudes for valenced words compared to neutral words. Predicted results if depression alone effects attention and processing of valenced words (a) and if obesity alone effects attention and processing of valenced words (b).

As previously discussed, the P3 component of ERPs is a well-established index of attention and information salience. Therefore, according to the first explanation (depression only), I would predict that the depressed, obese group would show an increased attention bias to negative physical and negative non-physical words, as demonstrated by an increased P3 relative

to the obese, non-depressed group and the healthy weight, non-depressed group (Figure 1a). The second explanation (obesity only) would predict that both the depressed, obese and the obese, non-depressed groups would show an increased attention to negative physical and non-physical words relative to the healthy weight, non-depressed group. (Figure 1b).

Finally, the third explanation (interaction between depression and obesity) would predict that depressed, obesity group would show a strong attention bias to negative physical and non-physical words, as indexed by a heightened P3. However, in this possible interaction, the obese group should have a heightened P3 to negative physical words, given that they are relevant to their body size and shape compared to the control group. This finding would be consistent with Chen and Jackson's work on embodied, self-relevant words in obesity (Chen & Jackson, 2006). A theoretically critical outcome of this study is to observe what happens with obese, non-depressed group for the negative, non-physical stimuli. I expect that one of two outcomes are possible. (Figure 2, Option 1) A P3 in the obese, non-depressed group to both negative physical and non-physical words would suggest that the obese, non-depressed group would look similar to the obese, depressed group and has a generalized negative attention bias, putting them at a high risk for depression. This may also mean that ERPs may be a more sensitive marker of pre-clinical depression. (Figure 2, Option 2). However, the absence of an elevated P3 to negative non-physical words would indicate that the obese, non-depressed group processes emotional information in a way that is more similar to the healthy-weight, non-depressed group. This result would suggest that the way in which obese individuals process emotional information may not be what leads them to have a higher risk for depression and that they are not more sensitive to self-referent, negative stimuli than people who are health-weight, if that information is unrelated to their weight and physical appearance.

## Attention Bias



*Figure 2.* Predicted P3 difference amplitudes for valenced words compared to neutral words. Predicted results if attention and processing of valenced words are influenced by an interaction between depression and obesity. (Option 1) Potential result if obese, non-depressed individuals show an overall negativity bias. (Option 2) Potential result if obese, non-depressed individuals show a selective negativity bias to negative words related to body image.

## Method

### Participants

**Word norming study.** The word stimuli for the current study were normed in a previous study. In that study, 61 participants (33 male and 28 female) from an introductory psychology class at the University of Kansas, who received course credit for their participation, rated 409 word stimuli. These participants self-report age, height, weight, handedness, and whether English was their first language.

**Electrophysiological study.** For the current study, 77 females from an introductory psychology class at the University of Kansas and from the surrounding community, who did not participate in the norming of the stimuli, were recruited to participate. Female are the focus in this study since women are more susceptible to depression and obesity (Weissman et al., 1996; Simon et al., 2008). Participants from the introductory psychology course received course credit

for participating in this study. Community members who participated in the study received \$25 as compensation for their participation.

Individuals with a history of head trauma, neurological disorders, or substance abuse, as well as left-handed individuals and non-English speakers were excluded. Upon arrival for the study, participants' height and weight were measured to calculate BMI. Individuals whose BMI fell in the overweight category (BMI of 25-29.9) were also excluded. Participants were between the ages of 18 and 55 years old.

Table 1  
*Demographics*

<b>Group</b>	<b>Control</b>	<b>OND</b>	<b>OD</b>	<b>Total</b>
<b>Mean age (SD)</b>	21.54 (7.04)	20.22 (4.15)	29.09 (13.78)	23.70 (9.88)
<b>Ethnicity</b>				
Caucasian	92.3%	55.56%	63.64%	72.72%
African American	8.33%	0%	18.18%	9.09%
Native American	0%	11.11%	0%	3.03%
Other	0%	33.33%	18.18%	15.15%
<b>N</b>	13	9	11	33

Of the 77 females recruited from the electrophysiological study, 49 met inclusion criteria for the study. An additional 16 were excluded due to an insufficient number of usable trials (less than 10 per condition) in the ERP data. The final sample was comprised of 33 females (Table 1). Thirteen of these females were in a healthy weight range (BMI within the range of 18.5 to 24.9). These women also had no current or past history of depression, generalized anxiety disorder, or eating disorders and comprised the control group. Nine obese (BMI of 30 or above) women with no current or past history of depression, generalized anxiety disorder, anorexia nervosa, or bulimia nervosa comprised the obese group. Finally, 11 obese, depressed women were selected. These women had a BMI of 30 or above and met the SCID criteria for current major depressive disorder but had not current or past history of anorexia nervosa or bulimia nervosa. The

University of Kansas Institutional Review Board approved this study and all subjects were given written, informed consent prior to starting the study.

### **Stimuli development**

A norming study was completed prior to the current study and the results from this rating study were used to validate and select the word stimuli for the current study. In the norming study, 409 person-referent words were visually presented for 500 milliseconds (ms) each to 61 participants who rated each word in three ways: on a 1-5 scale for intensity, on a 1-5 scale for valence, and on whether the word describes physical appearance or whether it describes an emotional state, a mental characteristic, or a personality trait. From these ratings, a list of 48 affective stimuli were chosen from the norming study based on intensity, valence and whether the word describes physical appearance (physical) or whether it describes an emotional state, mental characteristic, or personality trait (nonphysical). Half the words were positive and the other half were negative. In order to compare selective attention to weight related information, 24 valenced words that are weight/appearance related (Fat or Slim) and 24 valenced words that are person-referent but not related to body shape or appearance (Caring or Unsympathetic) were selected. Additionally, 192 standard, affectively neutral words (Table) were selected from previous norming research (Affective Norms for English Words (ANEW); Bradley & Lang, 1999), yielding a ratio of 80% neutral-frequent words to 20% valenced-rare words, which is consistent with the oddball paradigm (Donchin & Heffley 1978 as cited in Luck & Kappenman, 2011; Prichard, 1981 as cited in Luck & Kappenman, 2011) (Table 2). All words were balanced for production frequency, valence, and intensity.

Table 2.  
*Examples of stimuli.*

<b>Stimuli Valence</b>	<b>Physicality</b>	<b>Examples</b>	<b>Number of stimuli presented</b>
Negative (Rare)	Physical	Chubby	12
	Non-physical	Worthless	12
Neutral (Frequent)	Neutral	Door	192
Positive (Rare)	Physical	Fit	12
	Non-physical	Self-confident	12

### **Electrophysiological study**

**Electrophysiological Recording and Analysis.** The EEG data were collected with a 128 channel high density Electrical Geodesics, Inc. (EGI) system, version 2.1. Stimulus onset was synchronized to ERP recordings through the use of E-Prime software (Psychology Software Tools, Inc., Pittsburgh, PA). The epoch of data that will be analyzed is from 100 ms prior to the critical word presentation to 1500 ms post-presentation. EGI's software was used to process the data. A 30Hz lowpass filter was applied, then the trials were segmented, artifact detection and bad channel replacement, followed by referencing to VRef and baseline correction 300ms prior to the start of the trial were applied to the data. Runs with motion artifact exceeding 65 millivolts (mV) were removed from analyses. The P3 component of the ERP data was computed from 500ms-600ms at channel 62, which is in the mid parietal region in the Pz cluster (Johnson, 1993). This area has been demonstrated to have differential P3 responses in depressed and non-depressed people. The later time window for P3 was also selected given that depressed individuals have been shown to have a latent P3 response, consistent with slower processing speed (Bruder, Kayser, & Tenke, 2012; Cavanagh & Geisler, 2006; Kayser, Bruder, Tenke, Stewart, & Quitkin, 2000).

Difference waves were calculated by subtracting the mean amplitude for the neutral words from the mean amplitude of the positive and the negative words. Individual participants'

mean amplitudes were then averaged within each of the three groups (OD, OND, HW) for the positive words and the negative words to produce grand averages. Statistics were then be run on those averages. To ensure that the newly developed stimuli set evoked a P3, valenced (rarely presented) and neutral (frequently presented) stimuli were compared with a one-sample t-test, comparing the difference amplitude to zero, collapsing across positive and negative word stimuli. To evaluate whether there was an effect of valence and physicality, difference amplitudes for positive and negative words and for physical and non-physical words were compared using 2x2 repeated measures ANOVA collapsing across groups. Group differences in the effects of valance and physicality of the stimuli were tested using a 3x2x2 repeated measures ANOVA (Group: healthy control, obese, or depressed and obese) x (Valance: positive or negative) x (Physicality: physical or non-physical).

**Experimental Procedure.** After giving consent, participants' heights and weights were measured. They also completed the Beck's Depression Inventory (BDI), which is a 21-item self-report measure of depression (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), and then the mood, eating disorder, and substance abuse modules of the Structured Clinical Interview (SCID) for DSM-IV Axis I Disorders, Research Version, Patient Edition (First, Spitzer, Gibbons, & Williams, 1997) to assess for depression, anxiety, substance abuse, and eating disorders. Next, participants were seated in front of a computer monitor and fitted with the ERP cap. They then complete the ERP portion of the study, viewing positive and neutral words, and negative and neutral words. Upon completion of this task, participants completed several self-report surveys on the computer, self-reporting their age and ethnicity and family history of depression. They also completed the Beck's Anxiety Inventory (BAI), which is a 21-item self-report measures of anxiety severity (Beck, Epstein, Brown, & Steer, 1988), the trait though-shape fusion

questionnaire as well as the state thought-shape fusion questionnaire, which is self-report measures of eating disorder psychopathology (Shafran, Teachman, Kerry, & Rachman, 1999), the Binge Eating Scale (BES), which is a 16-item self-report measure that assess binge eating behaviors (Gormally, Black, Daston, & Rardin, 1982), the Three-Factor Eating Questionnaire (TFEQ), which is a 51-item self-report measure of eating restraint, disinhibition, and hunger (Stunkard & Messick, 1985), the Rumination Response Scale (RRS), which is a 22-item self-report sub-scale of the Response Styles Questionnaire (RSQ) that measures participants' frequency of ruminative thoughts patterns (Nolen-Hoeksema & Morrow, 1991), and Stunkard's Figure Rating Scale, which measures individual's perception of their own body size as well as what they consider to be an ideal body size (Stunkard, Sørensen, & Schulsinger, 1983). The results of the self-report surveys will not be discussed in this document.

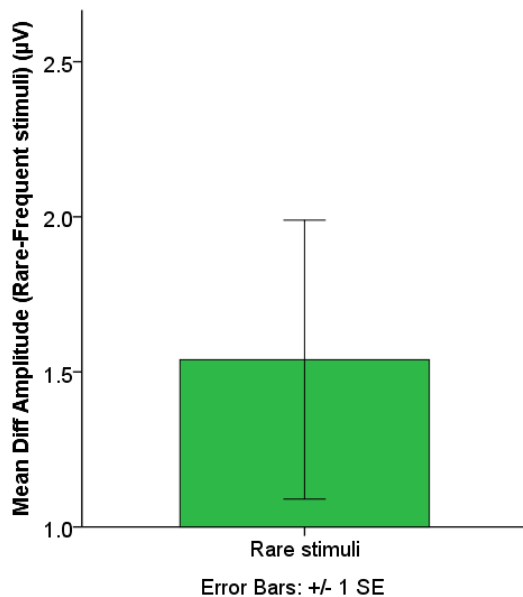
The task encompassed two blocks. One block contained positive and neutral words and the other block contained negative and neutral words. The same neutral words were used in both blocks and the order that the blocks were presented in were counterbalanced. As discussed above, the well-established oddball paradigm was employed, which is often used to evoke P3 responses (e.g., Osterhout & Holcomb, 1995; Reinvang, 1999). In this paradigm, the ERP response to a frequently occurring stimulus type (neutral words) was compared to a rare occurring stimulus type (either positively or negatively valenced words). Each word was presented for 500 ms followed by a 500 ms fixation. Neutral and valenced words were presented in a random order. At the conclusion of the study, study personnel debriefed participants. The study required approximately three hours to complete.

## **Results**

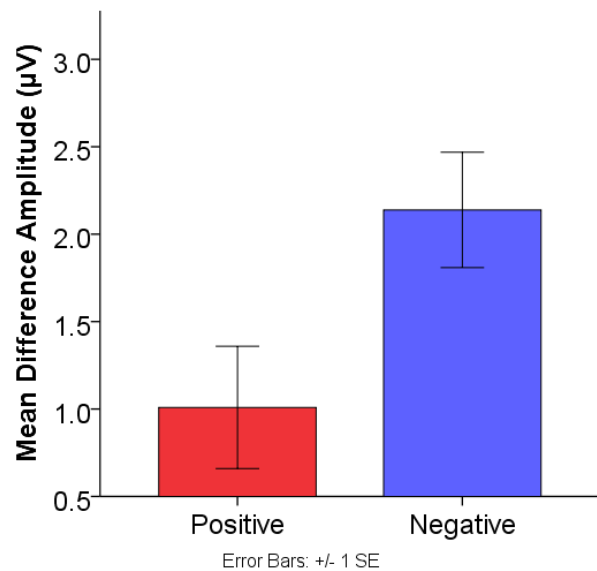
Analyses were conducted to establish that a P3 was successfully produced for the



rare/valenced word condition compared to the frequent/neutral word condition across all groups. One sample t-test results comparing difference waves indicated that there was a greater P3 for the rare/valenced words than for neutral words ( $t(131)=6.438$ ,  $p<0.001$ ), demonstrating that the paradigm was successful in eliciting a P3 response (Figure 3).



*Figure 3.* Mean difference amplitude for valenced (rare) – neutral (frequent) stimuli collapsing across groups.



*Figure 4.* Mean difference amplitude for positively and negatively valenced words, collapsing across groups.

The amplitude of the P3 for positively versus negatively valenced words was compared in an effort to replicate past literature finding an overall attention bias towards negative words as was the amplitude of the P3 for physical and non-physical words in a 2x2 repeated measures ANOVA. The results of this repeated measures ANOVA showed a significant main effect of valence and a significant interaction of valence x physicality, but no main effect of physicality (Table 3).

Table 3  
 2x2 Repeated Measures ANOVA

Variable	Mean	(SD)	F (1,32)	(p)
<b>Valence</b>			8.173	0.007
<b>Positive</b>	1.009	0.362		
<b>Negative</b>	2.139	0.404		
<b>Physicality</b>			0.203	0.656
<b>Physical</b>	1.640	.364		
<b>Non-physical</b>	1.507	.357		
<b>Physicality x Valence</b>			6.542	0.015
+ <b>Physical</b>	.479	.526		
+ <b>Non-physical</b>	1.539	.450		
- <b>Physical</b>	2.802	.476		
- <b>Non-physical</b>	1.475	.434		

These results support previous findings and show a larger P3 for negatively valence words compared to positively valenced words (Figure 4). There was no difference in P3 amplitude for physical words compared to nonphysical words. However there was an interaction between valence and physicality. Post-hoc t-tests showed difference between positively and negatively valenced physical words with negatively valenced physical words producing a larger P3 ( $t(32)=3.622, p=0.001$ ) and between negative physical and non-physical words with negative physical words evoking a larger P3 ( $t(32)=2.046, p=0.049$ ). The comparison between negative physical words and positive non-physical words was marginally significant ( $t(32)=1.942, p=0.061$ ) (Figure 6). Figure 5 depicts the P3 elicited the four stimuli conditions (negative non-physical, negative physical, positive non-physical, and positive, physical) in the three groups.

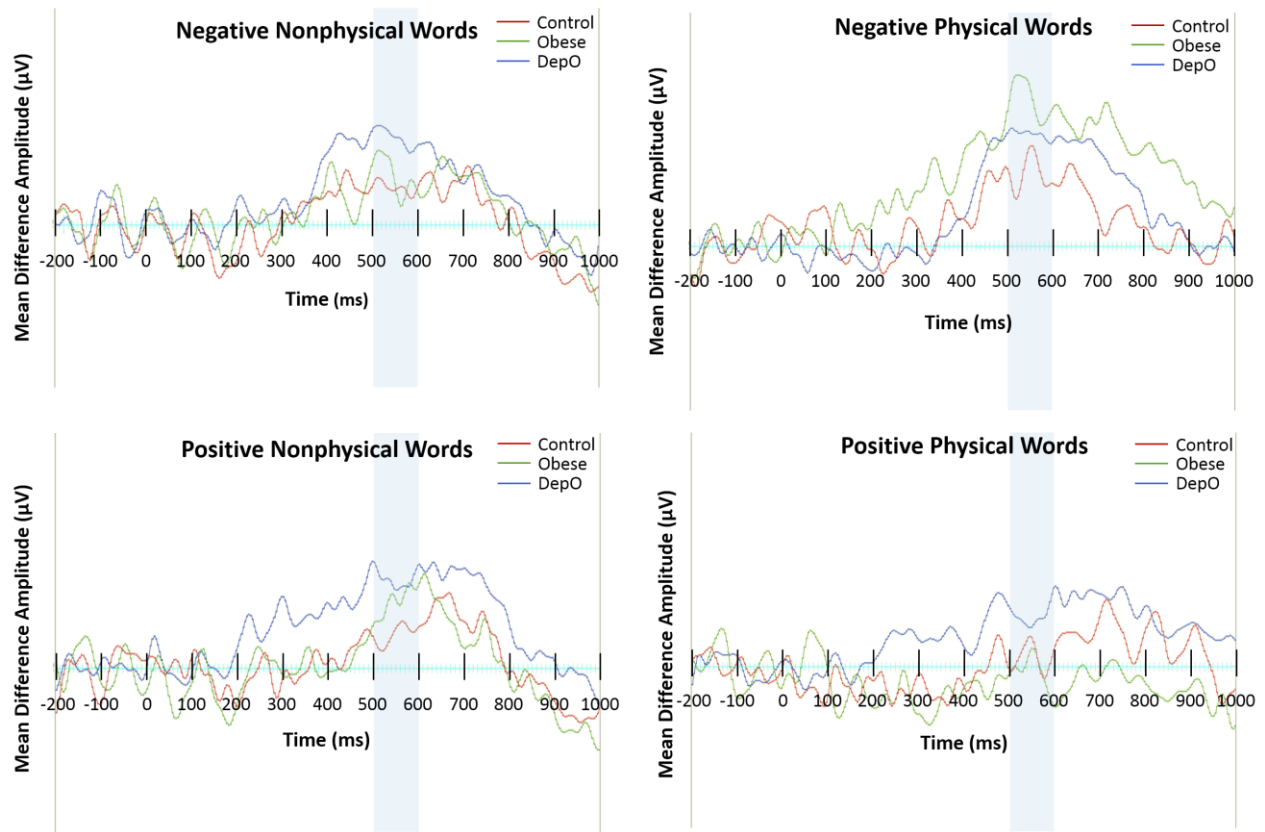


Figure 5. Time course plots of the ERP waveforms with 0 ms on the X-axis representing stimulus onset and the P3 window examined from 500-600ms depicted in blue.

There were no effects of group on valence ( $F(1,30)=0.534, p=0.592$ ) or physicality ( $F(1,30)=0.254, p=0.777$ ) or on the interaction of the two ( $F(1,30)=0.817, p=0.451$ ) in the 3x2x2 ANOVA (Group: healthy control, obese, or depressed and obese) x (Valance: positive or negative) x (Physicality: physical or non-physical). There was also no main effect of group ( $F(2,30)=1.264, p=0.297$ ).

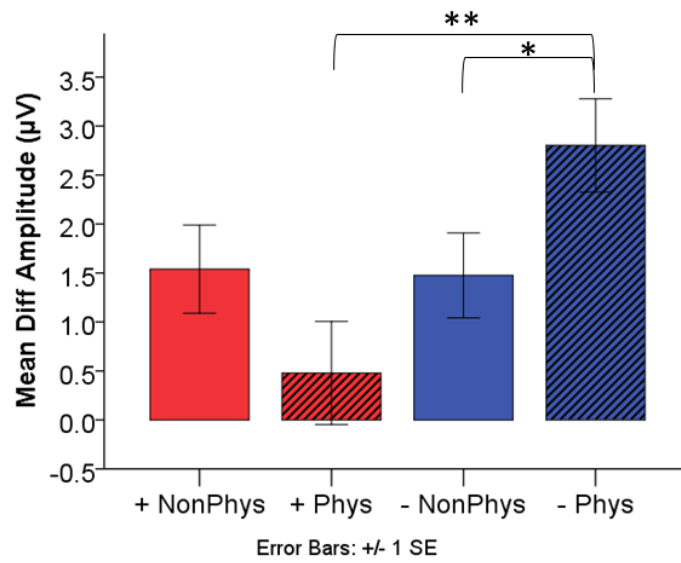


Figure 6. Mean difference amplitude for each stimulus type, collapsing across groups.  
 $*p < 0.05$ ,  $**p = 0.001$

## Discussion

The purpose of this study was to investigate differences in the cognitive processing of person-referent words in depression and obesity and identify a cognitive marker of depression vulnerability in obesity. Attention to physical and non-physical person-referent stimuli was compared through the analysis of P3 difference wave amplitudes, as the P3 captures attention allocation to salient stimuli. The results indicated three main findings: 1) The P3 oddball paradigm with valenced (rare) and neutral (frequent) words produces a reliable P3 ERP component. 2) The magnitude of the P3 is influenced by word valence, with an attention bias towards negative words across groups. 3) Valence impacts the response to the physicality of the words such that there is a greater attentional bias towards negative physical words than positive physical words and a greater attentional bias towards negative physical words than to negative non-physical words across groups. The numerical and statistical trends in the data seem to argue that there is a particular attentional salience for negative information that references physicality.

There was no difference in P3 amplitude between the two positive conditions and the negative, non-physical condition. There were no significant effects of group on overall amplitude, valence, or physicality.

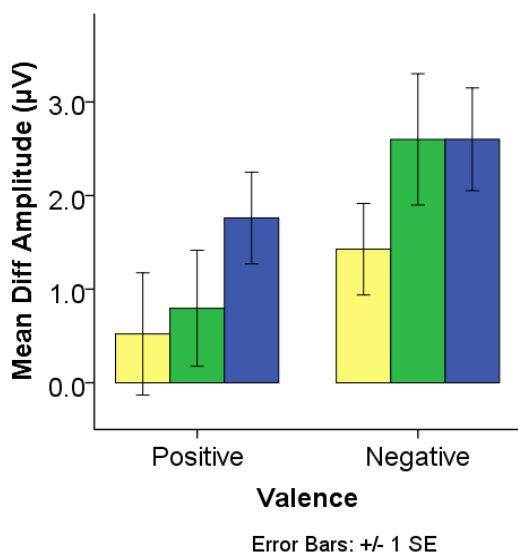
Establishment of a reliable P3 component demonstrates that the paradigm and this newly developed stimulus set are capable of capturing attention and could have applications in future studies of obesity and embodiment. While there was no rare, neutral word condition to compare the magnitude of the P3 for the rare, valenced word condition to, previous research has shown a greater P3 to emotionally valenced words compared to neutral words (Stormark, Nordby, & Hugdahl, 1995). As discussed by Stormark, Nordby, and Hugdahl, emotionally valenced words can evoke memories with emotional connotations, which then makes it more difficult to shift attention away from an emotionally valenced cue relative to a neural cue.

This general attention bias to affective information would suggest that valenced words would conjure up memories that are the most salient and accessible to a particular individual. Thus, one might expect positively valenced words to be more salient to euthymic individuals and negatively valenced words to be more salient to depressed individuals. While this study did not find statistically reliable differences in attentional salience between the non-depressed groups and the obese, depressed group, this line of reasoning has important implications for the current study. It suggests that the obese, non-depressed group may have more difficulty shifting attention away from the relevant self-referent words (i.e. negative physical word) and the obese, depressed group may have more difficulty shifting attention away from the negative physical and non-physical words as these words should be more salient to them and linked to memories that are more readily accessible, given their generalized depressotypic mindset. The interaction found between valence and physicality lends support to this hypothesis. The negative physical

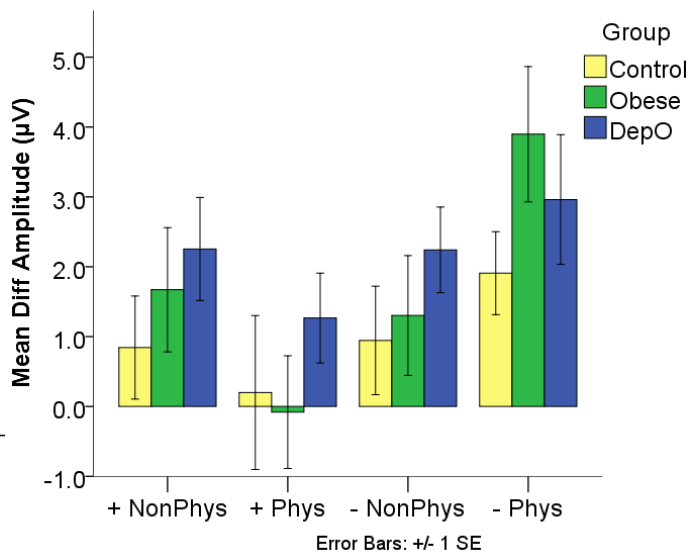
word condition evoked the largest P3 difference amplitude across groups, indicating that it was the most salient. Given that the negative, physical condition was predicted to be one of the most salient conditions for two out of the three groups examined in this study (obese, depressed and the obese, non-depressed groups), it follows that this condition should have an increased P3 difference amplitude when collapsing across groups.

Furthermore, negative cognitive styles have been found to interact with rumination to predict onset, number, and duration of depressive episodes (Robinson & Alloy, 2003), thus understanding if the obese, non-depressed group exhibits a negative cognitive style is critical to understanding their vulnerability to depression. Moreover, the general bias towards negative information and the propensity to ruminate, which are known features of depression, are a potential causal mechanism for the difficulties in shifting attention observed in depression. This notion is further supported by findings that suggest that depressed individuals have difficulty shifting attention during affective tasks compared to non-depressed controls (Lo & Allen, 2011) and show diminished ability to inhibit information after being primed with a rumination induction when compared to non-depressed controls (Watkins & Brown, 2002). While not statistically reliable, the current study found a trend for the obese, depressed group to have higher overall attention to valenced words compared to the control group, which was more pronounced in the negatively valenced words (Figure 7). The aberrant attentional patterns indicating a hyper-focus on negative information. Deficits in executive function seen in depression not only make these processes targets for cognitive therapy, but also demonstrate that cognitive markers such as the P3 vary between depressed and non-depressed groups and can be used to potentially distinguish between depressed and non-depressed individuals. Therefore when examining the data in the current study with respect to the obese, non-depressed group,

there is evidence to believe that this paradigm should be sensitive to cognitive vulnerabilities to depression.



*Figure 7.* Mean difference amplitude for positively and negatively valenced words broken down by group, collapsing across physical and non-physical conditions.



*Figure 8.* Mean difference amplitude for each stimulus type broken down by group.

As was just discussed, the obese, depressed group show a trend towards heightened attention to valenced words compared to the control group. Interestingly, the obese, non-depressed group tends to mirror the obese, depressed group's increased attention pattern to negative words, but looks more like the control group with respect to positive words (Figure 7). Furthermore, the obese, non-depressed group shows the greatest attentional bias to negative physical words, indicating that these words are particularly salient and relevant to them (Figure 8). These trends bolster the argument that the obese, non-depressed group has an aberrant attentional pattern to select negative stimuli, but that this attentional pattern has not generalized to the same extent that it has in the obese, depressed group. In fact, in 2008, Markowitz, Friedman, and Arent argued that negative thoughts might be a common mechanism leading to the bidirectionality of obesity and depression (Markowitz, Friedman, & Arent, 2008). However,

the full causal mechanism for these comorbid conditions may be more complicated. As discussed in Hrabosky's 2008 review, Kendall and colleagues argued that in obesity, having a high amount of negative self-thoughts and a low amount of positive self-thought was a better predictor of depression than negative self-thoughts alone (as discussed by Hrabosky & Thomas, 2008). This finding is relevant to the obese, non-depressed group in this study, who have a selective negative attention bias to physical information, similar to the obese, depressed group. However, the obese, non-depressed group mirrors the processing style of the control group for positive information, which suggests that they may have higher amounts of positive self-thoughts than depressed, obese individuals, which may be a protective factor against the development of depression in this group.

Another framework through which to interpret these results is to return to attribution theory. The trend towards an attention bias to negative physical words in the obese, non-depressed group could indicate that the obese, non-depressed group sees the negative weight and body image related words as more self-relevant and salient leading to a larger P3 and that this condition causes more cognitive dissonance for the obese, depressed group. Steele's argument for the role of self-affirmation in the maintenance of self-integrity could help support these finding (1988). Steele asserts that when people's self-concept is threatened, they will look for other ways to reaffirm their self-concept. Thus, the obese, non-depressed group could see rating the negative physical words that are self-descriptors (e.g. Fat) as negative during the ERP task as a threat to their self-concept and look to reaffirm that self-concept by viewing themselves more positively in other domains (e.g. positively valenced words). This would suggest that the obese, non-depressed group should have less dissonance in rating themselves high on the positive traits and may not perseverate on the choice to rate the word as positive or neutral as much. Thus if



the obese, non-depressed group still maintained a positive self-view, which may be mediated by a perceived lack of control of their weight, they would experience cognitive dissonance when forced to rate words that describe their body as negative. Steele's theory would then predict that they would work to reduce this dissonance and maintain overall self-integrity through affirming a positive self-value in other ways and thus not exhibit as great of an attention bias towards positive words, mimicking the control group for those conditions (Figure 7). This theoretical argument would also be supported by Kendall et al.'s research discussed in the previous paragraph such that while having an attentional response that is similar to the obese, depressed group, the obese non-depressed group maintains an attentional response to positive words that is similar to the control group. Kendall et al. linked this balance between positive and negative self-referent information to more positive mental health than the overall negative pattern evinced by the obese, depressed group (as discussed in Hrabosky & Thomas, 2008).

To look more closely at potential delineating factors between obese, non-depressed individuals and obese, depressed individuals that are consistent with the trend for the obese, non-depressed group to have increased attention that is specific to negative words related to body image, I will discuss the role of body image, self-esteem, and stigmatization in obesity. As discussed in the "Body Image and Obesity" section of the introduction, a higher belief in an internal locus of control of weight has been linked to lower self-esteem and worse psychological outcomes (Crandall, 1994; Quinn & Crocker, 1999; Tiggemann & Rothblum, 1997). Annis, Cash, and Hrabosky also found that overweight women tend to be more preoccupied with weight, their appearance, have lower self-esteem and life satisfaction and have been stigmatized than formerly overweight and health weight individuals (2004). This stigmatization has dramatically increased in the past decade and occurs at rates that are commensurate with racial

discrimination. According to Puhl and Heuer's 2009 review of the stigma of obesity, weight biases are present in the workplace, in health care, and in educational settings. They argue that individuals who are obese are stereotyped as "lazy, unmotivated, lacking in self-discipline, less competent, noncompliant, and sloppy" (Puhl & Heuer, 2009). These sentiments link closely to Crandall's argument about the protestant work ethic and place the locus of control on the individual, putting forth the idea that their weight should be controllable. Thus, bodily characteristics are the factor that is causing obese individuals to be stigmatized and they are also the stimuli in this study (negative physical words) that the obese, non-depressed individuals and the obese, depressed individuals find most salient and have a heightened attentional bias towards.

Typically, marginalized groups hold an in-group bias that helps buffer them from such out-group criticism. However, literature on stigmatization and obesity also suggests that overweight and obese people do not hold an in-group bias, but rather stigmatize other obese individuals (Wang, Brownell, & Wadden, 2004). There have been some cultural differences noted in this behavior. Specifically within the African American culture, women tend not to stigmatize obesity (Hebl, King, & Perkins, 2009). Nevertheless, this stigmatization and lack of in-group support may lead to less social support, which is a risk factor for depression.

Thus, some potential distinctions between obese individuals who are depressed and ones who are not depressed may be their exposure to these stigmas, whether they internalize these personality characteristics presented in the stigmas, and whether they see their weight status as controllable and an indicator of their failure to regulate their eating or other weight related behaviors. Individual's self-esteem may be impacted depending on where individuals align themselves on these variables, and may lead to the development of a negative generalized sense of self and subsequent depression. Low self-esteem and lack of social support are related to an

increased risk for depression (Brown, Andrews, Harris, Adler, & Bridge, 1986), whereas, higher levels of social support have been shown to buffer stress and be associated with better health outcomes (Cohen & Wills, 1985; Uchino, 2006). Thus the role of self-esteem and social support are important factors to consider when examining and attempting to explain the distinguishing cognitive features between these groups.

### **Conclusion**

This study aimed at exploring the differences in cognitive processing in HW, OND, and OD people, with the hopes of identifying how obesity increases a person's vulnerability for depression. The trend towards a difference in attention to negative non-physical words in the OD group compared to the control group and the extent to which obese individuals generalize negative self-referent information suggest potential risks for depression vulnerability in obesity. This knowledge may help guide cognitive therapy for obese individuals who are at risk for depression, emphasizing the importance of reinforcing positive self-attributes and avoiding negative self-focus and ruminative attention. Such an approach has been shown to be effective in addressing depression and the attentional biases that accompany it. For example, mindfulness-based cognitive therapy focuses on attention and has been shown to decrease rumination and depression (e.g., Deyo, Wilson, Ong, & Koopman, 2009; Helen & Teasdale, 2004; Teasdale et al., 2000).

Despite the fact that the hypotheses about group difference in attention were not statistically supported, the trends observed provide valuable insight for future directions in obesity and depression research. Finding no statistical differences between the obese, non-depressed group and the obese, depressed group may suggest that the obese group has a

subclinical level of depression that may eventually develop into depression over time, or that cognitive processing of physical words is not sensitive to this potential vulnerability.

### **Further Directions**

In order to further test the hypotheses and results from this study, a longitudinal study of obese, non-depressed participants could be performed to see if any of the participants develop depression as a later point, then a post-hoc analysis could be done to try to identify how these individuals differed from the ones who did not later develop depression. Additionally, this paradigm could be taken into an fMRI study to investigate structural and functional difference between these three groups. Given the research on perceived controllability of weight and its link to self-esteem, these factors should also be considered as potential mediators in cognitive differences and be explored in future work. Additional social and cultural factors such as social support and body image views within groups need to be examined to understand potential mediating factors.

### **Limitations**

A few limitations of this study should be considered. First, all participants are females. Since both obese and healthy weight females have a higher risk for depression than men, there may be a different cognitive process occurring in men that lowers their vulnerability to depression, which would be worthwhile to investigate. Second, this study does not include a depressed, healthy weight group. Given that one of the main aims of this study is to identify potential cognitive markers for depression in obesity, I was most interested in OND individuals. However, any differences I found between the OND and OD group could be due to depression alone and not the interaction of depression and obesity. Additionally, this study had a small sample size, which limited the power for between group comparisons. Lastly, a greater number

of trials for each stimulus type would potentially help to increase percentage of viable ERP data and help lower the standard error, thus increasing power and decreasing the chances of a type II error.

## References

- Ancy, J., Gangadhar, B. N., & Janakiramaiah, N. (1996). "Normal" P300 amplitude predicts rapid response to ECT in melancholia. *Journal of Affective Disorders, 41*(3), 211–215.  
doi:10.1016/S0165-0327(96)00090-0
- Andreyeva, T., Sturm, R., & Ringel, J. S. (2004). Moderate and severe obesity have large differences in health care costs. *Obesity Research, 12*(12), 1936–1943.  
doi:10.1038/oby.2004.243
- Annis, N. M., Cash, T. F., & Hrabosky, J. I. (2004). Body image and psychosocial differences among stable average weight, currently overweight, and formerly overweight women: the role of stigmatizing experiences. *Body Image, 1*(2), 155–167.  
doi:10.1016/j.bodyim.2003.12.001
- Beck, A. T. (1967). *Depression: Clinical, Experimental, and Theoretical Aspects*. University of Pennsylvania Press.
- Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology, 56*(6), 893–897. doi:10.1037/0022-006X.56.6.893
- Beck, A. T., Rush, A. J., Shaw, B. F., & Emery, G. Cognitive therapy of depression, 1979. *Guilford, New York*.
- Beck A.T., Ward C.H., Mendelson M.M., Mock J, & Erbaugh J. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*(6), 561–571.  
doi:10.1001/archpsyc.1961.01710120031004
- Berman, M. G., Nee, D. E., Casement, M., Kim, H. S., Deldin, P., Kross, E., ... Jonides, J. (2011). Neural and behavioral effects of interference resolution in depression and

- rumination. *Cognitive, Affective, & Behavioral Neuroscience*, *11*(1), 85–96.  
doi:10.3758/s13415-010-0014-x
- Bradley, M. M., Lang, P. J., Bradley, M. M., & Lang, P. J. (1999). *Affective Norms for English Words (ANEW): Instruction manual and affective ratings*.
- Brandeis, D., Banaschewski, T., Baving, L., Georgiewa, P., Blanz, B., Warnke, A., ... Scheuerpflug, P. (2002). Multicenter P300 brain mapping of impaired attention to cues in hyperkinetic children. *Journal of the American Academy of Child and Adolescent Psychiatry*, *41*(8), 990–998.
- Brown, G. W., Andrews, B., Harris, T., Adler, Z., & Bridge, L. (1986). Social support, self-esteem and depression. *Psychological Medicine*, *16*(04), 813–831.  
doi:10.1017/S0033291700011831
- Bruder, G., Kayser, J., & Tenke, C. E. (2012). Event-Related Brain Potentials in Depression: Clinical, Cognitive, and Neurophysiological Implications. In S. J. Luck & E. S. Kappenman (Eds.), *The Oxford Handbook of Event-Related Potential Components*. Oxford University Press.
- Bruder, G. E., Towey, J. P., Stewart, J. W., Friedman, D., Tenke, C., & Quitkin, F. M. (1991). Event-related potentials in depression: Influence of task, stimulus hemifield and clinical features on P3 latency. *Biological Psychiatry*, *30*(3), 233–246. doi:10.1016/0006-3223(91)90108-X
- Canli, T., Desmond, J. E., Zhao, Z., Glover, G., & Gabrieli, J. D. (1998). Hemispheric asymmetry for emotional stimuli detected with fMRI. *Neuroreport*, *9*(14), 3233–3239.

- Cavanagh, J., & Geisler, M. W. (2006). Mood effects on the ERP processing of emotional intensity in faces: A P3 investigation with depressed students. *International Journal of Psychophysiology*, *60*(1), 27–33. doi:10.1016/j.ijpsycho.2005.04.005
- Chakroun, H. (1988). Effects of selective attention on visual evoked potentials in depressed patients and healthy controls. *Acta Psychiatrica Belgica*, *88*, 138–152.
- Chen, H., & Jackson, T. (2006). Differential processing of self-referenced versus other-referenced body information among American and Chinese young adults with body image concerns. *Eating Behaviors*, *7*(2), 152–160. doi:10.1016/j.eatbeh.2005.08.012
- Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin*, *98*(2), 310–357.
- Crandall, C. S. (1994). Prejudice against fat people: ideology and self-interest. *Journal of Personality and Social Psychology*, *66*(5), 882–894.
- Davidson, R. J. (1995). Cerebral asymmetry, emotion, and affective style. In R. J. Davidson & K. Hugdahl (Eds.), *Brain asymmetry*. (pp. 361–387). Cambridge, MA, US: The MIT Press.
- de Wit, L., Luppino, F., van Straten, A., Penninx, B., Zitman, F., & Cuijpers, P. (2010). Depression and obesity: a meta-analysis of community-based studies. *Psychiatry Research*, *178*(2), 230–235. doi:10.1016/j.psychres.2009.04.015
- Deyo, M., Wilson, K. A., Ong, J., & Koopman, C. (2009). Mindfulness and Rumination: Does Mindfulness Training Lead to Reductions in the Ruminative Thinking Associated With Depression? *EXPLORE: The Journal of Science and Healing*, *5*(5), 265–271. doi:10.1016/j.explore.2009.06.005



Dietrich, D. E., Emrich, H. M., Waller, C., Wieringa, B. M., Johannes, S., & Münte, T. F.

(2000). Emotion/cognition-coupling in word recognition memory of depressive patients: an event-related potential study. *Psychiatry Research*, *96*(1), 15–29. doi:10.1016/S0165-1781(00)00187-6

Donchin, E., & Heffley, E. (1978). Linear combinations in the analysis of ERPs.

*Multidisciplinary perspectives in event-related brain potential research. EPA-600/9-77-043, US Government Printing Office, Washington, DC.*

Eckel, R. H., Barouch, W. W., & Ershow, A. G. (2002). Report of the National Heart, Lung, and Blood Institute-National Institute of Diabetes and Digestive and Kidney Diseases Working Group on the Pathophysiology of Obesity-Associated Cardiovascular Disease. *Circulation*, *105*(24), 2923–2928. doi:10.1161/01.CIR.0000017823.53114.4C

Faith, M. S., Matz, P. E., & Jorge, M. A. (2002). Obesity-depression associations in the population. *Journal of Psychosomatic Research*, *53*(4), 935–942.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1997). Structured Clinical Interview for DSM-IV Axis I Disorders, Clinician Version. Washington, DC: American Psychiatric Press.

Friedman, M. A., & Brownell, K. D. (1995). Psychological correlates of obesity: moving to the next research generation. *Psychological Bulletin*, *117*(1), 3–20.

Gao, X., Deng, X., Chen, N., Luo, W., Hu, L., Jackson, T., & Chen, H. (2011). Attentional biases among body-dissatisfied young women: An ERP study with rapid serial visual presentation. *International Journal of Psychophysiology*, *82*(2), 133–142. doi:10.1016/j.ijpsycho.2011.07.015

- Garner, D. M., Garfinkel, P. E., Stancer, H. C., & Moldofsky, H. (1976). Body image disturbances in anorexia nervosa and obesity. *Psychosomatic Medicine*, *38*(5), 327–336.
- Gormally, J., Black, S., Daston, S., & Rardin, D. (1982). The assessment of binge eating severity among obese persons. *Addictive Behaviors*, *7*(1), 47–55.
- Gotlib, I. H., Krasnoperova, E., Yue, D. N., & Joormann, J. (2004). Attentional Biases for Negative Interpersonal Stimuli in Clinical Depression. *Journal of Abnormal Psychology*, *113*(1), 127–135. doi:10.1037/0021-843X.113.1.121
- Gotlib, I. H., & Neubauer, D. L. (2000). Information-processing approaches to the study of cognitive biases in depression. *Stress, coping, and depression*, 117-143.
- Gray, H. M., Ambady, N., Lowenthal, W. T., & Deldin, P. (2004). P300 as an index of attention to self-relevant stimuli. *Journal of Experimental Social Psychology*, *40*(2), 216–224. doi:10.1016/S0022-1031(03)00092-1
- Hebl, M. R., King, E. B., & Perkins, A. (2009). Ethnic differences in the stigma of obesity: Identification and engagement with a thin ideal. *Journal of Experimental Social Psychology*, *45*(6), 1165–1172. doi:10.1016/j.jesp.2009.04.017
- Helen, S., & Teasdale, J. D. (2004). Mindfulness-Based Cognitive Therapy for Depression: Replication and Exploration of Differential Relapse Prevention Effects. *Journal of Consulting and Clinical Psychology*, *72*(1), 31–40. doi:10.1037/0022-006X.72.1.31
- Hrabosky, J. I., & Thomas, J. J. (2008). Elucidating the relationship between obesity and depression: Recommendations for future research. *Clinical Psychology: Science and Practice*, *15*(1), 28–34.

- Iardi, S. S., Atchley, R. A., Enloe, A., Kwasny, K., & Garratt, G. (2007). Disentangling attentional biases and attentional deficits in depression: An event-related potential P300 analysis. *Cognitive Therapy and Research, 31*(2), 175–187.
- Ingram, R. E., Miranda, J., & Segal, Z. (2006). Cognitive vulnerability to depression. *Cognitive vulnerability to emotional disorders, 63*-91.
- Ivarsson, T., Svalander, P., Litlere, O., & Nevonen, L. (2006). Weight concerns, body image, depression and anxiety in Swedish adolescents. *Eating Behaviors, 7*(2), 161–175.  
doi:10.1016/j.eatbeh.2005.08.005
- Johnson, R., Jr. (1993). On the neural generators of the P300 component of the event-related potential. *Psychophysiology, 30*(1), 90–97.
- Kayser, J., Bruder, G. E., Tenke, C. E., Stewart, J. E., & Quitkin, F. M. (2000). Event-related potentials (ERPs) to hemifield presentations of emotional stimuli: differences between depressed patients and healthy adults in P3 amplitude and asymmetry. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology, 36*(3), 211–236.
- Keil, A., Bradley, M. M., Hauk, O., Rockstroh, B., Elbert, T., & Lang, P. J. (2002). Large-scale neural correlates of affective picture processing. *Psychophysiology, 39*(5), 641–649.  
doi:10.1017.S0048577202394162
- Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*(6), 593.
- Kim, S., Thibodeau, R., & Jorgensen, R. S. (2011). Shame, guilt, and depressive symptoms: A meta-analytic review. *Psychological Bulletin, 137*(1), 68–96. doi:10.1037/a0021466

- Kuster, F., Orth, U., & Meier, L. L. (2012). Rumination Mediates the Prospective Effect of Low Self-Esteem on Depression A Five-Wave Longitudinal Study. *Personality and Social Psychology Bulletin*, 38(6), 747–759. doi:10.1177/0146167212437250
- Lo, B. C. Y., & Allen, N. B. (2011). Affective bias in internal attention shifting among depressed youth. *Psychiatry Research*, 187(1–2), 125–129. doi:10.1016/j.psychres.2010.10.001
- Luck, S. J., & Kappenman, E. S. (2011). *The Oxford Handbook of Event-Related Potential Components*. Oxford University Press.
- Luppino, F. S., de Wit, L. M., Bouvy, P. F., Stijnen, T., Cuijpers, P., Penninx, B. W. J. H., & Zitman, F. G. (2010). Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Archives of General Psychiatry*, 67(3), 220.
- Markowitz, S., Friedman, M. A., & Arent, S. M. (2008). Understanding the relation between obesity and depression: causal mechanisms and implications for treatment. *Clinical Psychology: Science and Practice*, 15(1), 1–20.
- Mathers, C. D., & Loncar, D. (2006). Projections of Global Mortality and Burden of Disease from 2002 to 2030. *PLoS Med*, 3(11), e442. doi:10.1371/journal.pmed.0030442
- Mokdad, A. H., Bowman, B. A., Ford, E. S., Vinicor, F., Marks, J. S., & Koplan, J. P. (2001). The continuing epidemics of obesity and diabetes in the United States. *JAMA: The Journal of the American Medical Association*, 286(10), 1195–1200.
- Mokdad, A. H., Serdula, M. K., Dietz, W. H., Bowman, B. A., Marks, J. S., & Koplan, J. P. (1999). The spread of the obesity epidemic in the United States, 1991-1998. *JAMA: The Journal of the American Medical Association*, 282(16), 1519–1522.

- Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G., & Dietz, W. H. (1999). The disease burden associated with overweight and obesity. *JAMA: The Journal of the American Medical Association*, *282*(16), 1523–1529.
- Nijs, I. M. T., & Franken, I. H. A. (2012). Attentional Processing of Food Cues in Overweight and Obese Individuals. *Current Obesity Reports*, *1*(2), 106–113. doi:10.1007/s13679-012-0011-1
- Nijs, I. M. T., Franken, I. H. A., & Muris, P. (2010). Food-related Stroop interference in obese and normal-weight individuals: Behavioral and electrophysiological indices. *Eating Behaviors*, *11*(4), 258–265. doi:10.1016/j.eatbeh.2010.07.002
- Nijs, I. M. T., Muris, P., Euser, A. S., & Franken, I. H. A. (2010). Differences in attention to food and food intake between overweight/obese and normal-weight females under conditions of hunger and satiety. *Appetite*, *54*(2), 243–254. doi:10.1016/j.appet.2009.11.004
- Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and posttraumatic stress symptoms after a natural disaster: the 1989 Loma Prieta Earthquake. *Journal of Personality and Social Psychology*, *61*(1), 115–121.
- Nolen-Hoeksema, S., Morrow, J., & Fredrickson, B. L. (1993). Response styles and the duration of episodes of depressed mood. *Journal of Abnormal Psychology*, *102*(1), 20–28. doi:10.1037/0021-843X.102.1.20
- Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity in the United States, 2009-2010. *NCHS Data Brief*, (82), 1–8.

- Onyike, C. U., Crum, R. M., Lee, H. B., Lyketsos, C. G., & Eaton, W. W. (2003). Is obesity associated with major depression? Results from the Third National Health and Nutrition Examination Survey. *American Journal of Epidemiology*, *158*(12), 1139–1147.
- Osterhout, L. & Holcomb, P. J. (1995). Event-related potentials and language Comprehension. *Electrophysiology of Mind: Event-Related Brain Potentials and Cognition*. M. D. Rugg & M. G. H. Coles (Eds.). Oxford, NY, Tokyo: Oxford University Press.
- Pan, A., Sun, Q., Czernichow, S., Kivimaki, M., Okereke, O. I., Lucas, M., Hu, F. B. (2012). Bidirectional association between depression and obesity in middle-aged and older women. *International Journal of Obesity*, *36*(4), 595–602. doi:10.1038/ijo.2011.111
- Peterson, C., Seligman, M. E., & Vaillant, G. E. (1988). Pessimistic explanatory style is a risk factor for physical illness: a thirty-five-year longitudinal study. *Journal of Personality and Social Psychology*, *55*(1), 23–27.
- Puhl, R. M., & Heuer, C. A. (2009). The Stigma of Obesity: A Review and Update. *Obesity*, *17*(5), 941–964. doi:10.1038/oby.2008.636
- Quinn, D. M., & Crocker, J. (1999). When ideology hurts: effects of belief in the protestant ethic and feeling overweight on the psychological well-being of women. *Journal of Personality and Social Psychology*, *77*(2), 402–414.
- Reinvang, I. (1999). Cognitive Event-Related Potentials in Neuropsychological Assessment. *Neuropsychology Review*, *9*(4), 231–248. doi:10.1023/A:1021638723486
- Robinson, M. S., & Alloy, L. B. (2003). Negative Cognitive Styles and Stress-Reactive Rumination Interact to Predict Depression: A Prospective Study. *Cognitive Therapy and Research*, *27*(3), 275–291. doi:10.1023/A:1023914416469

- Scott, K. M., McGee, M. A., Wells, J. E., & Oakley Browne, M. A. (2008). Obesity and mental disorders in the adult general population. *Journal of Psychosomatic Research, 64*(1), 97–105. doi:10.1016/j.jpsychores.2007.09.006
- Shafran, R., Teachman, B. A., Kerry, S., & Rachman, S. (1999). A cognitive distortion associated with eating disorders: Thought-shape fusion. *British Journal of Clinical Psychology, 38*(2), 167–179. doi:10.1348/014466599162728
- Simon, G. E., Arterburn, D., Rohde, P., Ludman, E. J., Linde, J. A., Operskalski, B. H., & Jeffery, R. W. (2011). Obesity, depression, and health services costs among middle-aged women. *Journal of General Internal Medicine, 26*(11), 1284–1290.
- Simon, Gregory E, Von Korff, M., Saunders, K., Miglioretti, D. L., Crane, P. K., van Belle, G., & Kessler, R. C. (2006). Association between obesity and psychiatric disorders in the US adult population. *Archives of General Psychiatry, 63*(7), 824–830.  
doi:10.1001/archpsyc.63.7.824
- Steele, C. (1988). *Advances in Experimental Social Psychology* (Vol. 21). New York: Academic Press.
- Stormark, K. M., Nordby, H., & Hugdahl, K. (1995). Attentional shifts to emotionally charged cues: Behavioural and erp data. *Cognition & Emotion, 9*(5), 507–523.  
doi:10.1080/02699939508408978
- Stunkard, A J, Sørensen, T., & Schulsinger, F. (1983). Use of the Danish Adoption Register for the study of obesity and thinness. *Research Publications - Association for Research in Nervous and Mental Disease, 60*, 115–120.

- Stunkard, Albert J., & Messick, S. (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of Psychosomatic Research*, 29(1), 71–83. doi:10.1016/0022-3999(85)90010-8
- Teasdale, J. D., Segal, Z. V., Williams, J. M., Ridgeway, V. A., Soulsby, J. M., & Lau, M. A. (2000). Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology*, 68(4), 615–623.
- Tiggemann, M., & Rothblum, E. D. (1997). Gender Differences in Internal Beliefs About Weight and Negative Attitudes Towards Self and Others. *Psychology of Women Quarterly*, 21(4), 581–593. doi:10.1111/j.1471-6402.1997.tb00132.x
- Uchino, B. N. (2006). Social support and health: a review of physiological processes potentially underlying links to disease outcomes. *Journal of Behavioral Medicine*, 29(4), 377–387. doi:10.1007/s10865-006-9056-5
- Wang, S. S., Brownell, K. D., & Wadden, T. A. (2004). The influence of the stigma of obesity on overweight individuals. *International Journal of Obesity*, 28(10), 1333–1337. doi:10.1038/sj.ijo.0802730
- Watkins, E., & Brown, R. G. (2002). Rumination and executive function in depression: an experimental study. *Journal of Neurology, Neurosurgery & Psychiatry*, 72(3), 400–402. doi:10.1136/jnnp.72.3.400
- Watkins, E., & Teasdale, J. D. (2004). Adaptive and maladaptive self-focus in depression. *Journal of Affective Disorders*, 82(1), 1–8.
- Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review*, 92(4), 548–573. doi:10.1037/0033-295X.92.4.548



Weissman, M. M., Bland, R. C., Canino, G. J., Faravelli, C., Greenwald, S., Hwu, H.-G., Yeh,

E.K. (1996). Cross-National Epidemiology of Major Depression and Bipolar Disorder.

*JAMA: The Journal of the American Medical Association*, 276(4), 293 –299.

doi:10.1001/jama.1996.03540040037030

World Health Organization. (2013, March). Obesity and overweight. WHO Fact Sheet No 311.

*World Health Organization*. Retrieved March 25, 2014, from

<http://www.who.int/mediacentre/factsheets/fs311/en/>