BRIGHT LIGHT THERAPY FOR THE TREATMENT OF NIGHT EATING SYNDROME

A DISSERTATION IN
Clinical
Psychology

Presented to the Faculty of the University
of Missouri-Kansas City in partial fulfillment of
the requirements for the degree

DOCTOR OF PHILOSOPHY

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2014

BRIGHT LIGHT THERAPY FOR THE TREATMENT OF NIGHT EATING SYNDROME

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ABSTRACT

The purpose of this study was to examine the effect of an open label bright light therapy (BLT) intervention on night eating behaviors as well as secondary outcomes of mood and sleep quality. It was hypothesized that night eating symptoms, depression, and sleep would significantly improve over the course of treatment. Results showed statistically significant reductions in mean scores on measures assessing night eating symptoms (NESS), depression (BDI), and sleep (ISI). NESS scores decreased on average 9.47 points. Mean BDI scores decreased an average of 9.60 points and mean ISI scores decreased 5.40 points. In addition, participants reported a 47% reduction of weekly nocturnal ingestions ($t = 2.68$, $p = .02$) from pre- to post-treatment, decreasing from an average from 3.47 times per week before treatment to 1.83 times per week after treatment. There was not a significant change in weight. This study was one of the first steps in advancing the chronobiological treatment literature by testing the efficacy of bright light therapy to improve symptoms of night eating syndrome.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the College of Arts and Sciences have examined a dissertation titled “Bright Light Therapy for the Treatment of Night Eating Syndrome,” presented by Ashley Michelle McCune, candidate for the Doctor of Philosophy degree, and certify that in their opinion it is worth of acceptance.

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CHAPTER 1

OVERVIEW

Night eating syndrome (NES) is conceptualized as a disorder of aberrant circadian eating behavior and includes the following symptoms: evening hyperphagia and/or nocturnal awakenings with ingestions of food, awareness of eating behavior, morning anorexia, strong urges to eat between dinner and sleep onset, insomnia, a belief that must one eat in order to initiate or return to sleep, and depressed mood (Allison et al., 2010). Biological markers, including attenuated nocturnal rises of melatonin and leptin, as well as increased diurnal levels of cortisol have been documented in persons with NES (Birketvedt, Florholmen, & Sundsfjord , 1999). Treatments for NES, based on both cognitive-behavioral principles (Allison et al., 2009) and the serotonin system (i.e., sertraline; (O'Reardon et al., 2006) have been found beneficial in a small number of studies. The biological markers of NES, specifically those associated with circadian rhythm suggest that chronobiological treatments, for example bright light therapy, should be considered as possible treatments for NES. To date, only two case studies have examined light therapy as a treatment for NES (Friedman, Even, Dardennes, & Guelfi, 2002; Friedman, Even, Dardennes, & Guelfi, 2004). This study is a first step in advancing the chronobiological treatment literature by testing the efficacy of bright light therapy to improve symptoms of night eating syndrome.

CHAPTER 2

REVIEW OF THE LITERATURE

Night Eating Syndrome: Diagnostic Criteria

NES was originally defined as the consumption of greater than 25% of daily calories after the evening meal, insomnia at least 50% of the time, and morning anorexia (Stunkard, Grace, & Wolff, 1955). Nearly 40 years passed before these criteria were revised by Stunkard and his collaborators. In 1996, these criteria were suggested: evening hyperphagia (operationalized as at least 50% of one's total daily caloric intake after 7:00 p.m.), difficulty sleeping, and morning anorexia (Stunkard et al., 1996). Throughout the years, many definitions of NES have been utilized making it very challenging for researchers to study this disorder in an effective manner as well as impeding the recognition of NES as clinically significant (Alison et al, 2010). Thus, diagnostic criteria for NES were revised at the First International Night Eating Symposium (April 26, 2008, Minneapolis, MN) (Allison et al., 2010). As a result, proposed research diagnostic criteria for NES were proposed and are presented in Table 1.

Table 1

Research diagnostic criteria for night eating syndrome (Allison et al., 2010).

A. The daily pattern of eating demonstrates a significantly increased intake in the evening and/or nighttime, as manifested by one or both of the following:
    1. At least 25% of food intake is consumed after the evening meal
    2. At least two episodes of nocturnal eating per week
B. Awareness and recall of evening and nocturnal eating episodes are present.

The clinical picture is characterized by at least three of the following features:

1. Lack of desire to eat in the morning and/or breakfast is omitted on four or more mornings per week
2. Presence of a strong urge to eat between dinner and sleep onset and/or during the night
3. Sleep onset and/or sleep maintenance insomnia are present four or more nights per week
4. Presence of a belief that one must eat in order to initiate or return to sleep

C. Mood is frequently depressed and/or mood worsens in the evening
D. The disorder is associated with significant distress and/or impairment in functioning.
E. The disordered pattern of eating has been maintained for at least 3 months.
F. The disorder is not secondary to substance abuse or dependence, medical disorder, medication, or another psychiatric disorder.

Overview of the Diagnostic Criteria

Evening Hyperphagia

One of the core features of NES is the delay of the circadian rhythm of food intake, characterized by minimal intake of calories in the first half of the day and marked increase of intake through the second half of the day that disrupts the sleep cycle (O'Reardon et al., 2005). The delay in circadian rhythm of food intake is manifested by evening hyperphagia and nocturnal ingestions of food. Evening hyperphagia is defined as the consumption of 25% or more of caloric intake after the evening meal (Allison et al., 2009). It can co-occur with nocturnal ingestions but must be present to receive a diagnosis of NES if nocturnal ingestions are absent.

Evening hyperphagia was first proposed by Stunkard in 1955 and was reconfirmed by O'Reardon and colleagues (2004) who compared the sleep and eating patterns of obese individuals suffering with night eating syndrome to weight-matched controls. After monitoring behavior through actigraphy and food diaries for 7 days, they found people with night eating syndrome had significantly different eating patterns. The NES group demonstrated a delay in food intake and a consumption of three times more food after the evening meal than the control group (35% vs. 10%) (O'Reardon & Ringel et al., 2004). A similar pattern of food intake has been documented in non-obese persons with NES compared to weight-matched controls (Lundgren et al., 2008).

Birketvedt, Florholmen, & Sundsfjord (1999) also observed that night eaters had significantly different eating patterns than healthy controls. Delay in food consumption was observed and 74% of caloric intake was consumed by the night eaters after 6 pm vs. 37% in the healthy controls. Furthermore, night eaters consumed significantly greater amounts of food (56% of daily calories) from 8:00 pm to 6:00 am when compared to the controls (15% of daily calories.)

Some cultural concerns exist around the construct of evening hyperphagia, and the arbitrary timing of the "evening meal" has been challenged because some cultures eat later in the day. For example, in Mediterranean cultures lunches and dinners are usually eaten at later hours of the day in comparison to northern Europe (Bellisle, 2009). However, the evening meal has been demonstrated over the years to be a helpful cutoff criterion for categorizing excessive nighttime eating. If all other criteria are absent, a person would not receive a diagnosis of NES simply based on cultural differences in meal times (Allison et al., 2009).

Nocturnal Ingestions

Nocturnal ingestions occur when a person wakes from sleep and ingests what is typically a small amount of food (O'Reardon & Ringel et al., 2004). A person with NES often feels it is necessary to consume food in order to return to sleep (Allison et al., 2009). As described in a self-help book by Allison, Stunkard, and Their (2004), most patients report getting up at similar times during the night in order to eat. They report a lack of control over their eating behavior as well as extreme distress if they feel they will be unable to eat. If an attempt is made to avoid eating upon awakening, patients report they are unable to get back to sleep until they "give in" and consume their snack. Once the patient has eaten their snack they report being able to return to sleep easily. This pattern often persists night after night and may become more severe in nature the longer the night eating behavior continues (Allison et al., 2004), creating a cycle the causes significant distress. Nocturnal ingestions can co-occur with evening hyperphagia but two or more awakenings with nocturnal ingestions per week are required to receive a diagnosis of NES if evening hyperphagia is absent (Allison et al., 2010).

In a study comparing night eaters to a control group, night time awakenings were significantly more frequent in night eaters (3.6 vs. 0.3, $p < .001$) (Birkevedt et al., 1999). Fifty-two percent of nocturnal awakenings resulted in the consumption of food in the night eaters and 0% of the nocturnal awakenings in the control group were associated with nocturnal ingestions (Birkevedt et al., 1999). In a study comparing people with NES to matched controls, those with NES consumed food 74% of the time upon awakening vs. 0% in the control group (O'Reardon & Ringel et al., 2004). Furthermore, Lundgren et al. (2008a) found non-obese people with NES reported a significantly higher amount of nocturnal awakenings with ingestions of food (9.6 ± 7.8) compared to non-obese people without NES (0.1 ± 0.2).

Awareness of Eating Behavior

A person must have awareness of their eating behavior and be able to recall the behavior the following day to receive a diagnosis of NES (Allison et al., 2010). This becomes very important when trying to determine whether a person is suffering from NES or the parasomnia, sleep-related eating disorder (SRED). With SRED, patients are often unaware of their eating behavior and may be sleepwalking. They can ingest strange foods or even nonfood items in this state and usually do not have recollection of their eating behavior (Vinai et al., 2012). With NES, desired food items or food that was intentionally restricted through the day is often consumed (Allison et al., 2004).

The criterion "awareness of the eating behavior" has caused some to question the difference between NES and SRED, as recent definitions of SRED do not require amnesia (Howell, Schenck, & Crow, 2009). Moreover, some people with NES do not always report full awareness of the event or total recollection thereafter. Further research is needed to help differentiate these disorders.

Morning Anorexia

Morning anorexia describes a lack of hunger upon waking and has been included in the diagnostic criteria for NES since its introduction in the literature (Stunkard et al., 1955). An individual meeting this criterion will exhibit morning anorexia and/or omit breakfast at least 4 days a week (Allison et al., 2010). Often a person will not be hungry until the second half of the day and avoid consumption of food in the first half of the day (Allison et al., 2009). Boston and colleagues (2008) corroborated these findings in their examination of caloric intake of persons with NES compared to healthy controls. They found persons with NES had significantly lower

caloric consumption at the “breakfast” meal in comparison to healthy controls (Boston et al., 2004).

Lundgren et al. (2008) found that non-obese individuals with NES reported less morning hunger when compared to non-obese matched controls. Gluck, Geliebter, and Satov (2001) found that people with NES showed reduced rates of daytime hunger. This criterion, however, is not required for the diagnosis of NES, as it is common among the general population, and did not prove to be a useful tool for evaluating NES in an item response theory analysis (Allison et al., 2008).

Strong Urge to Eat Between Dinner and Sleep Onset and/or Upon Waking at Night

A strong desire to eat between dinner and sleep onset, and/or upon awakening at the night is one of the five descriptor criteria proposed in the new diagnostic criteria for NES (Allison et al., 2010). This criterion is often assessed by the Night Eating Questionnaire (NEQ) which is a validated measure of NES symptoms (Allison, et al., 2008). The amount of food consumed is not usually large, however, the intake is associated with decreased anxiety and the belief that one cannot sleep/return to sleep without the intake of food (Allison, Stunkard, & Their, 2004). This particular criterion has not been studied thoroughly and is somewhat subjective. It is unclear how to operationalize “strong urge” to eat in the evening, which becomes important in the assessment and treatment of NES. This is analogous to problems operationalizing “control” in binge eating disorder, which requires that a person feels a lack of control over what and how much they are eating during a binge episode.

Insomnia

Insomnia has been a diagnostic criterion for NES that has been present since its first mention in the scientific literature (Stunkard et al., 1955). More specifically, sleep onset and maintenance insomnia are often described as elements of NES (Allison et al., 2010). Sleep onset insomnia is defined as when a person has difficulty falling asleep. Sleep maintenance insomnia is when a person has difficulty remaining asleep, which can manifest as early and/or frequent awakening and problems falling back asleep once awake (Roth, 2007). Insomnia is often observed in individuals with NES but not necessarily in all cases. In Allison and colleagues' (2008) item response analysis, sleep onset insomnia was a significant predictor of having a NES diagnosis. Birkevedt and colleagues (1999) found that night eaters woke in the night significantly more than a control group (3.6 awakenings per night vs. 0.3 per night). While individuals with NES were observed to have similar sleep onset, offset, and sleep duration relative to the control group, people with NES had significantly more nocturnal awakenings ($p < .001$) that occurred earlier in the sleep cycle (O'Reardon, Ringel, et al., 2004).

Belief That One Must Eat in Order to Initiate or Return to Sleep

The belief that one must eat in order to initiate sleep or return to sleep is often a central feature of NES, but is not necessarily required to receive the diagnosis. A person with NES will often describe high levels of anxiety if they are not able to have the food they desire through the evening or upon awakening in the night (Allison et al., 2004). A person with NES will believe that they will be unable to fall asleep or return to sleep without food, indicating a direct relationship between food intake and anxiety due to the insomnia (Allison et al., 2004). The Night Eating Questionnaire (NEQ) assesses this belief that one must eat in order to sleep.

In a study by Sassaroli and colleagues (2009), differences in nocturnal and diurnal anxiety was examined in persons with BED only, NES only, and a group of persons with both NES and BED. Each group was administered the Self Rating Anxiety Scale, Sleep Disturbance Scale (SDS), and the NEQ. Results indicated different patterns of anxiety between persons with BED and NES, supporting the idea that these are two distinct disorders. Specifically, in persons with NES, levels of evening hyperphagia, mood disturbance, and sleep disturbance were only correlated to their nocturnal anxiety; not with diurnal (i.e., throughout the day) anxiety. Conversely, in persons with BED, nocturnal overeating was correlated with diurnal (daytime) anxiety and not nocturnal anxiety. Persons struggling with both NES and BED had the most severe disturbances of anxiety (Sassaroli et al., 2009).

Depressed Mood

Depressed mood has been associated with NES since its introduction (Stunkard et al., 1955) and is currently listed as C criterion in the research diagnostic criteria for NES (Allison et al., 2010). Studies have corroborated the relationship between depressed mood and NES. For example, Birkevedt et al. (1999) found that the mood of people with NES steadily decreased after 4:00 pm, while no change in mood was observed in the control group throughout the day ($p < .001$). Ultimately, the mood of night eaters was significantly lower at night than in healthy controls ($p < .001$). Gluck, Geliebter, and Satov (2001) compared overweight persons with NES seeking weight loss treatment to overweight persons without NES. They found that people with NES had higher rates of depression ($p = .04$) and lower ratings of self-esteem ($p < .01$) in comparison to those without NES. In a study comparing people with either binge eating disorder (N = 177) or NES (N = 68) to an overweight control group (N = 45) without either diagnosis, depressive symptoms were found to be greater in the BED and NES groups relative to the control

group (Allison, Grilo, Masheb, & Stunkard, 2005). Depressed mood is a significant marker of NES, but is not present in all cases (Allison et al., 2009). In fact, depressed mood commonly co-occurs in those that suffer with eating disorders in general (Cooper & Fairburn, 1986).

Etiology of NES

The cause of NES is unknown, but it is hypothesized to develop from a complex interplay of genetic liability (Root et al., 2010; Lundgren, Allison, & Stunkard, 2006), stress (Vander Wal, 2011), and biobehavioral mechanisms (Stunkard, Allison, Lundgren, & O'Reardon, 2009). The serotonin system has been implicated in the development and maintenance of NES in part because of its role in the synthesis of melatonin, a circadian hormone involved in the regulation of the sleep wake cycle (Stunkard et al., 2009), but also because the primary pharmacotherapy for NES (sertraline; Stunkard et al., 2009) works via the serotonin system. A central feature of both the conceptualization of NES and the hypothesized etiology is that, at its core, NES is a disorder of circadian delayed food intake. Whether that is caused by biological or environmental factors or both is still unknown. The literature on circadian rhythm and eating behavior, especially animal models of circadian delayed eating behavior and obesity, are informative in understanding both the etiology of NES and potential treatments. Below is an overview of circadian rhythm and the animal literature which can be used as a model for the development and maintenance of NES in humans.

Circadian Rhythms: An Overview

Circadian rhythms regulate the sleep and feeding cycle in living organisms, including humans, plants, animals, fungi, and cyanobacteria (Silva, Santo, & Margolis, 2010). Circadian rhythms follow an approximate 24-hour cycle that is typically synchronized, or entrained, with the light/dark cycle. Circadian rhythms can be entrained to other cues, like the intake of food,

and there is evidence that exercise and temperature can also synchronize circadian rhythms (Vitaterna, Takahashi, & Turek, 2001). Circadian rhythms are believed to be regulated by the brain, specifically the suprachiasmatic nuclei (SCN), and other organs in the body such as the liver, gut, pancreas, fat and muscles (Silva et al., 2010). The mechanisms through which light and food affect circadian rhythms are referred to as light entrained oscillators (LEO) and food entrained oscillators (FEO), respectively. LEO and FEO operate in synchrony to promote eating behavior during normal times during the light/dark cycle (Lundgren, Boston, & Noble, 2012). Thus, a shift in normal circadian rhythms can occur when the LEO and FEO are not synchronized, resulting in eating during times when sleeping/fasting typically occurs. This change occurs at the cellular level (Turek et al., 2005).

Disruption of Circadian Rhythms in Animals

Circadian rhythms in animals have been investigated since the early 1970's. Over the last forty years, animal research has allowed identification of genetic mutations that affect disruption of circadian rhythms. Initial research took place with the fruit fly (Konopka & Benzer, 1971) and eventually moved to mice (Vitaterna et al., 1994; Vitaterna et al., 2001; Walter-Smith & Kay, 2000). *Clock*, the first mammalian circadian gene, was discovered in mice (Vitaterna et al., 2001) and further research has identified additional circadian genes that, when mutated, result in the loss of circadian rhythm, reduction of amplitude, as well as lengthening and shortening of period (Vitaterna et al, 2001;).

Research with *Clock* mutant mice helped further the understanding of dysregulated circadian rhythm and its impact on health (Turek et al., 2005). During the 24-hour light/dark cycle, mice are typically active during the dark phase and sleep during the light phase. When compared to wild-type mice, however, the *Clock* mutant mice are more active during the light

phase when they should typically be sleeping/fasting. The *Clock* mutant mice also consumed 22% more of their daily food intake at abnormal times (light phase) when compared to the food intake of the wild-type mice. Over the 10-week observation period, the *Clock* mutant mice consumed more food, had significant weight gain, and had higher levels of triglycerides, cholesterol, glucose and leptin (Turek et al., 2005).

Animal literature supports the idea that timing of food intake can reinforce a phase advance or phase delay of circadian rhythm. For instance, when researchers restrict food from rodents when they typically eat at night, and only present food during the daytime hours, food anticipatory activity begins to occur at the new feeding times (Mistlberger, 2009). The circadian rhythm of the rodents becomes re-entrained to this new feeding time even though it is outside of their typical cycle. Not only does behavior shift, but biological markers of circadian rhythm do as well (e.g., insulin, glucose, leptin, ghrelin, and thyroid stimulating hormone (TSH)) (Silver and Balsam, 2010).

The animal literature provides a useful model for conceptualizing the development and maintenance of dysregulated of circadian rhythm in persons with NES. Specifically, it supports the hypothesis that there are both genetic and environmental factors that can re-entrain eating behavior to abnormal times during the 24-hour sleep/wake cycle. Consistent with the animal literature, several human studies support the hypothesis that NES results from a circadian disruption. These are reviewed below.

Behavioral and Biological Evidence for Circadian Disruption in NES

Circadian Rhythm in NES: Behavior

Birketvedt and colleagues (1999) demonstrated circadian delayed eating behaviors in persons with NES compared to weight matched controls of in a carefully controlled clinical setting. To investigate differences in behavioral characteristics, 10 obese individuals who met criteria for NES and 10 matched controls were observed for one week in an outpatient setting. Significant differences between the two groups indicating distinct behavioral markers in night eaters were found. For example, the night eaters had more eating episodes in 24-hours (M = 9.3, SD = 0.6) compared to the control group, (M = 4.2, SD = 0.2, p<.001). The night eating group demonstrated evening hyperphagia, whereby 56% of their food intake was consumed at night after 6:00 pm versus 15% in the control group (p <.001). The night eating group (M = 3.6, SD = 0.9) also reported significantly more awakenings per night than the control group (M = 0.3, SD = 0.3, p <.001). Most interestingly, in the night eating group 52% of nocturnal awakenings resulted in ingestions of food compared to 0% in the control group. These findings by Birketvedt and colleagues (1999) offered the first behavioral markers for NES that were observed and tested in a laboratory setting.

O'Reardon, Ringel, and colleagues (2004) examined eating and sleep patterns in individuals suffering with NES. Specifically, they examined 7-days of self-report food and sleep diaries and sleep patterns measured through actigraphy. Participants included forty-six overweight/obese persons with NES and 43 control subjects. Results did not indicate significant differences in actual caloric consumption between the two groups, however, significant differences in the pattern of intake were observed. The NES group consumed 3-times as many calories after the evening meal in comparison to the control group. As with total caloric

consumption, sleep patterns also appeared similar in the NES and control groups. What set the NES group apart were nocturnal awakenings that occurred at a significantly greater frequency than the control group *(p<.001)*. Furthermore, awakenings occurred earlier in the sleep cycle for NES participants (128 minutes vs. 193 minutes, *p=.01)*. Finally, those with NES demonstrated nocturnal ingestions of food on 74% of their awakenings while the control group did not have any intake of food (O'Reardon, Ringel, et al., 2004). Overall, this study indicates that individuals with NES have very different circadian eating and sleeping patterns in comparison to those without NES.

Rogers and colleagues (2006) assessed sleep patterns in individuals struggling with NES in comparison to healthy controls. They did not find significant differences in sleep onset or offset, but the NES group spent less time in stage 2 sleep, had lower sleep efficiency, and overall had less sleep than healthy controls. The NES group had more awakenings and spent more time in REM sleep (Rogers et al., 2006). These findings, in conjunction with those documented in the O'Reardon et al. 2004 report, suggest that sleep onset and offset are intact, but that sleep architecture may show a circadian disruption. No studies have conducted a circadian analysis of sleep architecture in persons with NES.

Circadian Rhythm in NES: Neuroendocrine Hormones

To examine the neuroendocrine markers of NES, Birkedvedt and colleagues (1999) collected 24-hour blood samples from 12 women with NES and 21 female control subjects in an inpatient clinical research center. Participants were admitted in the morning after an overnight fast and were at the clinic for a 24-hour period. Blood samples were taken at 2-hour intervals following an initial draw at admission (8:00 am). Exposure to light was carefully controlled to ensure that each subject had equal exposure to light for the duration of their clinic stay.

Neuroendocrine markers of circadian rhythms were specifically measured and included: 24-hour plasma melatonin, incremental plasma leptin, blood glucose, plasma insulin and plasma cortisol. The night eaters showed significant differences in plasma melatonin, plasma leptin, and plasma cortisol in comparison to the control group. Specifically, the night eaters had attenuation of the nocturnal rise in plasma melatonin ($p < .001$) and plasma leptin ($p < .001$) and greater levels of plasma cortisol ($p = .001$). Significant differences between groups on blood glucose and plasma insulin were not found. These findings supported the evidence that NES not only had behavioral markers but biological markers as well. This study offers evidence that NES is related to a disruption of circadian rhythms and chronobiology. This suggests that treatments like BLT that target circadian rhythm could be an effective intervention for NES.

Findings from the Birkevedt (1999) study have not been replicated, although other studies have been performed to better understand the biological influences on NES. Allison and colleagues (2005) performed a study where 15 obese female NES participants and 14 matched female controls were admitted for a 3-day stay in a clinic at the University of Pennsylvania. On the third day of hospitalization, blood samples were taken via catheter every 2-hours from 8:00 am – 10:00 pm and then every hour from 11:00 pm - 9:00 am the following morning (total of 25-hours) (Allison et al., 2005). Blood samples were assessed for glucose, insulin, ghrelin, leptin, melatonin, cortisol, TSH, and prolactin. As in the Birkevedt study, exposure to light was carefully controlled so that each group had the same exposure. Results indicated that the night eaters had increased levels of insulin ($p < .01$) and glucose ($p = .07$) when compared to the control group. This was expected, however, due to the nocturnal ingestions of food in the night eating group that did not occur in the control group. The night eaters also had lower levels of ghrelin between 1:00 am and 9:00 am compared to the control group ($p = .003$). There were no

significant differences between night eaters and controls on any other hormone (Allison et al., 2005).

Goel and colleagues (2009) have suggested that chronobiological treatments such as bright light therapy could be helpful in treating individuals with NES. They base this recommendation on their 2009 study that examined the neuroendocrine circadian rhythms in persons with NES. Participants included15 women with NES and 14 weight-matched control subjects who spend 3 nights in a laboratory setting. Daily food intake was recorded along blood-glucose levels, insulin, leptin, ghrelin, melatonin, cortisol, thyroid-stimulating hormone (TSH), and prolactin through blood draws. Blood samples were collected and analyzed over a 25-hour period. Specifically, blood samples were taken every hour from 8:00 am to 8:00 pm and every 2-hours between 9:00 and 9:00 am. The control group demonstrated normal circadian rhythm patterns. In comparison, the NES group showed significant delays in timing of meals and consumption of caloric and carbohydrate intake. Blood results showed that the NES group also had 1-2.8 hour delays in leptin and insulin, which both aid in the regulation of food. They also demonstrated a delay in melatonin rhythms. Interestingly, the hormone largely responsible for hunger (ghrelin) was phase advanced by 5.2 hours in comparison to the healthy control group (Goel et al., 2009). Overall, the NES group had abnormal circadian rhythms of food intake, cortisol, ghrelin, and insulin, with increased TSH amplitude, in comparison to controls. These are significant changes in behavioral and biological circadian rhythm that are associated with appetite and neoroendocrine regulation (Goel et al., 2009).

The studies reviewed above provide significant evidence that the circadian rhythm of food intake, and associated biological processes, are disrupted in NES. Treatment for NES is underdeveloped compared to other health conditions, and the behavioral and pharmacotherapy

interventions that have been tested have focused on the regulation of food intake as a primary outcome goal. The treatment literature for NES is reviewed below.

Treatment for NES

Psychotherapy Interventions

Progressive muscle relaxation. NES is associated with stress, and symptoms can be exacerbated with a perceived increase in stress. Thus, relaxation training is utilized in the treatment of NES to help alleviate stress. Pawlow, O'Neil, & Malcom (2003) examined whether relaxation training would reduce symptoms of night eating behaviors. Twenty adult participants were randomly assigned to receive abbreviated (20 minutes) progressive muscle relaxation therapy (APRT) or to control group (quietly sitting for 20 minutes). Each group participated in 2 sessions that took place 1-week apart. Participants in the experimental group were given an audiotape of the APRT exercise and were asked to practice their muscle relaxation strategies each night. Each participant was asked to complete pre-and post session self-report measures of mood, stress, anxiety, and relaxation. In addition, salivary cortisol was taken at the beginning and end of each session. All participants were asked to keep a daily food diary that assessed nocturnal ingestions, morning food consumption, and hunger for the week between session 1 and 2. Results indicated that participants assigned to the relaxation training group had significantly reduced levels of stress, state-anxiety, and salivary cortisol immediately following the intervention and again after 1-week compared to the control group. The experimental group also reported a significant increase in morning hunger and decreased evening hunger, but did not show significant reductions in nocturnal ingestions or increase in morning consumption (Pawlow et al., 2003).

Cognitive-behavioral self help. Allison, Stunkard, and Thier (2004) wrote the book *Overcoming Night Eating Syndrome: A Step-by-Step Guide to Breaking the Cycle* in order to offer a self-help option for individuals seeking treatment for their symptoms of NES. The book offers education on NES, takes the reader through a multitude of journaling exercises meant to help identify automatic thoughts that exist in relation to their night eating, and finally offers suggestions on how to break the cycle of night eating behavior. Some of these suggestions include different nutrition, meal planning, and relaxation training. This book was written before standardized CBT interventions for NES existed and its efficacy as a self-help intervention has not been established.

Cognitive behavioral therapy: Therapist administered. CBT is the gold standard treatment for eating disorders. Although NES is not a recognized eating disorder in the DSM-IV, it was hypothesized that CBT might also be an effective treatment for NES. Allison et al. (2010) developed first CBT intervention for NES, modeling it after cognitive behavioral treatments for binge eating disorder. Allison et al. (2010) conducted a pilot study with 25 night eating patients using 10-sessions of CBT. The CBT treatment was broken into 3 stages. The first stage included sessions 1-4 and was meant to develop therapeutic alliance and explain the process of CBT. The second stage included sessions 5-8 and focused on strengthening of coping skills and to challenge automatic thoughts relative to night eating symptoms. The third stage included sessions 9-10 that were scheduled on a biweekly basis. Progress, challenges, and successes were reviewed and problem solving techniques were addressed (Allison et al., 2010). Results showed significant reductions in nocturnal ingestions (70%), significant reductions of caloric intake, and significant reductions in weight (Allison et al., 2010). As this was the first trial for CBT, further investigation is needed.

Pharmacological Interventions

Sertraline. The selective serotonin reuptake inhibitor (SSRI) sertraline has been shown to be useful in the treatment and management of symptoms of NES (Miyaoka et al., 2003; O'Reardon, Stunkard, & Allison, 2004). In a study by O'Reardon & Stunkard et al. (2004), sertraline was given to 17 persons meeting criteria for NES in a 12 week open-label, non-blind trial. Results were impressive and resulted in a reduction of nocturnal awakenings, nocturnal ingestions, evening hyperphagia, and improved ratings on the Clinical Global Impression of Improvement Scale in all 17 participants, including a complete reduction in symptoms in 5 of the participants (O'Reardon & Stunkard et al., 2004). O'Reardon, et al., (2006) aimed to test the effectiveness of sertraline in a randomized, double-blind, placebo-controlled trial. They recruited 34 participants with NES and randomly assigned 17 participants to receive sertraline and 17 to receive the placebo. Patients who received sertraline showed significant decreases in nocturnal ingestions, evening hyperphagia, depressive symptoms, nocturnal awakenings, and had a mean weight loss of 2.9 kilograms after 8-weeks of treatment.

In a follow up study, Stunkard and colleagues (2006) followed 50 patients that were prescribed sertraline by their own physician. These persons contacted the researchers through their website, by phone, or via email requesting help for their NES and were offered consultation for their participation. Participants were initially screened using the NEQ and the NESHI to verify the diagnosis of NES. For the next 8 weeks the participants were asked to complete assessments every 2 weeks and were assessed by phone at week 8 to determine progress (Stunkard et al., 2006). The authors found significant reductions in symptoms of NES and a mean weight loss of 3.0 kilograms after 8-weeks of treatment.

Lexapro. Vander Wal and colleagues (2012) recently evaluated the short term effects of escitalopram (Lexapro; selective serotonin reuptake inhbitor) for the treatment of NES (Vander Wal, Gang, Griffing, & Gadde, 2012) in a double-blind randomized controlled clinical trial. Forty participants meeting criteria for NES were randomly assigned to receive either 20 mg of escialopram or a placebo for 12-weeks. Primary outcome was a mean change in total scores on the Night Eating Questionnaire (NEQ). At 12-weeks, there were non-significant reductions in total score on the NEQ in both the intervention and control group. Of note, both groups documented participants that no longer met criteria for NES at the conclusion of the 12-week study: 16 participants in the intervention group versus 12 patients in the control group. Essentially, Lexapro was not more effective than a placebo in the treatment of NES (Vander Wal et al., 2012).

Topiramate. Topiramate (anticonvulsant) may also be of use in the treatment of night eating syndrome. In a case study, nocturnal ingestions were reduced at 100% with the use of topiramate in one patient and three other patients had a marked to moderate decrease in symptoms (Winkelman, 2003).

In another case report involving a 40 year old woman with comorbid NES and PTSD, a dose of 100 mg of topiramate given at night resulted in reduction of PTSD symptoms, NES, and resulted in 70 pound weight loss (Tucker, Masters, & Nawar, 2004). Further research is needed to demonstrate the efficacy of topiramate for the treatment of NES.

Chronobiological Interventions: Bright Light Therapy (BLT)

Chronobiological treatments, such as BLT, have been considered as a treatment option for NES. To date, two case studies have been reported that address this relationship. The first is a case study of a 51-year old obese woman meeting criteria for depression and night eating

syndrome showed that exposure to bright light therapy improved symptoms of night eating behaviors (Friedman, Even, Dardennes, & Guelfi, 2002). In this case, after receiving 14 daily morning 30-minute sessions of l0,000-lux white light therapy, night eating symptoms were reportedly absent. One month after the completion of light therapy, however, all previous symptoms of NES had returned. An additional 12 morning sessions were administered, which again reportedly resolved all symptoms of NES (Friedman et al., 2002).

The second case study involved a non-obese 46-year old man meeting DSM-IV criteria for a major depressive episode and NES (Friedman, Even, Dardeness, & Guelfi, 2004). After receiving 14 daily morning 30-minute sessions of 10,000-lux light therapy, this individual no longer met criteria for depression or NES. Because light therapy for the treatment of NES has only been described in case studies, more research is necessary to demonstrate its efficacy.

Summary of Treatment for NES

Very few treatments exist for NES, and persons seeking treatment for NES often find it very difficult to find a treatment professional that can address their problems. Unfortunately, it is not uncommon for a person with NES to be dismissed by a health care provider (Allison et al., 2004). There are a handful of studies that show promising results for the use of topiramate and sertraline for the treatment of NES; however, more research is needed in order to demonstrate efficacy. To date only one uncontrolled study examines how effective CBT is in the treatment of NES (Allison et al., 2010). Although this study yielded promising results in the reduction of symptoms of NES, more research is needed in order to advance the treatment of NES. Although NES is conceptualized as a disorder of circadian delayed food intake, few studies have targeted circadian rhythm per se, which is an important weakness in the treatment literature. Two case

studies showed promising results, and suggest that light therapy, which specifically targets circadian rhythms, may be a useful intervention.

Why Bright Light Therapy (BLT) is a Promising Intervention for NES

Although the exact mechanisms of change associated with BLT are largely unknown, BLT has been shown to be helpful with many conditions believed to be caused by dysregulated circadian rhythms (Quera Salva et al., 2011). Bright light therapy is believed to target behavioral and biological markers of circadian rhythm such as body temperature, melatonin, and sleep. When an individual receives BLT, it is hypothesized that their circadian rhythm shifts either ahead or back depending on what time of day the light is presented. With this shift, individuals are thought to experience symptom relief because circadian rhythms are re-entrained to mimic normal patterns and in turn, decrease symptoms (Pawlow, 2012).

There is evidence that even brief exposure to BLT is effective in effective in shifting both behavioral and biological indicators of circadian rhythm. Lack and colleagues (2005) examined behavioral and biological markers of circadian rhythm shifts using brief exposure to bright light therapy in individuals with early morning awakening insomnia. Participants were twenty-four healthy adults with early waking insomnia who were either assigned to receive 2,500-lux white light therapy for 2 evenings or to a dim-red light control group. In order to monitor behavioral effects of BLT, mood scales, sleep diaries, and activity monitors were used before BLT and for 4-weeks during follow-up.

For biological markers, rectal temperature and urinary melatonin rhythms were assessed prior to treatment and after 2 sessions of BLT. Results indicated no changes in circadian rhythms shifts in the control group but the BLT group demonstrated 2-hour phase delays of circadian melatonin rhythm and temperature. Furthermore, after the 4-week follow up the BLT

group had an overall reduction in time spent awake through the night, increase in total sleep time, and reported waking later in the morning compared to the control group. Finally, the BLT group reported fewer symptoms of depression at 4-week follow up (Lack, Wright, Kemp, & Gibbon, 2005). Overall, these findings offer support for brief courses of BLT as an effective treatment for dysregulated circadian rhythms, as well as mood.

Because circadian rhythms are malleable and will synchronize to changed cues, for example to a new light/dark cycle when travel across time zones occurs (Vitaterna et al., 2001), it is possible that eating behaviors can shift with the use of BLT.

Seasonal Affective Disorder: A BLT Model

Bright light therapy has been used in the treatment of many psychological conditions such as seasonal affective disorder (SAD). In fact, it is the gold standard treatment for persons with SAD (Pail et al., 2011). When a person receives bright light therapy they are typically seated closely in front of a light therapy box that simulates natural outdoor light. The individual is encouraged to keep their eyes open but not to look directly in to the lights. The head and body must be oriented toward the light box. A person may engage in normal activities, such as reading, as long as they are oriented toward the light. The frequency, intensity, and duration of use vary depending on symptom severity and recommendations from the prescribing treatment provider. BLT is similar to natural light and has an effect that indoor light cannot produce. A significant advantage of BLT is there seem to be virtually no adverse side effects.

There is evidence that BLT can have rapid effects for SAD. Reeves and colleagues (2012) were interested in rapid effects of bright light therapy in people suffering with seasonal affective disorder (SAD). These authors used a placebo-controlled crossover design where participants received 1-hour of light therapy and 1-hour of dim red light therapy. They measured

symptoms of depression using two self-report scales (POMS-D and BDI-II). The results indicated an immediate improvement in depressive symptoms after receiving both light therapy sessions (*p=.02)* (Reeves et al., 2012).

In a separate study, twenty-eight adolescents meeting criteria for mild depressive disorder were administered BLT in a randomized crossover trial. One week of placebo light therapy (50 lux) and 1-week of therapeutic BLT (2,500 lux) was administered. Significant improvements in BDI scores and assays of saliva measuring cortisol and melatonin were significantly different between treatment and placebo (Niederhofer & von Klitzing, 2012).

If BLT can deliver improvement in behavioral and biological markers of SAD, it is hypothesized that BLT could be an effective treatment for NES. Like NES, SAD is thought to be related to circadian dysregulation, thus, BLT could deliver significant improvement in symptoms of NES. If circadian rhythms can be re-entrained to the time of BLT (early morning) then a phase advance in eating behavior might occur.

Table 2

A Review of Six BLT Trials Completed for the Treatment of SAD.

Authors	N	Lux	Duration (minutes)	Frequency	Time of Day	Control Group
Reeves et al., 2012	41	10,000	60	One administration	Not earlier than 11:00 am	60 minutes of placebo dim red light
Meester et al., 2011	22	10,000	30	10 sessions over 2 weeks, M-F	Between 7:45 and 8:45 am	Blue enriched white light
Flory et al., 2010	19	10,000	30	12 consecutive sessions	Between 7:30 and 11:00 am	Compared to dim red light and 2 other conditions
Michalak et al., 2007	19	10,000	30-wk 1 45-wk 2 60–wk 3 & 4	Daily for 4 weeks	Any time before 7:00 pm	Dim red light
Terman et al., 2007	83	5,000	120	Daily for 1 week	Morning, time not specified	None

Aims of the Current Study

The purpose of this study was to examine whether light therapy was an effective treatment for night eating behavior. Because NES is hypothesized to be related to a circadian delay of eating behavior, BLT may re-entrain eating behavior that occurs during the evening and nighttime to the daytime hours. Specifically, this study aimed to examine the effect of an open label BLT intervention on the primary outcomes of scores on the Night Eating Symptom Scale *(NESS)* and secondary outcomes of mood and sleep quality.

Treatment development occurs in stages (Rounsaville, Carroll, & Onken, 2001), beginning with a stage 1a research including: specification of theoretical rationale, hypothesized causal chain, identification of target population, specification of procedures for monitoring performance in the intervention, and specification of measures to monitor treatment outcome

(Rounsaville et al., 2001). Although some activities fall into stage 1b (specification of analysis to test hypotheses, specification and justification of inclusion/exclusion criteria, and specification of pilot testing procedures), the current proposal was a stage 1a pilot study with a goal of examining a largely untested treatment for night eating behavior (Rounsaville et al., 2001).

CHAPTER 3

METHODOLOGY

Participants

Recruitment

I aimed to enroll 20 individuals with interview-confirmed night eating behavior, operationalized as evening hyperphagia (≥25% of total daily caloric intake consumed after the evening meal) and/or nocturnal awakenings with ingestions of food that occur once or more a week. Night eating behavior, rather than a diagnosis of NES was chosen because of the low prevalence of NES in the general population (i.e., 1.5%-5.7%; Rand, Macgregor, & Stunkard,1997; Colles, Dixon, & O'Brien, 2007; Streigel-Moore et al., 2006) as well as the interest in the effect of BLT on night eating behavior independent of a diagnosis of NES.

In order to compensate for attrition, I planned to recruit 40 individuals to have a final sample 20. A description of the study was posted on flyers throughout the University of Missouri – Kansas City campus as well as advertised online through www.craigslist.com and www.backpage.com. Flyers were also provided to local practitioners who have specialty in eating disorders, obesity, and sleep disorders. These flyers contained basic information about the study including the purpose, requirements for participation, and compensation.

Significant recruitment challenges were encountered that led to the decision to decrease the final number of participants from 20 to 15. Recruitment began in April 2013 through monthly postings to Craig's List, weekly postings to Backpage, and posting fliers around campus and at a private practice for eating disorders. Dr. Lundgren also screened several participants as part of recruitment for a larger night eating study. Responses primarily came from online postings (3-15 per posting), but many people indicated their unwillingness to participate without

financial compensation. In response to this, IRB approval was obtained to offer compensation of $4 for each day light therapy ($56 for 14-day completion) starting in the fall of 2013. This helped with recruitment but only 12 participants had completed the study by June 1, 2014. The request was approved at this time to reduce the total number of participants to 15.

Inclusion Criteria

Participants were individuals between 18-65 years of age and who self-reported night eating behaviors over the last three months. This was confirmed with the *Night Eating Syndrome History and Inventory (NESHI),* described in the assessments below. Specifically, individuals who have nocturnal ingestions of food at least once a week and/or evening hyperphagia (≥25% of total daily caloric intake consumed after the evening meal) were included in the study. Although the research diagnostic criteria for NES requires nocturnal ingestions that occur at least twice a week, less stringent criteria was used for this study (Alison et al., 2010). The primary reason for reducing this criteria was that proposals for modification to the DSM-V diagnostic criteria for eating disorders in general moved toward once a week occurrences of problematic behaviors (purging, binging, etc.) (American Psychiatric Association, 2013). Participants were either male or female with a body mass index (BMI) over 18.5 kg/m^2.

Exclusion Criteria

Individuals were not enrolled in the study if they were engaged in active treatment for their night eating behavior during the previous 3 months, if they had a current full threshold diagnosis of bipolar disorder, a substance abuse disorder or eating disorder, or if they had any changes to their prescribed psychotropic medications in the last month. Individuals taking regular prescription or over the counter sleep aid medications (including melatonin) were excluded. Individuals were also excluded if they are pregnant or trying to become pregnant, if

they had any self-disclosed ocular or retinal pathology, and if they had a self-reported sleep disorder (other than sleep onset or maintenance insomnia). Finally, individuals who had worked a regular or rotating night shift in the last 3-months or who were enrolled in a medically monitored weight program were excluded from the study.

Assessments for Diagnosis

The Demographic Questionnaire

The demographic questionnaire gathered information needed to describe the sample and to assess for inclusion/exclusion criteria. Participants were asked to provide their age, gender, ethnicity, socio-economic status, and education level. Height and weight were measured and used to compute BMI.

Structured Clinical Interview for the Diagnosis of Axis I Mental Disorders

The *Structured Clinical Interview for the Diagnosis of Axis I Mental Disorders (SCID I)* is a diagnostic interview used to determine if an individual meets criteria for Axis I psychiatric disorders (First et al., 2002). The SCID is administered by a clinician and takes approximately 1-2 hours depending on the interviewee's past and present psychiatric symptoms. The SCID is considered to be a gold standard assessment tool and has been cited in over 700 published studies. All participants will be screened with the Structured Clinical Interview for the Diagnosis of Axis I Mental Disorders (SCID I) modules to confirm they do not have a current full threshold Axis I diagnosis including mood, anxiety, substance, psychotic, somatic, or other eating disorders.

The Night Eating Syndrome History and Inventory (NESHI)

The *Night Eating Syndrome History and Inventory* (NESHI) (Lundgren et al., 2012) is a semi-structured interview that aids in establishing a diagnosis of NES. Questions include details

about food intake throughout a typical day, previous symptoms of NES, sleep and mood patterns, weight, diet history, medications, supplements, other medical conditions, and previous methods used to help with symptoms of NES (Allison et.al, 2008). Dietary recalls are imbedded in the NESHI; therefore, additional food records are not necessary in this study. The *Night Eating Questionnaire (NEQ)*, is also included in the NESHI, which is a 14-item scale developed to screen for night eating behaviors in clinical populations (Allison et al., 2008). The NEQ assesses morning anorexia, first consumption of food during the day, food cravings and perceived control over food intake throughout the evening and night, percentage of food consumed after the evening meal, initial insomnia, number of nocturnal awakenings, food consumption and awareness at those times, and mood (Allison et al., 2008). Responses are given and scored based on a 5-point scale (0-4). The NESHI has been used in several studies to help diagnose NES (Dalle Grave, et al., 2011; Calugi, Dalle Grave, & Marchesini, 2009; Stunkard, et al., 2006; Lundgren, Allison, & Stunkard, 2006; de Zwaan, et al., 2006).

The Morningness Eveningness Questionnaire (MEQ)

The Morningness-Eveningness Questionnaire (MEQ) is a 19-item self-assessment questionnaire originated by Horne and Ostberg (1976), which has been measured and validated against circadian rhythm variation of oral temperature. Its main purpose is to measure whether a person's peak sleepiness and alertness is in the morning versus evening. The MEQ is widely used in many areas of psychological and medical research, and is frequently cited in circadian rhythm literature.

Outcome Assessments

The Night Eating Symptom Scale (NESS)

The *Night Eating Symptom Scale* (NESS) is a 14-item scale, nearly identical to the NEQ, developed to assess night eating symptoms during the *past week*. Scores range from 0-56, with higher scores indicating more severe symptoms (O'Reardon & Ringel et al., 2004). Specifically, this measure is sensitive to capturing changes in evening hyperphagia and nocturnal ingestions of food that have taken place over the previous seven days. The NESS has been used in previous treatment studies to assess for changes night eating behaviors. For example, the NESS was used to assess eating behavior in a treatment study using sertraline for NES (O'Rearon & Ringel et al., 2004). The NESS has also been used in a study examining the effects of CBT on NES (Alison et al., 2008).

Beck Depression Inventory (BDI-II)

The *Beck Depression Inventory* is a 21-item scale developed by Aaron Beck to assess symptoms and severity of depression. This is a self-report survey and each item is scored on a scale of 0-3, with higher scores indicating greater severity of mood symptoms (Beck, Steer, & Brown, 1996). Scores range from 0-63 and cutoff values are used to categorize symptoms in to minimal depression (0-13), mild depression (14-19), moderate depression (20-28), and severe depression (29-63). This is a widely used measure with high internal consistency, test-retests reliability and convergent and discriminant validity designed for individuals over the age of thirteen (Beck et al., 1996).

Insomnia Severity Index (ISI)

The *Insomnia Severity Index* is a 7-item self-report measure that is used to detect perceived sleep difficulties over the previous 2 weeks. This ISI specifically assesses difficulty

with sleep onset and maintenance, problems with early awakening, satisfaction with sleep patterns, interference with daily functioning as a result of sleep problems, noticeability of sleep problems to others, and degree of distress caused by sleep problem. The items are scored from 0-4, with higher scores indicating more severe symptoms. Score categories include: no clinically significant insomnia (0-7), subthreshold insomnia (8-14), moderate clinical insomnia (15-21) and severe clinical insomnia (22-28). This is a widely used measure that has been shown to be valid and reliable in detecting severity of perceived insomnia. It also demonstrates good concurrent validity and internal consistency (Bastien, Vallieres, & Morin, 2001).

Height and Weight

Each participant's height and weight was measured at their baseline appointment and upon their completion of treatment. BMI was calculated from these measurements.

Intervention

Bright Light Therapy

Bright light therapy has been used in the treatment of many psychological conditions such as seasonal affective disorder (SAD), chronic depression, and bipolar disorder (Reeves et al., 2012). BLT involves sitting closely in front of a light therapy box that simulates natural outdoor light. The individual is encouraged to keep his or her eyes open but not to look directly in to the lights. The head and body must be oriented toward the light box. The light selected for this study was the Uplift Technologies DL930 Day-Light 10,000 Lux Lamp. This light has been specifically designed for BLT and features three fluorescent light tubes designed to emit light at 10,000 lux, which is a standard therapeutic lux (Golden et al, 2005. This light is UV filtered and

is glare free. The light measures 4 inches x 21 inches x 16 inches and weighs 3 pounds. Four lights were purchased for this study and the cost was $113.71 per light.

Each participant was given a light to use in his or her home for the duration of the study and will be asked to complete 14-consecutive sessions of BLT at 10,000 lux. Each session was 60 minutes in length. Timing of light therapy administration was the most essential element of this treatment and consistency was heavily stressed to the participant. Participants were instructed to utilize their light immediately after waking and by 9:00 am. They were instructed to place the light box on a flat surface at an angle of approximately 30° to their body, with their eyes at mid-fixture level. They were also instructed not to stare directly at the light. It was acceptable to perform activities while undergoing light therapy, such as reading, as long as the individual remained seated facing the light. Because the efficacy of BLT depends on the consistency of administration, each participant was asked to email, text, or phone the researcher upon completion of their therapy each day. Each time a participant confirmed they had completed their light therapy at the appropriate time each day, the researcher compensated the individual $4.00. If it had been more than 1 days without correspondence, the researcher contacted the participant for follow up.

Procedure

Screening Procedure

Once a participant expressed interest in the study, he/she was asked to complete a brief phone screen to determine eligibility. If the participant was eligible for participation they were scheduled for a baseline appointment.

Consent

At the baseline assessment, all participants were provided with a written consent form, given explanation of study in detail, and had the opportunity to ask questions. After providing informed consent, participants began the baseline assessments.

Pre-Treatment Assessment Procedures

First, all participants were screened with Structured Clinical Interview for the Diagnosis of Axis I Mental Disorders (SCID I) modules to confirm they do not have an active full threshold axis I diagnosis. Next, participants completed the demographic questionnaire, the NESHI, the NESS, the BDI, the MEQ, and the ISI. Height and weight were measured and BMI was calculated. Please see Table 3 for a schedule of assessment administration.

Once baseline assessments were completed, participants were given instructions on how to use the light for therapy. They were instructed to use the light for 60 minutes each day for 14-days and were sent home with the light box. In order to ensure each participant was consistent with their light therapy, they were asked to phone, text message, or email the researcher each day when they completed their treatment each day. They were also be asked to keep a daily log of their sleep and wake times, food intake, and to provide mood and anxiety ratings.

Anticipated time for baseline testing was approximately 2 hours and took place in the laboratory of Dr. Jennifer Lundgren.

Post-Treatment Assessment Procedures

Upon completion of 14-days of light therapy, each participant was asked to return to the lab in order to return the light box and to complete the following post-treatment questionnaires: NESS, BDI, and ISI. They were asked to return the light box and daily food/mood records at their final appointment. Weight was also assessed at the end of treatment.

Table 3

Assessments Used at Pre-and Post-Treatment

		Pre-Treatment	Post-Treatment
Baseline	SCID	X	
	NESHI	X	
	MEQ	X	
	Height	X	
	Weight	X	X
Primary Outcomes	NESS	X	X
Secondary Outcomes	BDI	X	X
	ISI	X	X

Program Completion

Program completion was defined as both (a) administering light therapy at least 8 of14 sessions, and (b) completing at least 4 light therapy sessions each of the 2-weeks of the treatment duration (Lundgren, O'Neil, Martin, & Binks, 2005). Thus, participants who completed 8/14 bright light therapy sessions, of which at least 4 occurred each week, were considered completers. Measures of adherence were based on the daily contact between the researcher and the participant either via phone message, text message, or email. This took place according to the participants' communication preference. Participants were required to make contact with the researcher by 10:00 am each day in order to ensure the therapy occurred close to the recommended time. If more than one day had passed without participant contact, the researcher contacted the participant.

Barriers to Recruitment and Intervention

It was difficult to recruit individuals with night eating behavior due to the low occurrence of night eating behaviors in the general population. NES has been reported in 1.5%, 1.6% and 5.7% of the general population (Rand et al., 1997; Colles et al., 2007; Streigel-Moore, 2006), which is a relatively small percentage. The low occurrence of NES is also why inclusion criteria

were broadened to include night eating behaviors versus limiting it those that meet NES diagnostic criteria. Additionally, this was a time intensive intervention that may have presented adherence challenges for the participant. Specifically, both waking up each day at the designated time and engaging in the light therapy may have been difficult. In order to help with this process, we asked the participant to be in communication with the researcher on a daily basis. Originally, participants were eligible to win a VISA gift card if they completed the study. Each day a participant completed a light therapy session, their name was to be entered in a drawing to win a VISA gift card. However, after significant recruitment challenges an amendment was submitted and approved to offer participants $4.00 each day they correctly notified the researcher they completed light therapy. If participants properly administered and notified the researcher for the full 14-day protocol, they were compensated a total of $56.00.

Control Group

The use of a control group was given strong consideration; however, this study did not include a control group for the following reasons: First, a very small number of treatment studies for NES have been performed, none of which have included BLT as an intervention of interest. Given this is one of the first studies examine BLT as a treatment for NES, it was appropriate to determine if there is an effect before adding a control group to the research design. Second, most NES treatment studies to date have been open label trails. This study was also an open label design where the experimenter as well as the participant knew the treatment they were receiving. Thus, the participant understood if they had been randomized to a control group that does not involve any intervention. Finally, a control group was not added to the design for feasibility purposes. Recruitment challenges were anticipated and including a control group would have

extended the length and/or sample size of study considerably. Overall, this study provided an incremental contribution to the NES literature that was also feasible for a dissertation project.

Table 4

Study Timeline at the Time of Project Initiation

October 2012	**November 2012 –August 2013**	**August 2013 - October 2013**
Begin Recruitment	Assess and treat 4 participants each month (N=40)	Study wrap up; data analysis

Note. Study duration was extended to July 2014 to meet recruitment goals.

Statistical Analyses

Power Analysis and Sample Size Determination

G-power was used for the power analysis. For the power analysis, I used power of 0.80 as recommended by Cohen (1988). To detect a medium sized effect ($f^2 = .15$) at alpha = 0.05 using a paired sample t-test, a sample of 34 participants were needed. However, given this is a pilot study and effect size for light therapy is unknown, 20 participants were to be the final target sample size. I planned to recruit 40 participants in order to compensate for an estimated 50% attrition rate seen in previous NES treatment studies (Allison et al., 2008). This was planned to allow 20 participants to complete the study as outlined by the program completion criteria.

Primary Aim

The primary aim of this study was to determine if BLT caused a significant reduction in symptoms of night eating behavior. Descriptive statistics were used to examine the means and frequencies of the participants' characteristics.

Hypothesis One

The first hypothesis was that scores from the NESS would significantly improve over the course of light therapy. A paired sample t-test was used test this hypothesis. Effect sizes were evaluated using Cohen's d.

Secondary Aims

Hypothesis Two

The second hypothesis was that scores on the ISI would significantly improve over the course of light therapy. A paired sample t-test was used test this hypothesis. Effect sizes were evaluated using Cohen's d.

Hypothesis Three

The third hypothesis was that depression scores from BDI would significantly improve over the course of light therapy. A paired sample t-test was used test this hypothesis. Effect sizes were evaluated using Cohen's d.

CHAPTER 4

RESULTS

Sample

A total of 15 participants completed the 14-day trial of BLT. Recruitment took place from spring 2013 through fall 2014. See Appendix F for a breakdown of recruitment processes. Participants were recruited across all seasons, controlling for possibility of differential seasonal effectiveness.

The average age was 42.2 years *(SD = 15.03).* Participants completed an average of 13.4 days of light therapy with an average duration of light therapy of 60.08 minutes per day. Administration of light therapy varied amongst participants as they were instructed to complete light therapy upon waking but to begin before 9:00 am. As a result, start time of BLT was not stable across participants. The majority of participants elected to email the researcher to confirm daily completion of BLT (73%), while 20% chose to text and 6.7% chose to leave voicemails. Regardless of method of confirmation, contact with the investigator was kept to a minimum.

On average, participants had been struggling with night eating behaviors for 13.73 years (*SD = 14.12).* Nearly half of participants (46.7%) reported having a family history of night eating behavior (i.e., mother or father). Within this sample, 66.7% of participants met full threshold criteria for NES and 33.3% met sub-threshold criteria. Table 5 provides information regarding participant characteristics.

Table 5

Participant Characteristics

	Total Sample (N=15)
Night Eating Diagnosis	
% Full-Threshold	66.7
% Sub-Threshold	33.3
Primary Night Eating Symptoms	
% Evening Hyperphagia	86.7
% Evening Hyperphagia Only	26.7
% Nocturnal Ingestions	73.3
% Nocturnal Ingestions Only	13.3
% Evening Hyperphagia and Nocturnal Ingestions	60.0
Gender	
% Female	93.3
% Male	6.7
Education	
% High School	13.3
% Some College	26.7
% Bachelors	40.0
% Graduate Degree	20.0
Marital Status	
% Single	40.0
% Married	26.7
% Divorced	26.7
% Separated	6.7
Income	
% Under 10,000	13.3
% 10-29,000	20
% 30-49,000	20
% 50-74,000	6.7
% Above 75,000	20
% Declined to answer	20
Ethnicity	
% White	80.0
% Asian	6.7
% Latino/Latina	6.7
% Black	0
% Declined to answer	6.7

Of those that met sub-threshold criteria for NES, the absent symptom that most often prevented a full-threshold diagnosis was that night eating behavior was not associated with significant distress (n = 2). Of note, 73.3% of the sample endorsed having nocturnal ingestions of food, but only 60% met the full diagnostic criteria of having 2 or more nocturnal eating episodes a week.

Participants were asked on the NESHI to indicate how stressful night eating behavior is for them and how much it has affected their life based on a 0-4 scale, with 4 indicating extreme severity. If participants responded to either of these questions with a rating of 2 or above, they were considered to have met criteria for the disorder causing significant distress and/or impairment in functioning. In order to better understand what symptoms were present in this sample, Table 6 provides a breakdown of diagnostic symptoms endorsed by the total sample, by those who met full-threshold criteria for NES, and by participants who met sub-threshold criteria for NES.

Table 6.

Diagnostic Symptoms

	% criterion met		
	Total Sample (N=15)	Participants with Full Threshold NES (N=10)	Participants with Sub-Threshold NES (N=5)
The daily pattern of eating demonstrates a significantly increased intake in the evening and/or nighttime, as manifested by *one or both* of the following:	100.0	100.0	100.0
A. At least 25% of food intake is consumed after the evening meal	86.7	90.0	80.0
B. At least two episodes of nocturnal eating per week	60.0	70.0	40.0
Awareness and recall of evening and nocturnal eating episodes are present	100.0	100.0	100.0
The clinical picture is characterized by *at least three* of the following features:	80.0	90.0	60.0
A. Lack of desire to eat in the morning and/or breakfast is omitted on four or more mornings a week	73.3	80.0	60.0
B. Presence of a strong urge to eat between dinner and sleep onset and/or during the night	93.3	100.0	80.0
C. Sleep onset and/or sleep maintenance insomnia are present four or more nights each week	80.0	80.0	80.0
D. Presence of a belief that one must eat in order to initiate or return to sleep	66.7	40.0	40.0
E. Mood is frequently depressed and/or mood worsens in the evening	33.3	40.0	20.0
The disorder is associated with significant distress and/or impairment in functioning	80.0	100.0	40.0
The disordered pattern of eating has been maintained for at least 3 months	100.0	100.0	100.0
The disorder is not secondary to substance abuse or dependence, medical disorder, medication, or another psychiatric disorder	100.0	100.0	100.0

All participants denied receiving any current treatment for NES. In addition, participants who had participated in a weight loss program in the last 3 months were excluded. Participants

with a history of a mental health condition were included, but in order to participate in the study, they could not meet full-threshold criteria for a mental health condition. This was confirmed with the SCID prior to beginning treatment. Thirty-three percent of the sample was prescribed psychotropic medication by an outside medical provider. These individuals had to have been stable on their medication for at least 1-month to be included in the study and could not to be planning any changes in the prescription for the duration of the study. If changes in medication were made unexpectedly, participants were asked to inform the researcher. All participants who were on medication at the beginning of BLT remained stable on their medication throughout treatment.

Participants were asked to identify any previous treatment attempts made in the past to help improve their night eating behavior. Please see Table 7 for a breakdown of various treatment attempts.

Table 7

Previous Treatment Attempts

	Total Sample (N=15)
% No previous treatment attempts	33.3
% Medication	20.0
% Restrict Food/Diet	20.0
% Consult Sleep Specialist	6.7
% Self-Control	6.7
% Health Clinic	6.7
% Sleep	6.7
% Appetite Suppressant	6.7
% Evening Exercise	6.7
% Positive Self-Care	6.7
% Melatonin Supplement	6.7
% Eliminate Evening Sugar	6.7
% Skip Breakfast	6.7
% Bell on Door	6.7
% Distraction	6.7
% Barricade Kitchen	6.7
% Lay out Food	6.7

Hypothesis One

A paired sample t-test was used to test the hypothesis that scores from the NESS would significantly improve over the course of light therapy. This hypothesis was supported. Results showed a statistically significant difference in mean NESS scores before and after light therapy with moderate to large effect sizes; see Table 8. Scores decreased an overall average of 9.47 points following a 14-day administration of light therapy of 60 minute duration.

Participants reported a 47% reduction of weekly nocturnal ingestions ($t = 2.68$, $p = .02$) from pre- to post-treatment. This was assessed through self-report from the following question on the NESS: "When you got up in the middle of the night, how many times total did you snack in the past week?" Nocturnal ingestions of food decreased on average from 3.47 times per week to 1.83 times per week after treatment.

Paired sample t-tests were used to further assess specific NES symptoms measured on the NESS. Results indicate that following symptoms significantly improved: reduction in cravings or urges to eat snacks after supper, but before bedtime (Evening Cravings), increased control over eating between supper and bedtime (Evening Control), reduction in amount of food consumed after suppertime (EH), reduced problems getting to sleep at night (Sleep Trouble), reduction in total awakenings (Total Awakenings), reduction in nocturnal ingestions (NI), reduced cravings or urges to eat when awake at night (Night Cravings), reduced need to eat in order to get back to sleep when awake at night (Need To Eat), increase in control over eating when up at night (Night Control), and reduced feelings of being blue or down in the dumps (Blue). Table 8 provides mean pre- and post-treatment scores reflecting specific symptoms assessed by the NESS. Items are scored on a 0-4 scale, with 4 indicating more severe NES symptoms.

Table 8

NESS Scores Before and After BLT

	Before Light Therapy		After Light Therapy						
Outcome	M	SD	M	SD	N	t	df	*P*	*d*
Total NESS Score	25.87	9.17	16.40	7.12	15.00	5.38	14.00	0.00	2.88
Morning Hunger*	2.47	1.19	2.07	1.10	15.00	1.87	14.00	0.08	1.00
Time Eaten	.47	.64	.47	.52	15.00	.00	14.00	1.00	0.00
Evening Cravings	3.0	1.20	1.67	.98	15.00	4.39	14.00	0.001	2.35
Evening Control*	2.67	1.29	2.00	.85	15.00	2.32	14.00	0.04	1.24
EH	2.00	.65	1.33	.49	15.00	3.57	14.00	0.003	1.91
Sleep Trouble	1.60	1.30	1.00	1.07	15.00	2.36	14.00	0.03	1.26
Total Awakenings	2.73	1.44	.20	1.66	15.00	2.48	14.00	0.03	1.33
NI	1.93	1.49	1.07	1.28	15.00	2.83	14.00	0.01	1.53
Night Cravings	1.93	1.53	1.00	1.20	15.00	2.82	14.00	0.01	1.51
Need To Eat	1.60	1.35	.67	.98	15.00	2.71	14.00	0.02	1.45
Night Control*	2.33	1.30	1.47	1.13	15.00	2.10	14.00	0.05	1.12
Blue	1.53	1.41	.80	1.21	15.00	2.58	14.00	0.02	1.38
Mood Change	1.60	1.60	.73	1.33	15.00	1.68	14.00	0.12	0.90

Note **Items are reverse scored, lower scores indicate improved outcome of NES symptoms*

Hypothesis Two

A paired sample t-test was used to test the hypothesis that scores from the ISI would significantly improve over the course of light therapy. This hypothesis was supported. Results show a statistically significant difference in mean ISI scores before and after light therapy. Scores decreased an average of 5.40 points following a 14-day administration of light therapy of 60 minute duration. Table 9 provides mean pre- and post-treatment scores.

Table 9

ISI Scores Before and After BLT

	Before Light Therapy		After Light Therapy						
Outcome	M	SD	M	SD	n	*t*	*df*	*P*	*d*
ISI Score	13.73	96.55	8.33	6.29	15	3.14	14	0.007	1.68

Hypothesis Three

A paired sample t-test was used to test the hypothesis that scores from the BDI would significantly improve over the course of light therapy. This hypothesis was supported. Results show a statistically significant difference in mean BDI scores before and after light therapy. Scores appear to decrease an average of 9.60 points following a 14-day administration of light therapy of 60 minute duration. Table 10 provides mean pre- and post-treatment scores.

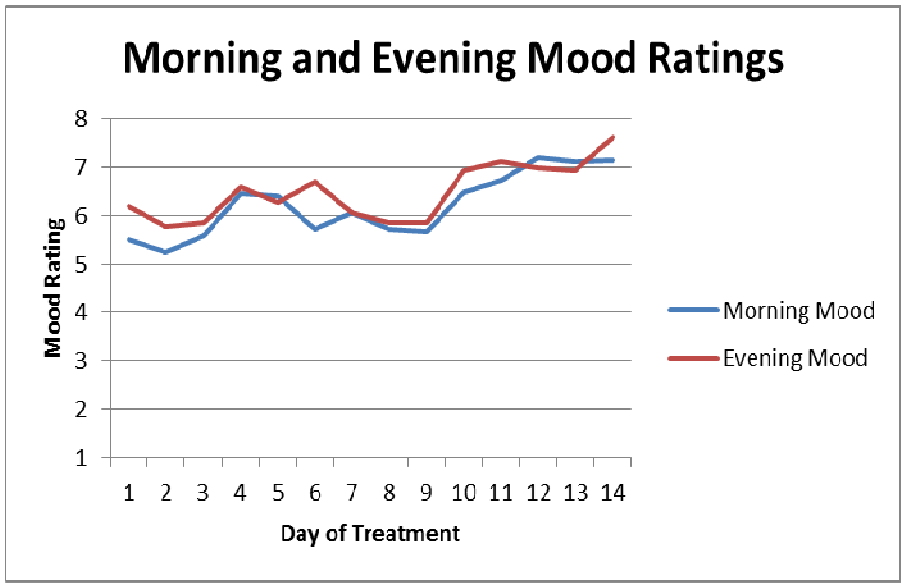
Table 10

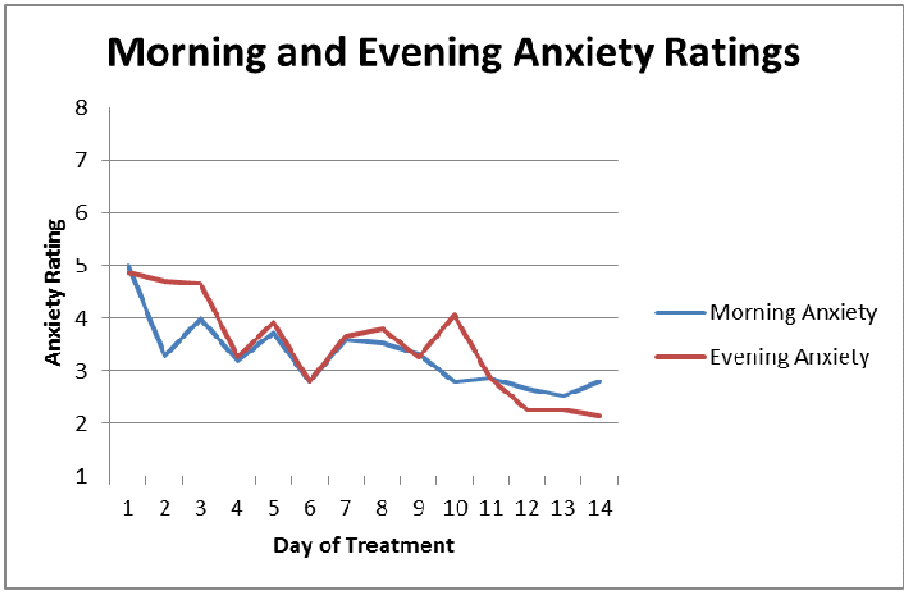
BDI Scores Before and After BLT

	Before Light Therapy		After Light Therapy						
Outcome	M	SD	M	SD	n	*t*	*df*	*p*	*d*
BDI Score	17.33	12.66	7.73	11.31	15	3.36	14	.005	1.80

Daily morning and evening ratings of mood and anxiety were assessed through self-report measures throughout the 14-day trial of BLT. Participants were asked to rank morning and evening levels of mood on a 1-10 scale (10 indicating “mood is very high”) as well as levels of anxiety on a 1-10 scale (10 indicating “anxiety is very high”). Over the course of treatment, morning ratings of mood significantly improved by an average score of 1.29 from day 1 to day 14 ($t = -2.39$, $p = .03$). There was not a significant difference on evening ratings of mood over the course of treatment.

Anxiety ratings, however, were significantly reduced on both morning and evening ratings from day 1 to day 14 of treatment. Morning ratings of anxiety decreased by an average of 1.86 points (t = 2.48, *p* = *.03*) and evening ratings decreased by an average of 2.85 points (t = 3.56, *p* = *.004*).





Exploratory Analyses

Although this sample is too small to make meaningful statistical comparisons, mean NESS and ISI scores seemed to improve at a greater rate in the full-threshold group versus the sub-threshold group. NESS scores reduced on average 12.0 points ($t = 6.1$, $df = 9$, $p = .00$) versus 4.4 points in the group who met sub-threshold criteria ($t = 1.92$, $df = 4$, $p = .13$). In addition, ISI scores dropped an average of 7.2 points ($t = 4.6$, $df = 9$, $p = .001$) in the full-threshold group versus 1.8 points in the sub-threshold group ($t = .47$, $df = 4$, $p = .67$). Interestingly, BDI scores averaged a 9.6 drop in both groups. See Table 11 for a breakdown of average scores on these measures.

Table 11

Primary Outcome Scores Before and After BLT

	Full-Threshold NES (N=10)		Sub-Threshold NES (N=5)	
	Before Light Therapy	After Light Therapy	Before Light Therapy	After Light Therapy
NESS	27.1	15.1	23.4	19.0
ISI	14.5	7.3	12.2	10.4
BDI	16.9	7.3	18.2	8.6

By dividing the sample in to symptom subgroups, Evening Hyperphagia Only (EH Only), Nocturnal Ingestions Only (NI Only), and Both NI and EH (Both), a preliminary examination of specific symptoms of night eating was possible. Again, this sample was too small to make meaningful statistical comparisons, but it appears that BLT may have had the most overall impact on those with both NI and EH. See Table 12 for a breakdown of average scores on these measures by symptom subgroups.

Table 12

Primary Outcome Scores Before and After BLT by Symptom Group

	Participants with Evening Hyperphagia Only (N=4)		**Participants with Nocturnal Ingestions Only (N=2)**		**Participants with both Evening Hyperphagia AND Nocturnal Ingestions (N=9)**	
	Before Light Therapy	After Light Therapy	Before Light Therapy	After Light Therapy	Before Light Therapy	After Light Therapy
NESS	20.8	15.5	13.5	10.5	30.9	18.1
ISI	12.3	10.5	11.5	6.5	14.9	7.8
BDI	20.8	8.8	4.5	2.5	18.7	8.4

For participants with evening hyperphagia only, sleep did not seem to improve as much as it did for those struggling only with nocturnal ingestions, although pre-treatment scores on the ISI were similar. Participants who endorsed evening hyperphagia without nocturnal ingestions depression scores were much higher prior to beginning treatment (M= 20.8) and reduced an average of 12 points post-treatment. Pre-treatment BDI scores in those with nocturnal ingestions were quite low (M=4.5) and reduced on average by 2 points. See Table 13 for average score reductions on these primary outcome measures.

Table 13

Average score reduction after BLT

	Full-Threshold NES (N=10)	Sub-Threshold NES (N=5)	Evening Hyperphagia Only (N=4)	Nocturnal Ingestions Only (N=2)	Evening Hyperphagia AND Nocturnal Ingestions (N=9)
NESS	12.0	4.4	5.3	3	11.0
ISI	7.2	1.8	1.8	5	6.73
BDI	9.6	9.6	12.0	2	8.73

Finally, weight was assessed at pre-and post-treatment and analyzed to determine if there was any change. Although it was not a statistically significant change, there was a .33 reduction in weight from pre-to post-treatment. It is possible that with a longer duration of treatment that

weight could continue to trend downward, but further research would be required to investigate this relationship.

CHAPTER 5

DISCUSSION

This is one of the first studies to provide information on the efficacy of BLT for NES. To date, only two case studies have shown light therapy as an effective treatment for NES. The first was a case study of a 51-year old obese woman meeting criteria for depression and night eating syndrome (Friedman et al., 2002). In this case, after receiving 14 daily morning 30-minute sessions of l0,000-lux white light therapy, night eating symptoms were reportedly absent. An additional 12 morning sessions were administered one month post-treatment due to symptoms returning. After this second administration, all symptoms of NES reportedly resolved (Friedman et al., 2002). The second case study involved a non-obese 46-year old man meeting criteria for a major depressive episode and NES (Friedman et al., 2004). After receiving 14 daily morning 30-minute sessions of 10,000-lux light therapy, this individual no longer met criteria for depression or NES.

NES is conceptualized as a disorder of dysregulated circadian rhythm. Melatonin is an essential regulator of circadian rhythm, and is believed to be a primary target of light therapy. This study may indicate that with resynchronization of circadian rhythm obtained through morning administration of BLT, night eating behaviors will be significantly reduced.

Overall NESS scores decreased by 37.6% (mean 25.67 to 16). Nocturnal awakenings were also reduced by 47% on average or 1.6 times per week. Individual item analysis of the NESS further indicates that symptom reduction occurred in the following areas: evening hyperphagia, cravings or urges to eat snacks after supper, but before bedtime, control over eating between supper and bedtime, problems getting to sleep at night, nocturnal awakenings nocturnal

ingestions, cravings or urges to eat when awake at night, need to eat in order to get back to sleep when awake at night, control over eating when up at night, and feelings of being blue or down in the dumps. In addition to improvements in night eating, symptoms of depression were significantly reduced. On average, participants had a 55% reduction in BDI scores (17.33 mean value to 7.73). Sleep quality also improved with significant reductions in scores on the ISI of 39.3% (13.73 mean value to 8.33).

Weight was measured at the baseline appointment and at follow-up. There was not a significant change in weight over the course of treatment, although participants averaged a .33 pound weight loss. It is possible that with a longer course of treatment weight loss would be greater, particularly if night eating behaviors continued to improve.

The pattern of symptom change is unclear in the relationship between depression, sleep, and night eating behavior. It is possible that NES symptom reduction is occurring as a result of sleep, anxiety, and mood improvement. Daily ratings of mood and anxiety indicate that morning and evening ratings of anxiety significantly improve over the course of treatment. In addition, morning rating of mood significantly improved over the 14-day trial of BLT. Thus, light therapy may be improving mood, sleep quality, and anxiety and as a result of these changes, night eating behavior improves. Based on these data, it appears that these changes occur concurrently but further research is needed to determine if change in mood/anxiety is driving night eating symptom reduction, if night eating symptom reduction is driving changes in mood/anxiety, or if the changes are independent.

This sample appears to have comparable characteristics in comparison to other participants included in other treatment studies for NES. A study examining the efficacy of sertraline on night eating behaviors obtained a sample of 34 individuals all meeting current

criteria for NES (O'Reardon et al., 2006). As in the current study, the sertraline sample was made up of primarily Caucasian (79%) women (67%) in their mid-forties (45.1 years). Pre-treatment mean NESS scores (31.7) and BDI-II scores (14.4) were also similar to this study. In the first CBT trail for the treatment of NES, the 25 participants included were also primarily female (76%), Caucasian (68%), and in their mid-forties (46.8 years) (Allison et al., 2010). Average NESS score was 28.7 prior to beginning treatment. In this trial for CBT, however, mean BDI-II score was significantly lower (9). BLT is a potential efficacious treatment for NES. This study offers preliminary evidence that with a relatively short-term administration of morning light therapy, night eating behaviors can significantly improve. Additional benefits are improvements to mood and sleep quality.

Based on these data, BLT may offer comparable symptoms improvement when compared to previously investigated treatments. Sertraline was found to be an effective treatment for NES and reduced nocturnal ingestions by 80% in the treatment group. This study also found that many of their participants had a quick and robust response to treatment, even those that had experienced symptoms for many years (O'Reardon et al., 2006). In the CBT trail, NESS scores were reduced from 28.7 at session 1 to 16.3 by session 10 (Allison et al., 2010). As in these studies, these data also demonstrate a relatively robust change in mood and night eating behaviors in a short period of time.

Despite the small sample size, large effect sizes were seen for primary and secondary outcomes. This allows an assessment of the effect this treatment may have in the general population. Given the effect sizes seen in this study, a short-term treatment of BLT may provide significant improvement of night eating behaviors, sleep quality, and mood.

Limitations

This study had several limitations. First, this study had a small sample size that was comprised of primarily Caucasian women. Thus, it is unknown whether these results would replicate outside of this demographic group. Second, participants were asked to keep food records which may have had an impact on their food intake. Research indicates eating behavior can be altered as a result of self-monitoring because it increases an individual's awareness of their eating behavior and the circumstances that surround the behavior (Waden, Crerand, & Brock, 2005) Self-monitoring is also strongly related to weight loss and weight maintenance (Baker & Kirschenbaum, 1998; Baker & Kirschenbaum, 1993; Guare et al., 1989). Due to these effects, participants may have experienced a change in eating behaviors as a result of self-monitoring alone. Self-regulation, however, does not have the same effect on mood and sleep improvement as is does with eating behavior. This indicates BLT may improve outcomes beyond the benefits of self-regulation associated with monitoring food intake.

Third, this study did not include a control group which prevents a comparison between a treatment group and a group that did not receive BLT. A control group would provide an enhanced understanding if BLT is an effective intervention for NES, specifically it would be important to use a 3-arm design (active, usual care, and wait-list control) to determine efficacy (Kinser & Robins, 2012). Alternatively, sham light therapy could have been used as a control (this is a better option that the 3 arm option because 1) there is no usual care for NES and 2) a wait list control might not be justified when there is a viable placebo option. Finally, there are possible intervention effects in this study. Specifically, by enrolling in this study, participants were provided attention and a proposed treatment from a health care professional for a condition that is not widely recognized. Individuals with NES have often struggled with symptoms in

private without receiving any help. Although contact between the researcher and participant was kept to a minimum (daily email, text, or phone message), it is possible that the attention received through the intervention was the active ingredient rather than the potential circadian regulation resulting in exposure to the light. Future studies examining sham light therapy as a control could address this limitation.

In addition, this sample was likely comprised of persons who were highly motivated to seek treatment for their symptoms. This is demonstrated by treatment adherence and completion. Treatment adherence was extraordinarily high and zero participants withdrew from the study. Motivation is important to consider when thinking about how this treatment would generalize to other persons struggling with NES and it is possible that less motivated individuals would not have these same results due to non-compliance with BLT recommendations. Treatment compliance, however, was also based on self-report so fidelity may not be as high as what was reported. Participants were asked to either text, call, or email the researcher to confirm completion of light therapy each day. Thus, it is possible that an individual did not complete treatment even if they confirmed they had in order to be financially compensated, for social desirability reasons, or both purposes.

Finally, there is possible influence in this study of carryover effect. The interval between administrations was relatively short which could impact answers at post-treatment. This limitation could be addressed in the future with the inclusion of a control group.

Future Research

Although this evidence is promising, further research is needed to investigate BLT for the treatment of NES. Future studies should include randomized controlled trials that include larger sample sizes and valid control conditions such as sham light therapy (non-therapeutic light).

Further, participants should be blind to their treatment condition in order to address performance, expectation and detection bias. In order to address these concerns, groups could be added to the research design that include non-therapeutic light exposure (basic lamp).

Once efficacy of BLT for NES has been established, dosing should be considered to determine duration, frequency and intensity of light needed (lux) for maximum symptom reduction. Studies testing longer durations of light therapy administration would be appropriate, as this was only a 14-day trial and there may be additional benefit to completing a longer course of treatment. In addition, long-term studies that examine the duration of symptom relief should be included. It would be beneficial to perform dismantling studies that help determine the active ingredient of treatment (e.g., attention vs. light or food records vs. light). Future studies might also include salivary or blood sample testing of hormonal shifts that occur during and after BLT in individuals with NES. Biological samples to be assessed might include 24-hour melatonin, leptin, blood glucose, insulin and/or cortisol. Finally, future studies could examine the possible benefit of adding a melatonin supplement to a trial of BLT for NES to determine if the combined treatment would provide benefit above and beyond light therapy alone.

Future studies that include daily assessment of constructs that may be influencing night eating behavior are necessary to determine if change in one symptom is leading to change in another or if they are changing concurrently/independently. As noted, with the current design, it is not possible to determine if mood, anxiety, and/or sleep changes led to changes in eating behavior, vice versa, or if the changes were independent of one another. This will be important to determine the pattern of behavior change. In order to assess this pattern, reliable methods of assessing NI and EH should be included in the research design. An example of this might be verbal 24-hour dietary recalls that use a multiple-pass structure.

Finally, sample size in this study was too small to run statistical analyses, however, this intervention may be more beneficial for those who meet full diagnostic criteria for NES. In full-threshold group, NESS and ISI scores seemed to improve at a greater rate, with NESS scores dropping on average 12 points and ISI dropping on average 7.2 points at post-treatment. This appears to be a stronger treatment outcome compared to the sub-threshold group, who had average NESS decreases of 4.4 points and average ISI point decreases of 1.8 points. Interestingly, depression scores reduced at the same rate in the full- and sub-threshold groups, with a mean BDI drop of 9.6 points

It is possible this treatment may best target those with full-threshold NES, but sleep quality might be most improved in those specifically struggling with nocturnal ingestions. Further, depression ratings may be more severe and show more improvement in those with evening hyperphagia. Further studies could examine what treatments might be more beneficial based on symptom endorsement and how treatments can be tailored to create the best outcome.

This study was an important step in advancing the literature on treatments for night eating behavior. Until this time, BLT had been shown to be a helpful treatment for NES in two case studies. This is the first study to systematically examine whether this is an efficacious treatment for this disorder. Given the improvement to night eating behaviors after a 14-day intention, further research is needed to better understand BLT as a treatment for night eating.

APPENDIX A

PHONE SCREEN

Name	
Preferred Contact Information	Email: Phone:
Age (18-65)	
Height	
Weight	
BMI (must be above 18.5)	
Have you struggled with night eating in the last 3 months?	
How much of your daily caloric intake to do you consume after your evening meal?	0% 25% 50% 75%
Have you been in treatment in the last 3 months for any mental health condition?	
Have you been diagnosed with a mental health condition?	
Are you taking any medication?	
Are you pregnant or trying to become pregnant?	
Do you have any ocular or retinal pathology?	
Have you worked a regular or rotating night shift in the last 3 months?	
Have you been diagnosed with a sleep disorder?	

APPENDIX B

Night Eating Symptom Scale-II (NESS-II)

Directions: Refer to your experiences in the *past week*. Please give ONE answer for each question.

1. How hungry were you in the morning during the past week?

0	**1**	**2**	**3**	**4**
Not at all	A little	Somewhat	Moderately	Very

2. When did you usually eat for the first time each day?

0	**1**	**2**	**3**	**4**
Before 9am	9:01 to 12pm	12:01 to 3pm	3:01 to 6pm	6:01 or later

3. Did you have cravings or urges to eat snacks after supper, but before bedtime this week?

0	**1**	**2**	**3**	**4**
None at all	A Little	Somewhat	Very much so	Extremely so

4. How much control do you have over your eating between supper and bedtime?

0	**1**	**2**	**3**	**4**
None at all	A Little	Somewhat	Very much	Complete

5. How much of your daily food intake did you consume *after* suppertime?

0	**1**	**2**	**3**	**4**
0% (none)	1-24% (up to a quarter)	25-49% (between a quarter and a half)	50-74% (more than half)	75-100% (almost all)

6. How often did you have trouble getting to sleep this week?

0	**1**	**2**	**3**	**4**
Never	1-2 times	3-4 times	5-6 times	every night

7. How many times total did you get up in the middle of the night in the past week?

_____ # times whole week

8. When you got up in the middle of the night, how many times total did you snack in the past week?

_____ # times whole week

9. Did you have cravings or urges to eat snacks when you woke up at night this week?

0	**1**	**2**	**3**	**4**
None at all	A little	Somewhat	Very much so	Extremely so

10. When you were up at night this week, how much did you need to eat in order to get back to sleep?

0	**1**	**2**	**3**	**4**	_____ check here if you
Not at all	A little	Somewhat	Very much so	Extremely so	did not get up

11. How much control do you have over your eating while you are up at night?

0	**1**	**2**	**3**	**4**	_____ check here if
None at all	A little	Some	Very much	Complete	you did not get up

12. Were you feeling blue or down in the dumps this week?

0	**1**	**2**	**3**	**4**
Not at all	A little	Somewhat	Very much so	Extremely so

13. When you were feeling blue, was your mood lower in the:

0	**1**	**2**	**3**	**4**	_____ check here if
Early Morning	Late Morning	Afternoon	Early Evening	Late Evening/ Nighttime	you did not feel blue at all

Scoring Key:

Items 1, 4, and 11 are reverse-scored. For items 7 and 8, a response of 0 = 0 points, 1 - 2 times = 1 point, 3 – 4 times = 2 points, 5 – 6 times = 3 points, and 7+ times = 4 points. Then sum all items to get the total score.

APPENDIX C

Insomnia Severity Index

For each question, please *CIRCLE* the number that best describes your answer.
Please rate the *CURRENT (i.e. LAST 2 WEEKS) SEVERITY* of your insomnia problem(s).

Insomnia problem	None	Mild	Moderate	Severe	Very severe
1. Difficulty falling asleep	0	1	2	3	4
2. Difficulty staying asleep	0	1	2	3	4
3. Problem waking up too early	0	1	2	3	4

4. How SATISFIED/DISSATISFIED are you with your CURRENT sleep pattern?

Very Satisfied Satisfied Moderately Satisfied Dissatisfied Very Dissatisfied
0 1 2 3 4

5. How NOTICEABLE to others do you think your sleep problem is in terms of impairing the quality of your life?

Not at all Noticeable A Little Somewhat Much Very Much Noticeable
0 1 2 3 4

6. How WORRIED/DISTRESSED are you about your current sleep problem?

Not at all Worried A Little Somewhat Much Very Much Worried
0 1 2 3 4

7. To what extent do you consider your sleep problem to INTERFERE with your daily functioning (e.g. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) CURRENTLY?

Not at all Interfering A Little Somewhat Much Very Much Interfering
0 1 2 3 4

Scoring and Interpretation:

The total score is the sum of all seven items

Interpretation

0–7 = **No clinically significant insomnia**
8–14 = **Subthreshold insomnia**
15–21 = **Clinical insomnia (moderate severity)**
22–28 = **Clinical insomnia (severe)**

APPENDIX D

BECK DEPRESSION INVENTORY-II

Name:_____ Marital Status:_____ Age:____ Sex:_____

Occupation:_____ Education:_____

Instructions: This questionnaire consists of 21 groups of statements. Pleas read each group of statements carefully and then pick out the one statement in each group that best describes the way you have been feeling during the **past two weeks, including today**. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in Sleeping Pattern) or Item 18 (Changes in Appetite).

1. Sadness
- 0 I do not feel sad.
- 1 I feel sad much of the time.
- 2 I am sad all the time.
- 3 I am so sad or unhappy that I can't stand it.

2. Pessimism
- 0 I am not discouraged about my future.
- 1 I feel more discouraged about my future than I used to be.
- 2 I do not expect things to work out for me.
- 3 I feel my future is hopeless and will only get worse.

3. Past Failure
- 0 I do not feel like a failure.
- 1 I have failed more than I should have.
- 2 As I look back I see a lot of failures.
- 3 I feel I am a total failure as a person.

4. Loss of Pleasure
- 0 I get as much pleasure as I ever did from the things I enjoy.
- 1 I don't enjoy things as much as I used to.
- 2 I get very little pleasure from then things I used to enjoy.
- 3 I can't get any pleasure from the things I used to enjoy.

5. Guilty Feelings
- 0 I don’t feel particularly guilty.
- 1 I feel guilty over many things I have done or should have done.
- 2 I feel quite guilty most of the time
- 3 I feel guilty all they time.

6. Punishment Feelings
- 0 I don't feel I am being punished.
- 1 I feel I may be punished.
- 2 I expect to be punished.
- 3 I feel I am being punished.

7. Self-Dislike
- 0 I feel the same about myself as ever.
- 1 I have lost confidence in myself
- 2 I am disappointed in myself
- 3 I dislike myself.

8. Self-Criticalness
- 0 I don't criticize or blame myself more than usual.
- 1 I am more critical of myself than I used to be.
- 2 I criticize myself for all of my faults.
- 3 I blame myself for everything bad that happens.

9. Suicidal Thoughts or Wishes
- 0 I don’t have any thoughts of killing myself.
- 1 I have thoughts of killing myself, but I would not carry them out.
- 2 I would like to kill myself.
- 3 I would kill myself if I had the chance.

10. Crying
- 0 I don't cry anymore than I used to.
- 1 I cry more than I used to.
- 2 I cry over every little thing.
- 3 I feel like crying, but I can't.

11. Agitation

0 I am no more restless or wound up than usual.
1 I feel more restless or wound up than usual.
2 I am so restless or agitated that it's hard to stay still.
3 I am so restless or agitated that I have to keep moving or doing something.

12. Loss of Interest

0 I have not lost interest in other people or activities.
1 I am less interested in other people or things than before.
2 I have lost most of my interest in other people or things.
3 It's hard to get interested in anything.

13. Indecisiveness

0 I make decisions about as well as ever.
1 I find it more difficult to make decisions than usual
2 I have much greater difficulty in making decisions than I used to.
3 I have trouble making any decisions.

14. Worthlessness

0 I do not feel I am worthless.
1 I don't consider myself as worthwhile and useful as I used to.
I feel more worthless as compared to other people.
I feel utterly worthless.

15. Loss of Energy

0 I have as much energy as ever.
1 I have less energy than I used to have.
2 I don't have enough energy to do very much.
3 I don't have enough energy to do anything.

16. Changes in Sleeping Pattern

0 I have not experienced any change in my sleeping patterns.

1a I sleep somewhat more than usual.
1b I sleep somewhat less than usual.

2a I sleep a lot more than usual.
2b I sleep a lot less than usual.

3a I sleep most of the day.
3b I wake up 1-2 hours early and can't get back to sleep.
---

17. Irritability

0 I am no more irritable than usual.
1 I am more irritable than usual.
2 I am much more irritable than usual.
3 I am irritable all the time.

18. **Changes in Appetite**

0 I have not experienced any change in my appetite.

1a My appetite is somewhat less than usual.
1b My appetite is somewhat greater than usual.

2a My appetite is much less than before.
2b My appetite is much greater than usual.

3a I have no appetite at all.
3b I crave food all of the time.

19. Concentration Difficulty 0 I can concentrate as well as ever. 1 I can't concentrate as well as usual. 2 It's hard to keep my mind on anything for very long. 3 I find I can't concentrate on anything. **20. Tiredness or Fatigue** 0 I am no more tired or fatigued than usual. 1 I get more tired or fatigued more easily than usual. 2 I am too tired or fatigued to do a lot of the things I used to do. 3 I am too tired or fatigued to do most of the things I used to do. **20. Loss of Interest in Sex** 0 I have not noticed any recent change in my interest in sex. 1 I am less interested in sex than I used to be. 2 I am much less interested in sex now. 3 I have lost interest in sex completely.	

APPENDIX E

DAILY LOG

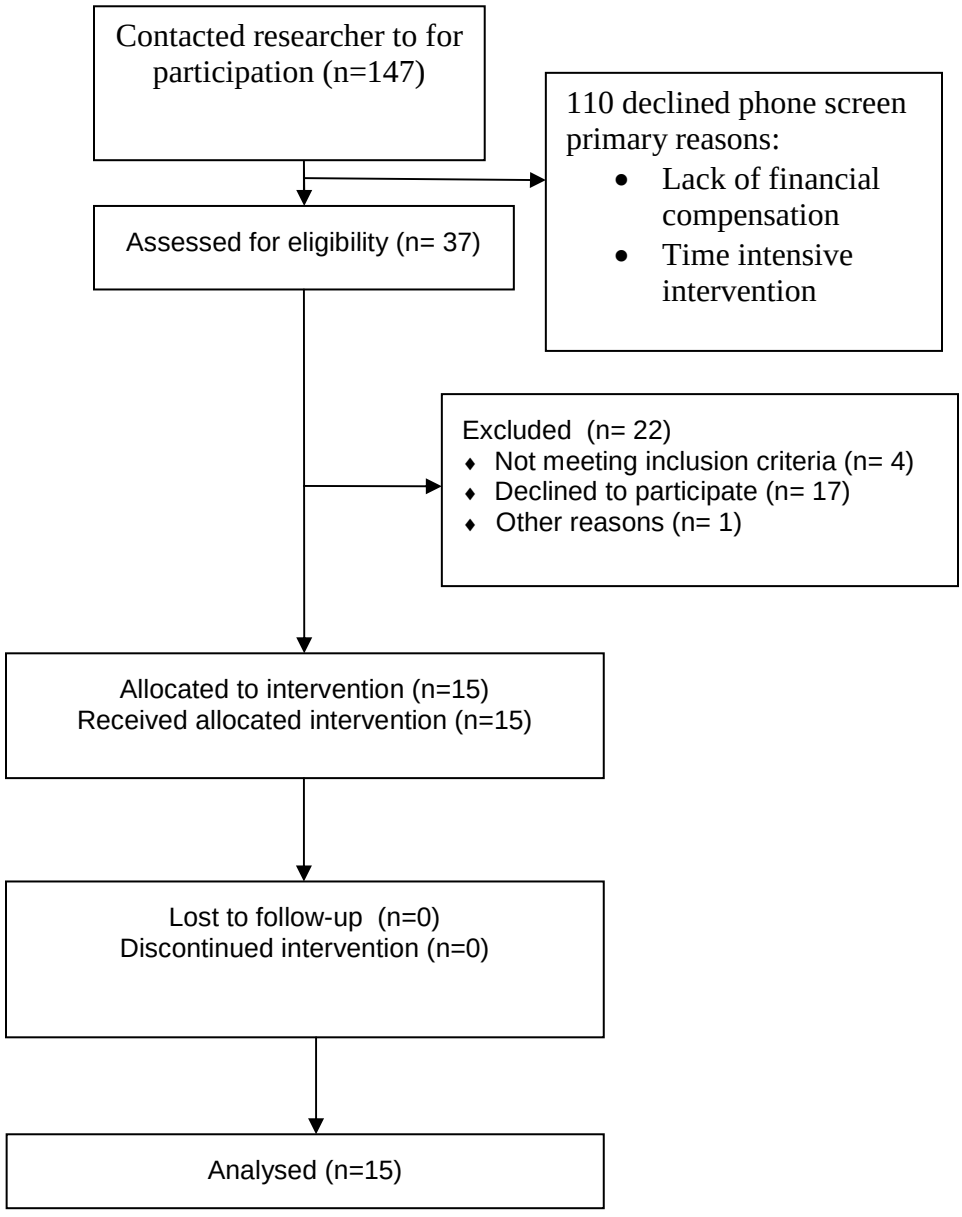
What time did you go to bed last night?	
What time did you wake up this morning?	
How many times did you wake up during the night last night?	
Did you have anything to eat after going to sleep last night?	
How hungry were you when you woke up today (circle)?	1 2 3 4 5 6 7 8 9 10 1- not at all 10-very
Did you administer your light therapy today?	
What time did you begin your light therapy today?	
What time did you end your light therapy today?	
Please rate your mood when you woke up today (circle):	1 2 3 4 5 6 7 8 9 10 1-mood is very low 10-mood is very high
Please rate your mood before going to bed today (circle):	1 2 3 4 5 6 7 8 9 10 1-mood is very low 10-mood is very high
Please rate your anxiety when you woke up today (circle):	1 2 3 4 5 6 7 8 9 10 1-anxiety is very low 10-anxiety is very high
Please rate your anxiety before going to bed today (circle):	1 2 3 4 5 6 7 8 9 10 1-anxiety is very low 10-anxiety is very high

Food Intake

TIME	AMOUNT	WHAT MEAL WAS THIS?	WHAT DID YOU EAT AND/OR DRINK?

APPENDIX F

Recruitment Consort Chart



REFERENCES

Allison, K., Ahima, R., O'Reardon, P., Dinges, D., Sharma, V., Cummings, D., Heo, M., Martino, N., & Stunkard, A. (2005a). Neuroendocrine profiles associated with energy intake, sleep, and stress in the night eating syndrome. *The Journal of Clinical Endocrinology & Metabolism, 90,* 6214-6217.

Allison, K.C., Engel, S.G., Crosby, R.D., de Zwaan, M., O'Reardon, J.P., Wonderlich, S.A., Mitchell, J.E., Smith West, D., Wadden, T.A., & Stunkard, A.J. (2008). Evaluation of diagnostic criteria for night eating syndrome using item response theory analysis. *Eating Behavior, 9,* 398-407.

Allison, K.C., Grilio, C.M., Masheb, R.M., & Stunkard, A.J. (2005b). Binge eating disorder and night eating syndrome: A comparative study of disordered eating. *Journal of Consulting and Clinical Psychology, 73,* 1107-1115.

Allison, K.C., Lundgren, J.D., Moore, R., O'Reardon, J., & Stunkard, A.J. (2009). Cognitive behavioral therapy for night eating syndrome: A pilot study. *American Journal of Psychotherapy, 64*(1), 91-106.

Allison, K.C., Lundgren, J.D., O'Reardon, J.P., Geliebter, A., Gluck, M., Piergiuseppe, V., Mitchell, J.E., Schenck, C.H., Howell, M.J., Crow, S.J., Engel, S., Latzer, Y., Tzischinsky, O., Mahowald, M., & Stunkard, A.J. (2010). Proposed diagnostic criteria for night eating syndrome. *International Journal of Eating Disorders, 43,* 241-247.

Allison, K.C., Lundgren, J.D., O'Reardon, J.P., Martino, N.S., Sarwer, D.B., Wadden, T.A. (2008). The Night Eating Questionnaire (NEQ): Psychometric properties of a measure of severity of the night eating syndrome. *Eating Behavior, 9,* 62-72.

Allison, K.C., Stunkard, A.J., & Their, S.L. (2004) *Overcoming Night Eating Syndrome: A step-by-step guide to breaking the cycle.* Oakland, CA: New Harbinger.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Anderson, D., Lundgren, J., Shapiro, J., & Paulosky. (2004). Assessment of eating disorders: Review and reccommendations for clincial use. *Behavior Modification, 28*(6), 763-782.

Aronoff, N.J., Geliebter, A., & Zammit, G. (2001). Gender and body mass index as related to the night eating syndrome. *Journal of the American Dietetic Association, 101*, 102-104.

Baker, R.C., & Kirschenbaum, D.S. (1998). Weight control during the holidays: Highly consistent self-monitoring as a potentially useful coping mechanism. *Health Psychology, 17*, 367–370.

Baker, R.C., & Kirschenbaum, D.S. (1993). Self-monitoring may be necessary for successful weight control. *Behavior Therapy, 24*, 377–394.

Bastien, C., Vallieres, A., & Moran, C. (2001). Validation of the insomnia severity index as an outcome measure for insomnia research. *Sleep Medicine, 2*, 297-307.

Bellisle, F. (2009). Infrequently asked questions about the Mediterranean diet. *Public Health Nutrition, 12,* 1644-1647.

Birketvedt, G., Florholmen, J., & Sundsfjord, J. (1999). Behavioral and neuroendocrine characteristics of the night-eating syndrome. *JAMA, 282*, 657-663.

Boston, R.C., Moate, P.J., Allison, K.C., Lundgren, J.D., & Stunkard, A.J. (2008). Modeling circadian rhythms of food intake by means of parametric deconvolution: Results from

studies of the night eating syndrome. *American Journal of Clinical Nutrition, 87,* 1672-1677.

Colles, S.L., Dixon, J.B., & O'Brien, P.E. (2007). Night eating syndrome and nocturnal snacking: Association with obesity, binge eating and psychological distress. *International Journal of Obesity, 31,* 1722–1730.

Cooper, P.J., & Fairburn, (1986). Depressive symptoms of bulimia nervosa. *British Journal of Psychiatry, 148,* 268-274.

Dalle Grave, R., Calugi, S., Ruocco, A, & Marchesini, G. (2011). Night eating syndrome and weight loss outcome in obese patients. *International Journal of Eating Disorders, 44,* 150-156.

Devlin, M.J., Goldfein, J.A., Flancbaum, L., Bessler, M., & Eisenstadt. (2004). Surgical management of obese patients with eating disorders: A survey of current practice. *Obesity Surgery, 14,* 1252-1257.

First, M.B., Spitzer, R.L., Gibbon, M., & Williams, J.B. (2002). Structured clinical interview for DSM-IV-TR Axis I Disorders, research version, patient edition. (SCID-I/P) New York: Biometrics Research, New York State Psychiatric Institute

Friedman, S., Even, C., Dardennes, R., & Guelfi, J.D. (2002). Light therapy, obesity and night-eating syndrome. *American Journal of Psychiatry, 159, ,* 875-876.

Friedman, S., Even, C., Dardennes, R., & Guelfi, J.D. (2004). Light therapy, nonseasonal depression, and night eating syndrome. *Canadian Journal of Psychiatry, 49,* 790.

Gluck, M.E., Geliebter, A., Satov, T. (2001). Night eating syndrome is associated with depression, low self-esteem, reduced daytime hunger, and less weight loss in obese outpatients. *Obesity Research, 9,* 264-267.

Goel., N., Stunkard, A.J., Rogers, N.L., Van Dongen, H.P., Allison, K.C., O'Reardon, J.P., Ahima, R.S., Cummings, D.E., Heo, M., & Dinges, D.F. (2009). Circadian rhythm profiles in women with night eating syndrome. *Journal of Biological Rhythms, 24*(1), 85-94.

Goldschmidt, A.B., Engel, S.G., Wonderlich, S.A., Crosby, R.D., Peterson, C.B., Le Grange, D., Tanofsky-Kraff, M., Cao, L., & Mitchell, J.E. (2012). Momentary affect surrounding loss of control and overeating in obese adults with and without binge eating disorder. *Obesity (Silver Spring), 20*(6), 1206-1211. doi: 10.1038/oby.2011.286.

Goncalves, M., Moore, R., Stunkard, A.J., & Allison, K. (2009). The treatment of night eating: The patient's perspective. *European Eating Disorders Reviews, 17*, 184-190.

Guare, J.C., Wing, R.R., Marcus, M., Epstein, L.H., Burton, L.R., & Gooding, W.E. (1989). Analysis of change in eating behavior and weight loss in Type II diabetic patient: Which behaviors to change. *Diabetes Care, 12*, 500–503.

Howell, M.J., Schenck, C.H., & Crow, S.J. (2009). A review of nighttime eating disorders. *Sleep Medicine Reviews, 13*, 23-34.

Jones, K. (2010). The unstructured clinical interview. *Journal of Counseling & Development, 88*(2), 220-226.

Keel, P. (2005). *Eating Disorders.* Upper Saddle River, NJ: Pearson Education, Inc.

Lack, L., Wright, H., Kemp, K., & Gibbon, S. (2005). The treatment of early-morning awakening insomnia with 2 evening of bright light. *Sleep: Journal of Sleep and Sleep Disorders Research, 28*, 616-623.

Lundgren, J.D., Allison, K.C., Crow, S., O'Reardon, J.P., Berg, K.C., Galbraith, J., Martino, N.S, & Stunkard, A.J. (2006). Prevalence of the night eating syndrome in a psychiatric population. *American Journal of Psychiatry, 163*, 156–158.

Lundgren, J.D., Allison, K.C., Crow, S., O'Reardon, & Stunkard, A.J. (2008a). A descriptive study of non-obese persons with night eating syndrome and a weight-matched comparison group, *Eating Behaviors, 9*, 352–359.

Lundgren, J.D., Allison, K.C., O'Reardon, J.P., & Stunkard, A.J. (2008b). A descriptive study of non-obese persons with night eating syndrome and a weight-matched comparison group. *Eating Behavior, 9*, 343-351.

Lundgren, J.D., Allison, K.C., Vinai, P., & Gluck, M. (2012). Assessment instruments for night eating syndrome. In J.D. Lundgren, K.C. Allison, & A.J. Stunkard (Eds.). Night Eating Syndrome: Definition, assessment, and treatment. New York: Guilford.

Lundgren, J.D., Allison, K., & Stunkard. (2006). Familial aggregation in the night eating syndrome. *International Journal of Eating Disorders, 39*(6), 516-518.

Lundgren, J.D., Boston, R. & Noble, G.K. (2012). Circadian rhythms associated with night eating syndrome. In J.D. Lundgren, K.C. Allison, & A.J. Stunkard (Eds.), *Night eating syndrome: Research, assessment, and treatment* (pp. 40-57). New York, NY: The Guilford Press.

Lundgren, J.D., Rempfer, M.V., Brown, C.E., Goetz, J. & Hamera, E. (2010). The prevalence of night eating syndrome and binge eating disorder among overweight and obese individuals with serious mental illness. *Psychiatry Research, 28*, 233-236.

Lundgren, J.D., Shapiro, J.R., & Bulik, C.M. (2008b). Night eating patterns of patients with bulimia nervosa: A preliminary report. *Eating and Weight Disorders, 13*(4), 171-175.

Lundgren, J., O'Neil, P., Martin, C., & Binks, M. (2005). Smoking status and weight loss in three weight loss programs. *Eating Behaviors, 7,* 61-68.

Marshall, H.M., Allison, K.C., O'Reardon, J.P., Birketvedt, G., & Stunkard, A.J. (2004). Night eating syndrome among nonobese persons. *International Journal of Eating Disorders, 35*, 217-222.

Miyaoka, T., Yasukawa, R., Tsubouchi, K., Miura, S., Shimizu, Y., Sukegawa, T., Maeda, T., Mizuno, S., Kameda, A., Uegaki, J., Inagaki, T., & Horiguchi, J. (2003). Successful treatment of nocturnal eating/drinking syndrome with selective seratoning reuptake inhibitors. *International Clinical Psychopharmacology, 18*, 175-177.

Niederhofer, H., & von Klitzing, K. (2012). Bright light treatment as mono-therapy of non-seasonal depression for 28 adolescents. *International Journal of Psychiatry in Clinical Practice, 16,* 233-237.

O'Reardon, J.P., Peshek, A., & Allison, K. (2005). Night eating syndrome: Diagnosis, epidemiology and management. *CNS Drugs, 19,* 997-1008.

O'Reardon, J.P., Stunkard, A.J., & Allison, K.C. (2004). Clinical trial of sertraline in the treatment of night eating syndrome. *International Journal of Eating Disorders, 35,* 16-26.

O'Reardon, J.P., Ringel, B.L., Dinges, D.F., Allison, K.C., Rogers, N.L., Martino, N.S., & Stunkard, A.J. (2004). Circadian eating and sleeping patterns in the night eating syndrome. *Obesity Research, 12*, 1789-1796.

O'Reardon, J.P., Allison, K.C., Martino, N.S., Lundgren, J.D., Heo, M., & Stunkard, A.J. (2006). A randomized, placebo-controlled trial of sertraline in the treatment of night eating syndrome. *American Journal of Psychiatry, 163,* 893-898.

Pawlow, L.A., O'Neil, P.M., & Malcom, R.J. (2003). Night eating syndrome: Effects of brief relaxation training on stress, mood, hunger and eating patterns. *International Journal of Obesity and Related Metabolic Disorders, 27,* 970-978.

Pawlow, L. (2012). Other approaches to the treatment of night eating syndrome. In J.D. Lundgren, K.C. Allison, & A.J. Stunkard (Eds.), *Night eating syndrome: Research, assessment, and treatment* (pp. 266-278). New York, NY: The Guilford Press.

Quera Salva, M.A., Hartley, S., Barbot, F., Alvarez, J.C., Lofaso, F., & Guilleminault, C. (2011). Circadian rhythms, melatonin and depression. *Current Pharmaceutical Design, 17,* 1459-70.

Rand, C.S., Macgregor A.M., & Stunkard, A.J. (1997). The night eating syndrome in the general population and among post-operative obesity surgery patients. *International Journal of Eating Disorders, 22,* 65–69.

Reeves, G.M., Nijjar, G.V., Langenberg, P., Johnson, M.A., Khabazghazvini, B., Sleemi, A., Vaswani, D., Lapidus, M., Manalai, P., Tariq, M., Acharya, M., Cabassa, J., Snitker, S., & Postolache, T.T. (2012). Improvement in depression scores after 1 hour of light therapy treatment in patients with seasonal affective disorder. *The Journal of Nervous and Mental Disease*, *200*(1), 51-55.

Root, T.L., Thornton, L.M., Lindroos, A.K., Stunkard, A.J., Lichtenstein, P., Pedersen, N.L., Rasmussen, F., & Bulik, C.M. (2010). Shared and unique genetic and environmental influences on binge eating and night eating: A Swedish twin study. *Eating Behavior*, *11*(2), 92-98.

Roth, T. (2007). Insomnia: Definition, prevalence, etiology, and consequences. *Journal of Clinical Sleep Medicine, 3,* S7–S10.

Silva, C.M., Sato, S., & Margolis, R.N. (2010). No time to lose: Workshop on circadian rhythms and metabolic disease. *Genes and Development, 24,* 1456-1464.

Striegel-Moore, R.H., Franko, D., May, A., Ach, E., Thompson, D., & Hook, J. (2006). Should night eating syndrome be included in the DSM? *International Journal of Eating Disorders, 39*(7), 544-549.

Striegel-Moore, R.H., Franko, D., & Garcia, J. (2009). The validity and clinical utility of night eating syndrome. *International Journal of Eating Disorders, 42*(8), 720-738.

Striegel-Moore, R.H., Franko, D.L., Thompson, D., Affenito, S., & Kraemer, H.C. (2006). Night eating: prevalence and demographic correlates. *Obesity Research, 14,* 139–147.

Stunkard, A.J. (1976). *The Pain of Obesity.* Palo Alto, CA: Bull Publishing Co.

Stunkard, A.J., Allison, K., Geliebter, A., Lundgren, J., Gluck, M., & O'Reardon. (2009). Development of criteria for a diagnosis: Lessons from the night eating syndrome. *Comprehensive Psychiatry, 50,* 391-399.

Stunkard, A.J., Allison, K., & Lundgren, J. (2008). Issues for DSM-V: Night eating syndrome. *American Journal of Psychiatry, 165(4),* 424.

Stunkard, A.J., Allison, K.C., Lundgren, J.D., Martino, N.S., Heo, M., Etemad, B., & O'Reardon, J.P. (2006). A paradigm for facilitating pharmacotherapy at a distance: sertraline treatment of the night eating syndrome. *Journal of Clinical Psychiatry, 67,* 1558-1572.

Stunkard, A.J., Allison, K., Lundgren, J., & O'Reardon, J.P. (2008). A biobehavioural model of the night eating syndrome. *Obesity Reviews, 10,* 69-77.

Stunkard, A.J., Berkowitz, R., & Wadden, T. (1996). Binge eating disorder and the night eating syndrome. *International Journal of Obesity, 20,* 1-6.

Stunkard, A.J., Grace, W.J., & Wolff, H.G. (1955). The night eating syndrome: a pattern of food intake among certain obese patients. *American Journal of Medicine, 19,* 78-86.

Tucker, P., Masters, B., & Nawar, O. (2004). Topiramate in the treatment of comorbid night eating syndrome and PTSD: a case study. *Eating Disorders, 12,* 75-78.

Viaterna, M.H., Takahashi, J.S, & Turek, F.W. (2001). Overview of circadian rhythms. *Alcohol Research and Health, 25* (2), 85-93.

Vander Wal, J.S., Gang, C.H., Griffing, G.T., Gadde, K.M. (2012). Escitalopram for treatment of night eating syndrome: A 12-week, randomized, placebo-controlled trial. *Journal of Clinical Psychopharmacology, 32,* 341-345.

Vinai, P., Ferri, R., Ferini-Strambi, L., Cardetti, S., Anelli, M., Vallauri, P., Ferrato, N., Zucconi, M., Carpegna, G., & Manconi, M. (2012). Defining the borders between Sleep-Related Eating Disorder and Night Eating Syndrome. *Sleep Medicine, 13,* 686-690.

Wadden, T.A, Crerand, C.E., & Brock, J. (2005). Behavioral treatment of obesity. *Psychiatric Clinics of North America, 28,* 151–170.

Winkelman, J.W. (2003). Treatment of nocturnal eating syndrome and sleep related eating disorder with topiramate. *SleepMedicine, 4,* 243-246.

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