

## PAPER

# Night eating syndrome: effects of brief relaxation training on stress, mood, hunger, and eating patterns

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**BACKGROUND:** Night eating syndrome (NES) is characterized by a lack of appetite in the morning, consumption of 50% or more of daily food intake after 6:00 p.m., and difficulty falling and/or staying asleep. It has been associated with stress and with poor results at attempts to lose weight.

**OBJECTIVE:** The purpose of this study was to determine whether a relaxation intervention (Abbreviated Progressive Muscle Relaxation Therapy, APRT) that has been shown to significantly reduce stress levels in normal, healthy adults would also benefit an NES sample.

**RESEARCH METHODS AND PROCEDURES:** A total of 20 adults with NES were randomly assigned to either a relaxation training (APRT) or a Control (quietly sitting for the same amount of time) group, and all subjects attended two laboratory sessions 1 week apart. Pre- and postsession indices of stress, anxiety, relaxation, and salivary cortisol were obtained, as well as Day 1 and Day 8 indices of mood. Food diaries and hunger ratings were also obtained.

**RESULTS:** The results indicated that 20 min of a muscle relaxation exercise significantly reduced stress, anxiety, and salivary cortisol immediately postsession. After practicing these exercises daily for a week, subjects exhibited lowered stress, anxiety, fatigue, anger, and depression on Day 8. APRT was also associated with significantly higher a.m. and lower p.m. ratings of hunger, and a trend of both more breakfast and less night-time eating.

**DISCUSSION:** These data support the role of stress and anxiety in NES and suggest that practicing relaxation may be an important component of treatment for this condition.

*International Journal of Obesity* (2003) 27, 970–978. doi:10.1038/sj.ijo.0802320

**Keywords:** night eating syndrome; stress; relaxation; cortisol; eating disorder

Night eating syndrome (NES), as first described by Stunkard *et al.*<sup>1</sup> is characterized by the following three criteria: no appetite for breakfast, 50% or more of daily food intake after 6.00 p.m., and trouble getting to and/or staying asleep. It is estimated to affect 1.5% of the general population,<sup>2</sup> and 8.9% of patients in weight reduction programs.<sup>3</sup> This syndrome has been found to occur during periods of stress, and is associated with poor results at attempts to lose weight<sup>1,4</sup> and disturbances in the hypothalamic–pituitary–adrenal axis.<sup>5</sup>

A recent study<sup>6</sup> compared overweight and obese adults with and without NES on both behavioral and neuroendocrine characteristics. Compared to the non-NES subjects, the NES group had significantly lower mood scores throughout the day; after 4:00 p.m., the NES group's mood scores fell while those of the Controls remained unchanged. Although this study did not compare the self-reported stress levels of the NES and non-NES groups, the NES group had significantly higher levels of cortisol, a glucocorticoid released by the body during times of stress, throughout the majority of the day (8:00 a.m. to 2:00 a.m.) and an attenuation of the nocturnal rise of melatonin, which is suppressed by corticotropin releasing factor (CRF), whose levels are increased by stress.<sup>6</sup>

A reduction of stress in people with NES may be important for several reasons. First, the decreased secretions of CRF that accompany decreases in stress could alleviate the inhibition of melatonin in NES, possibly resulting in fewer sleep-related

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Received 17 September 2002; revised 21 January 2003; accepted 9 March 2003

problems. Second, in the original NES article, Stunkard *et al*<sup>1</sup> anecdotally reported clinical evidence that long-term psychotherapy resulting in lowered stress levels alleviated NES in 20 therapy patients. Finally, there are the same numerous reasons that stress reduction is important for all populations: stress can not only lead to increased blood pressure, damaged muscle tissue, and growth inhibition, but stress-induced elevated cortisol levels also lead to the destruction of the immune system's T cells, which are responsible for facilitating the production of antibodies/immunoglobulins by B cells.<sup>7</sup>

There are numerous techniques available to reduce stress and produce relaxation. One of these, Jacobsen's Progressive Muscle Relaxation technique,<sup>8</sup> has shown positive clinical results; however, the requirement of 40 individual sessions makes it too time consuming for most experiments. In 1973, Bernstein and Borkovec<sup>9</sup> streamlined Jacobson's training approach and specified, in a step-by-step manner, the procedures for administering a considerably shorter relaxation training procedure that produced relaxation effects after a single session. The Bernstein and Borkovec variation became known as the Abbreviated Progressive Muscle Relaxation technique (APRT).<sup>9</sup> This comparatively brief relaxation strategy has become a standard experimental intervention.<sup>10,11</sup>

In a meta-analysis of the literature dealing exclusively with APRT, Carlson and Hoyle<sup>12</sup> concluded that APRT is an effective treatment method for the reduction of stress and generalized anxiety, and that the reported effect sizes compared favorably with the estimates obtained in other meta-analyses of psychotherapy outcome studies. In 1980, King<sup>13</sup> provided a review of the psychophysiological effects of a single session of APRT. He found that across studies APRT consistently produced reductions in heart rate, blood pressure, muscle tension, respiration rate, and skin conductance.

In two separate studies, Pawlow and Jones found that a 20-min *in vivo* session of APRT significantly lowered college students' within-session levels of self-reported anxiety and stress (as measured by the State-Trait Anxiety Inventory-State (STAI) and the Perceived Stress Scale (PSS)), of a physiological measure of stress (heart rate), and of an endocrinological measure of stress (salivary cortisol)<sup>14</sup> (also in LA Pawlow and GE Jones, unpublished data). In the second study, APRT also significantly increased the level of an immunological variable (salivary immunoglobulin A) (LA Pawlow & GE Jones, unpublished data). In addition, in both studies, relaxation subjects reported significantly higher levels of relaxation on a 10-point Likert scale. These results indicate that a 20-minute relaxation session was able to lower stress to the point of positive psychological, endocrinological, and immunological change in a nonclinical, normally functioning population.

The current study tested the following hypotheses within an NES sample: (1) the relaxation intervention (APRT) that significantly reduced both subjective and endocrinological

indices of stress in a college student population would have similar effects with an NES sample; (2) a single session of APRT followed by daily practice for 7 days would reduce the frequency of postbedtime food consumption; and (3) relaxation training would increase appetite for breakfast, perhaps as a result of reduced night-time food consumption. The focus of this study was on short-term effects of the APRT intervention rather than possible long-term therapeutic effects on NES.

## Research method and procedures

### Subject and subject selection

Target sample size was set as 10 subjects in each of two (Experimental and Control) groups. Subjects of both genders were recruited by flyers, broadcast e-mail at the Medical University of South Carolina (MUSC), and announcements in the local media. All notices asked for volunteers with morning anorexia, evening overeating (defined as consumption of at least 50% of their daily food intake after 6:00 p.m.), and insomnia. All respondents were mailed an information sheet listing the following exclusion criteria: age less than 18y, serious emotional or physical illness, pregnancy, use of steroids (oral or intravenous), participation in a weight reduction program, or an occupation that involved night shifts or other unusual time requirements that interfered with meals. There were no ethnic- or gender-based exclusion criteria. Respondents were instructed to call for an assessment interview only if none of the exclusion criteria applied to them. During this assessment interview, they provided informed consent, completed the Night Eating Questionnaire,<sup>15</sup> and were questioned on exclusion criteria once again in order to confirm eligibility. No subject reported being aware of having any 'serious emotional or physical illness' that would have affected the results of the study, and no subject reported currently taking any psychotropic medication. No subject was excluded at this session. Medication use was as follows: two Control subjects were on birth control pills, one Control subject was on anti-hypertensive and urinary incontinence medications, and one Experimental subject was on hormone replacement therapy.

Of subjects who met full criteria for the study, one failed to attend the initial experimental session and thus was never randomized, and one Control subject had to be replaced because her Day 8 session was disturbed by repeated interruptions. The resulting sample consisted of 20 adults with NES who were randomly assigned to either the Experimental or the Control group. This study was approved by the MUSC Institutional Review Board for Human Subjects.

### Endocrinological measure

Samples of saliva for salivary cortisol levels were obtained by using a 3-in section of a plastic straw and a Wheaton Cryule

vial (Scientific Products). Subjects were asked to sit with their heads tilted forward and passively "drool" saliva down the straw and into the vial until a sufficient sample (2.0 ml) was collected. All samples were frozen and stored at  $-20^{\circ}\text{C}$  until analysis, and all samples were analyzed blindly in one batch by Diagnostic Systems Laboratory (Webster, TX, USA) using their assay DSL-10-67100 Cortisol EIA for Saliva. The laboratory used the following procedure: after thawing, the sample vials were centrifuged at 3000 rpm for 15 min to produce a clear, watery supernatant. Cortisol levels were determined by employing a time-resolved enzymatic immunoassay, where cortisol in standards and unknowns competed for antibody binding sites, and then bound cortisol was measured using an optical density reader.<sup>16</sup>

### Self-report measures

*Night Eating Questionnaire (NEQ)*.<sup>15</sup> The NEQ is a 13-item measure asking subjects to rate their night eating behaviors. Scores range from 0 to 52.

*State-Trait Anxiety Inventory (STAI, State and Trait versions)*.<sup>17</sup> The STAI consists of two 20-item questionnaires that measure subjects' perceived state (current) and trait (typical) levels of anxiety, respectively. Scores on each range from 20 to 80.

*Relaxation Rating Scale*. This is a simple item asking the subject to rate his or her current level of relaxation on a scale from 1 to 10, with 10 being the highest.

*Perceived Stress Scale (PSS)*.<sup>18</sup> The PSS is a 14-item self-report measure assessing subjectively appraised stress. Scores range from 0 to 56.

*Beck Depression Inventory (BDI)*.<sup>19</sup> The BDI is a 20-item inventory of depressive symptoms occurring during the past week. Scores range from 0 to 60.

*Profile of Mood States (POMS)*.<sup>20</sup> The POMS is a 65-item questionnaire assessing to what degree various moods have been felt during the past week. It produces scores on six scales: Anger-Hostility, Confusion-Bewilderment, Depression-Dejection, Fatigue-Inertia, Tension-Anxiety, and Vigor-Activity. Scores were converted to *T*-scores based on psychiatric outpatient norms.<sup>20</sup>

*Eating and Hunger Diary*. Subjects were provided with diary booklets they were to use during the week between their two visits. They were asked to record (a) food consumption after retiring for the night; (b) morning food consumption (ie between final awakening and noon); and (c) levels of hunger (1 = low, 10 = high) at final morning awakening, at 6:00 p.m., and at 9:00 p.m.

### Height and weight measures

Weight was recorded using a Mettler Toledo Panther model digital scale. Height was assessed using a STADI-O-METER wall-mounted device. Both measures were taken with shoes removed. Weight and height were used to compute body mass index (BMI) as  $\text{kg}/\text{m}^2$ .

### Procedure

As mentioned earlier, subjects attended a screening appointment where eligibility was verified; they also completed the STAI-Trait form at this initial session. Subjects then attended two laboratory sessions 1 week apart, each lasting no more than 1 h. All sessions were held on Wednesdays and Fridays. Due to marked circadian variation in cortisol release,<sup>21</sup> all experimental laboratory sessions were held between 7 and 10 a.m. Subjects were asked to refrain from nicotine, strenuous physical exercise, meals, and caffeine for at least 1 h prior to testing, and from alcohol for at least 6 h prior to testing.

**Session 1.** Upon arrival, subjects were randomly assigned to one of the two groups based on the type of number (odd or even) drawn out of a box with the restriction of equal *N*'s for the two groups. Participants were then given a questionnaire to assess their behavior (ie, alcohol, nicotine, caffeine and food consumption, and strenuous physical exercise) in the hour immediately prior to their arrival at the laboratory. The same questionnaire also asked subjects to list any medications they were currently taking, to verify that no subject was taking a prescription steroid. Next, subjects were weighed, measured, and given the PSS, STAI-State, POMS, BDI, and relaxation rating forms to complete. Then the first sample of salivary cortisol was taken.

At this point, the Experimental subjects were seated in a recliner in a recumbent position, the lights were dimmed (limiting ambient light to that from the windows on one wall), and the experimenter began the 20-min session of APRT. In order to minimize inconsistencies, all instructions were read from a standardized script,<sup>9</sup> and the instructor followed a standard rate and pace in APRT instructions and exercises. For the same 20 min that Experimental subjects spent doing APRT, Control subjects were merely asked to remain quietly seated alone in the room with the recliner in its upright position and the lights on. After the 20-min sessions, the subjects' saliva samples were again taken, and the STAI-State, PSS, and relaxation rating form were readministered.

At the end of the first session, all subjects were given the eating and hunger diary and instructed in its use over the next 7 days. In addition, Experimental subjects were given an audiotape of the relaxation exercise to be followed once each night before bedtime during the week.

**Session 2.** All subjects' second laboratory sessions were held exactly 1 week later at the same time as the original appointment. Again, all subjects were asked to refrain from smoking, heavy exercise, food, caffeine, and alcohol as before. They were given the same questionnaire to determine their behaviors before the session and their current medications. Subjects were weighed, had their saliva samples taken, completed the other questionnaires, and turned in their diaries. Experimental subjects were then dismissed.

Session 2 provided an opportunity to replicate the assessment of within-session effects of APRT conducted on

Experimentals at Session 1. Accordingly, after the initial measures noted above, Control subjects followed the same procedure as the Experimental subjects' first session, that is, they received 20 min APRT, completed postsession tests, and provided a postsession saliva sample.

### Data analysis

All subjects completed the STAI-State, PSS, and relaxation rating form and provided saliva samples at three different times (Day 1 pre- and postsession, and Day 8 presession). These data were analyzed using mixed design 2 (Groups) × 3 (Time: Day 1 pre and post, Day 8 pre) repeated measures ANOVAs. Significant interactions were examined with tests of simple effects.

Controls also provided these data at Day 8 postsession. Pre- and postsession Day 8 data for the Control subjects were analyzed with paired *t*-tests, as a replication of the Day 1 effects for Experimental subjects.

All subjects completed the BDI and the POMS at two different times (presession on Days 1 and 8). These data were analyzed using separate mixed design 2 × 2 ANOVAs. The between-subject independent variable consisted of Group (Experimental vs Control), and the within-subject independent variable was Time (Day 1 vs Day 8). Significant interactions were examined with tests of simple effects.

Finally, average hunger ratings, number of post-bedtime and breakfast eating episodes, and weights for each group were analyzed with paired *t*-tests.

## Results

### Subject demographics and compliance with study requirements

Experimental subjects consisted of nine females and one male, while the Control group consisted of 10 females. Data on age, height, weight, BMI, NEQ score and Trait Anxiety are shown in Table 1. Independent samples *t*-tests revealed that the two groups did not significantly differ on any of these variables ( $P > 0.40$ ).

Prior to each session, all subjects reported that they had abstained from caffeine, food, nicotine, alcohol, and stren-

uous exercise as directed. The mean number of nights the Experimental subjects reported doing the relaxation exercises at home was 5.8 out of 7 possible. The mean number of hunger ratings (out of 7 possible) completed by all subjects during the week were as follows: a.m. = 5.6, 6:00 p.m. = 5.1, and 9:00 p.m. = 5.5.

### Self-report measures of anxiety and relaxation

All three self-report measures of anxiety and relaxation showed the expected pattern of changes resulting from relaxation therapy.

**State Anxiety.** Results revealed a significant main effect for Time,  $F(2,36) = 9.92, P < 0.001$ , which was qualified by a significant interaction of Group × Time ( $F(2,36) = 9.51, P < 0.01$ ). There was no significant main effect for Group ( $P > 0.05$ ). Tests of simple effects revealed that Experimentals were significantly lower than Controls on State Anxiety scores at Day 1 postsession ( $F(1,36) = 15.90, P < 0.01$ ) and at Day 8 presession ( $F(1,36) = 12.06, P < 0.01$ ). There were also significant decreases over time in the Experimental group ( $F(2,36) = 11.62, P < 0.01$ ) but not in the Control group (Table 2) (Figure 1).

**Relaxation Rating.** Results revealed significant main effects for Time,  $F(2,36) = 11.44, P < 0.001$  and for Group,  $F(1,18) = 9.51, P < 0.01$ , both qualified by a significant inter-

**Table 1** Means, standard deviations, and ranges of subject demographics

	Mean	s.d.	Range
Age (y)	38.0	10.5	20–61
Night Eating Questionnaire score <sup>a</sup>	37.5	7.2	30–46
Trait Anxiety	46.8	9.7	26–59
Height (in)	65.6 (167 cm)	3.4	60–72
Weight (lb)	205.0 (92.3 kg)	56.0	140–345
BMI (kg/m <sup>2</sup> )	34.0 <sup>b</sup>	11.0	21–63

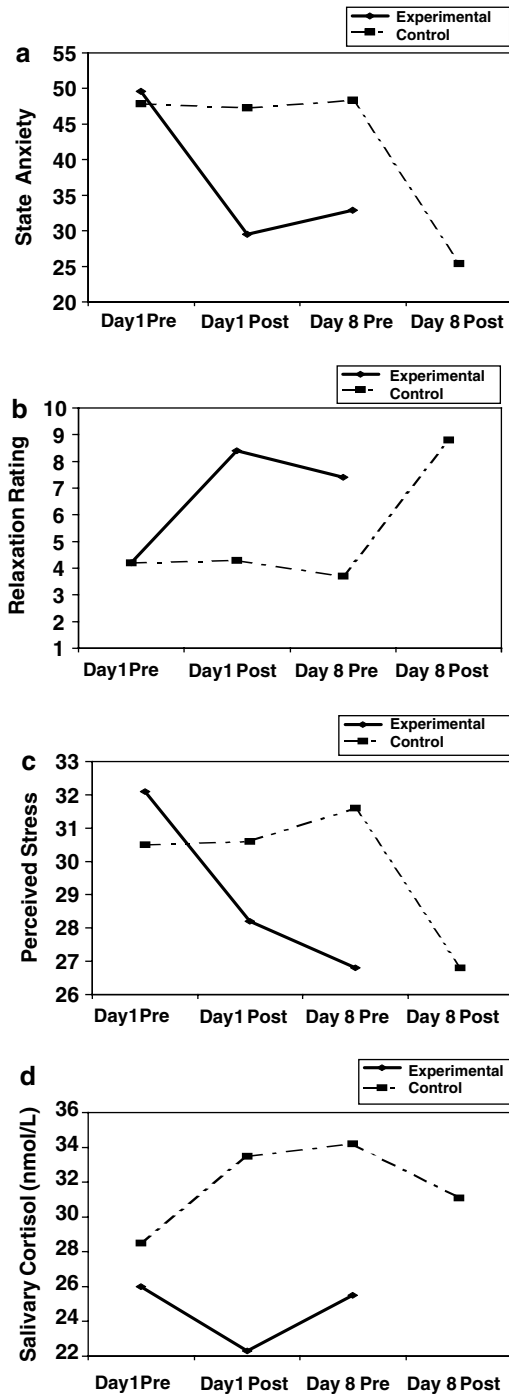
<sup>a</sup>Any NEQ score over 30 is considered a 'strong NES indicator' (KC Allison, personal communication), <sup>b</sup>classification = Obese 1.<sup>27</sup>

**Table 2** Means and Standard Deviations of Anxiety/Relaxation Scores by Group, Day, and Time

	Experimental (n = 10)				Control (n = 10)			
	Day 1		Day 8		Day 1		Day 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
State Anxiety	49.6 (12.5)	29.5 (9.0)*‡	32.9 (14.6)†‡		47.9 (15.4)	47.3 (16.2)	48.4 (15.3)	25.4 (10.2)*
Relaxation Rating	4.2 (2.0)	8.4 (1.7)*‡	7.4 (2.1)†‡		4.2 (2.7)	4.3 (2.7)	3.7 (2.1)	8.8 (2.2)*
Perceived Stress	32.1 (6.4)	28.2 (4.8)*‡	26.8 (4.9)†‡		30.5 (7.3)	30.6 (7.2)	31.6 (6.3)	26.8 (5.5)*
Cortisol (nmol/l)	26.0 (9.0)	22.3 (7.1)*‡	25.5 (7.1)		28.5 (6.5)	33.5 (5.4)	34.2 (4.3)	31.1 (6.7)

Note: Day 8 post measures taken only for Control group.

\* $p < 0.05$  vs same-day pre, † $p < 0.05$  vs Day 1, pre, ‡ $p < 0.05$  vs Control.



**Figure 1** Mean levels of State Anxiety (a), Relaxation Ratings (b), Perceived Stress (c), and Salivary Cortisol (nmol/L) (d) by Group, Day, and Time. Experimentals received APRT on Day 1 and Controls received APRT on Day 8.

action of Group  $\times$  Time ( $F(2,36) = 12.37, P < 0.001$ ). Tests of simple effects revealed that Experimentals were significantly higher than Controls on Relaxation scores at Day 1 postsession ( $F(1,36) = 12.98, P < 0.01$ ) and at Day 8 presession ( $F(1,36) = 12.53, P < 0.01$ ). There were also significant

increases over time in the Experimental group ( $F(2,36) = 10.17, P < 0.01$ ) but not in the Control group (Table 2) (Figure 1).

**Perceived stress.** There were no significant main effects for Group or Time ( $P > 0.05$ ), however, the results revealed a significant interaction of Group  $\times$  Time,  $F(2,36) = 5.20, P < 0.025$ . Tests of simple effects revealed that the Experimentals were significantly lower than the Controls on Perceived Stress scores at Day 1 postsession ( $F(1,36) = 4.69, P < 0.05$ ) and at Day 8 presession ( $F(1,36) = 8.19, P < 0.01$ ). There were also significant decreases over time in the Experimental group ( $F(2,36) = 6.89, P < 0.01$ ) but not in the Control group (Table 2) (Figure 1).

### Cortisol

With the exception of the Experimental group at Day 1 postsession, mean cortisol levels were above the expected range for normal healthy adults during early morning hours (ie 5.22–23.43 nmol/l).<sup>14,21</sup> The results revealed a significant main effect for Group ( $F(1,18) = 9.40, P < 0.01$ ), which was qualified by a significant Group  $\times$  Time interaction effect ( $F(2,36) = 4.21, P < 0.075$ ). There was no significant main effect for Time ( $P > 0.05$ ). Tests of simple effects revealed a significant decrease in salivary cortisol level from pre- to postsession on Day 1 for the Experimentals ( $F(2,36) = 3.27, P < 0.05$ ) (Table 2) (Figure 1). The nonsignificant Day 1 prepost increase in salivary cortisol level for the Controls appeared largely due to two outliers.

### Control subjects, Day 8

Recall that Control subjects were administered APRT and postsession measures on Day 8 in order to replicate the assessment of within-session effects conducted with Experimental subjects on Day 1. With the exception of salivary cortisol, the pre- to post-APRT significant changes found in the Experimental group on Day 1 were replicated on Day 8 for the Control group when they received APRT. On Day 8, the Control group significantly lowered their scores from pre- to post-APRT on State Anxiety scores ( $t(9) = 4.28, P < 0.01$ ) and Perceived Stress scores ( $t(9) = 4.13, P < 0.01$ ), and significantly increased their scores from pre- to post-APRT on the Relaxation Rating Form ( $t(9) = 5.08, P < 0.01$ ). The significant decrease in salivary cortisol from pre- to post-APRT for the Experimentals on Day 1 was not replicated for the Controls on Day 8 ( $t(9) = 1.66, P > 0.05$ ), although there was a similar trend toward a decrease (Table 2) (Figure 1).

### Self-report measures of mood

**Beck Depression Inventory.** Results revealed a significant main effect for Time ( $F(1,18) = 12.87, P < 0.01$ ) which was qualified by a significant interaction of Group  $\times$  Time,  $F(1,18) = 16.69, P < 0.01$ . There was no significant main effect for Group ( $P > 0.05$ ). Tests of simple effects revealed that the Experimentals were significantly more depressed than the

**Table 3** Means and standard deviations of mood indices by Group and Time

	Experimental (n = 10)		Control (n = 10)	
	Day 1	Day 8	Day 1	Day 8
Beck Depression Inventory	15.9 (11.3) <sup>†</sup>	8.2 (10.3)*	9.4 (6.4)	9.9 (6.5)
POMS-Anger	51.8 (9.2) <sup>†</sup>	42.8 (10.0)*	43.1 (4.5)	44.4 (5.3)
POMS-Depression	45.0 (7.6)	36.9 (7.6)*	39.0 (4.1)	40.9 (6.1)
POMS-Fatigue	49.0 (7.9)	40.3 (7.4)*	46.7 (6.4)	46.2 (5.3)
POMS-Tension	44.4 (6.4)	44.2 (6.6)	40.9 (7.8)	42.0 (6.7)
POMS-Vigor	54.4 (8.9)	58.3 (13.7)	65.2 (10.8)	62.5 (10.5)
POMS-Confusion	43.2 (5.9)	41.4 (6.0)	39.9 (5.7)	41.2 (7.2)

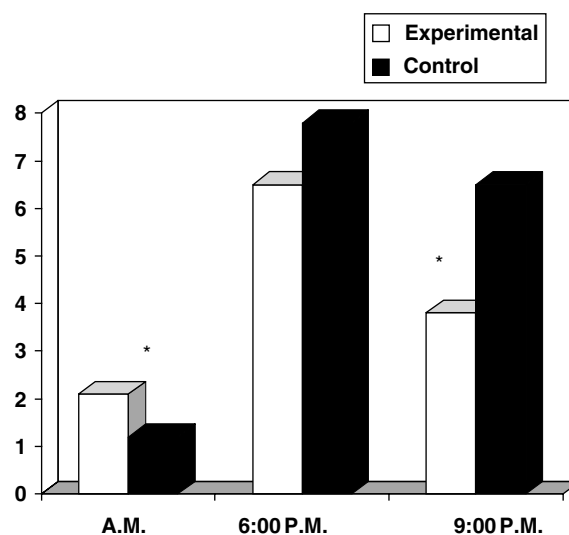
\* $p < 0.05$  vs Day 1, <sup>†</sup> $p < 0.05$  vs Control.

Controls on Day 1 ( $F(1,18) = 5.13, P < 0.05$ ), but not on Day 8, and that there was a significant decrease in depression from Day 1 to Day 8 for the Experimental ( $F(1,18) = 7.19, P < 0.025$ ) but not the Control group. With the exception of the Experimental group on Day 1, whose mean score would be diagnostically classified as 'Marginally Depressed,' mean scores for both groups were below the accepted diagnostic cut point at each session.<sup>19</sup> (Table 3).

**Profile of Mood States.** There were main effects for Time, qualified by significant Group  $\times$  Day interactions, on the Anger (Time  $F(1,18) = 6.96, P < 0.025$ ; Group  $\times$  Day  $F(1,18) = 12.46, P < 0.01$ ), Depression (Time  $F(1,18) = 6.66, P < 0.025$ ; Group  $\times$  Day  $F(1,18) = 17.31, P < 0.01$ ), and Fatigue (Time  $F(1,18) = 9.78, P < 0.01$ ; Group  $\times$  Day  $F(1,18) = 7.72, P < 0.025$ ) subscales. There were no main effects for Group ( $P > 0.05$ ). Tests of simple effects revealed that the Experimentals were significantly higher on Anger than the Controls on Day 1 ( $F(1,18) = 4.68, P < 0.05$ ), but not on Day 8. In addition, from Day 1 to Day 8, there was a significant decrease in Anger ( $F(1,18) = 4.79, P < 0.05$ ), Depression ( $F(1,18) = 4.48, P < 0.05$ ), and Fatigue ( $F(1,18) = 4.51, P < 0.05$ ) for the Experimentals, but not the Controls. There were no significant main effects or interactions on the POMS subscales of Tension, Vigor, or Confusion ( $P > 0.05$ ). (Table 3).

### Hunger, eating, and weight variables

During the week between Days 1 and 8, the Experimental group had significantly higher morning hunger ratings than did the Control group ( $t(18) = 2.27, P < 0.05$ ) and significantly lower 9:00 p.m. hunger ratings than the Controls ( $t(18) = 2.83, P < 0.025$ ) (Figure 2). There were marginally significant trends toward a higher number of breakfasts eaten during the week for the Experimentals ( $M = 2.8$ ) compared to the Controls ( $M = 0.9$ ) ( $P = 0.08$ ) and toward a lower number of post-retiring awakenings with food consumption for the Experimentals ( $M = 0.8$ ) compared to the Controls ( $M = 2.2$ ) ( $P = 0.06$ ). (Table 4). Using the APRT, tape before bedtime was strongly related to night-time eating: the



**Figure 2** Mean hunger ratings by Time, \* $p < 0.05$  vs Control.

Experimentals reported night-time eating on only 2.8% of the nights they listened to the tape as compared to 50% of the nights they did not listen to the tape. Over the week, for the entire sample, frequency of night-time eating episodes was inversely related to average a.m. hunger ratings ( $r(17) = -0.508, P < 0.05$ ) and to the number of breakfasts eaten ( $r(18) = -0.481, P < 0.05$ ), the latter measures being highly correlated ( $r(17) = 0.853, P < 0.001$ ).

A marginally significant trend was observed for weight change. The average weight change from Day 1 to 8 for the Experimentals was  $-1.8$  lb ( $-0.81$  kg), while for the Controls it was  $+0.6$  lb ( $0.27$  kg) ( $P = 0.07$ ). Seven out of the 10 Experimental subjects lost at least 1 lb ( $0.45$  kg) over the course of the week, as compared to only one Control subject losing weight (Fisher's exact test,  $P < 0.025$ ) (Table 4).

### Relations among measures

For the entire sample, NEQ score was positively correlated with Trait Anxiety scores ( $r(18) = 0.551, P < 0.025$ ), but not with BMI ( $r(18) = 0.080, P > 0.05$ ) or weight ( $r(18) = 0.226,$

**Table 4** Means and standard deviations of hunger and night eating characteristics during Days 1 – 8 by Group

	Experimental (n = 10)	Control (n = 10)	P
a.m. Hunger Rating	2.1 (1.3)	1.2 (0.3)	0.036
6:00 p.m. Hunger Rating	6.5 (3.3)	7.8 (2.2)	0.309
9:00 p.m. Hunger Rating	3.8 (1.6)	6.5 (2.4)	0.012
No. of nights with postbedtime eating	0.8 (1.3)	2.2 (1.8)	0.064
No. of mornings with breakfasts eaten	2.8 (2.7)	0.9 (1.7)	0.077
Weight change	-1.8 (3.8)	0.6 (1.0)	0.069

Note: Hunger rating scale ranged from 1 (lowest) to 10 (highest).

$P > 0.05$ ). Weight was positively correlated with many of the baseline mood indices: BDI ( $r(18) = 0.524$ ,  $P < 0.025$ ), Anger ( $r(18) = 0.612$ ,  $P < 0.01$ ), Depression ( $r(18) = 0.571$ ,  $P < 0.01$ ), Tension ( $r(18) = 0.713$ ,  $P < 0.001$ ), and Confusion ( $r(18) = 0.556$ ,  $P < 0.025$ ). BMI was also significantly related to several mood measures: BDI ( $r(18) = 0.460$ ,  $P < 0.05$ ), Anger ( $r(18) = 0.493$ ,  $P < 0.05$ ), Depression ( $r(18) = 0.451$ ,  $P < 0.05$ ), and Tension ( $r(18) = 0.640$ ,  $P < 0.01$ ).

## Discussion

The results of this study indicate that a 20-min laboratory session of APRT, administered to subjects with NES, immediately increased self-reported levels of relaxation and decreased self-reported levels of both state anxiety and stress. This increase in level of relaxation and decrease in stress and anxiety were accompanied by significantly lower levels of salivary cortisol for the Experimentals on Day 1. In addition, salutary effects were observed after 7 days of home practice of APRT: compared to Controls, relaxation subjects had significantly lower depression, anger, fatigue, state anxiety, and perceived stress scores and significantly higher relaxation scores. Importantly, the relaxation training intervention was also associated with significantly higher a.m. and lower p.m. ratings of hunger. Subjects receiving and practicing APRT for a week also tended to be more likely to eat breakfast and less likely to eat after retiring. Finally, although weight loss was not a goal of the investigation, subjects receiving relaxation training lost weight over the week. This last finding must be viewed with caution, however, in the light of the small sample and brief duration.

The results of this study confirm previous descriptions of elevated stress and anxiety as prominent characteristics of people with NES.<sup>1</sup> Both State and Trait Anxiety levels (as measured by the STAI) were above the range for normal, healthy adults<sup>17</sup> at baseline. Subjects with the highest NEQ scores also had the highest levels of Trait Anxiety. Similarly, perceived stress levels (as measured by the PSS) were at the highest end of a healthy community sample.<sup>18</sup> Consistent with elevated stress, mean baseline salivary cortisol levels were above the expected range for normal, healthy adults

during early morning hours.<sup>16,21</sup> This supports the findings of Birketvedt *et al*,<sup>6</sup> whose Night Eaters' plasma cortisol levels were at the high end of published normal ranges<sup>22</sup> and were significantly higher than the levels of non-NES subjects throughout the majority of the day. Taken together, these results indicate that stress and anxiety are an integral part of NES and should be addressed in both its conceptualization and treatment.

Because of the consistently elevated measures of stress and the pattern of disturbed sleep in NES, APRT appears to be a particularly appropriate intervention. First, its effects in reducing self-reported stress are well-documented here and elsewhere.<sup>12,13</sup> This extends to reductions in cortisol levels,<sup>14</sup> (also in LA Pawlow and GE Jones, unpublished data). Second, APRT has been shown to be effective in reducing sleep onset latency for patients with secondary insomnia.<sup>23</sup> This sleep-enhancing effect may be partly attributable to increased night-time melatonin levels, which have been found among practitioners of another stress reduction procedure, meditation.<sup>24</sup> Melatonin is thought to play an important role in regulating sleep-wake cycles,<sup>25</sup> and as noted earlier, NES subjects have been shown to have an attenuated nocturnal rise in melatonin.<sup>6</sup> Third, dysphoric mood has been reported among NES subjects,<sup>1,6</sup> and those in the present study who practiced APRT for 1 week showed significant drops in self-rated depression, anger, and fatigue. More support for the potential value of APRT in treating NES is seen in the present findings concerning hunger and night-time eating. A week of APRT practice was associated with increased morning hunger ratings and decreased evening hunger ratings, partly correcting the aberrant pattern of morning anorexia and excess evening hunger that characterize NES. Relative to Control subjects, subjects who practiced APRT over a week tended to be more likely to eat breakfast and less likely to eat after retiring.

Of course, because Control subjects did not receive any placebo or attention control treatment during the week, the differences seen between the two groups on mood, hunger and eating variables assessed over the week cannot be attributed definitively to APRT *per se*, as opposed to other aspects of the nightly APRT regimen (eg establishment of a consistent bedtime routine, listening to a soothing tape, added focus on NES) that may have affected mood and/or

NES features. However, although there were only eight instances of eating after retiring among relaxation subjects during the week studied, all but two of them occurred on evenings when the subjects did not practice APRT. The relation of morning and evening patterns is shown by the fact that postretiring eating was inversely related both to morning hunger and number of breakfasts eaten.

Several strengths and limitations of the present study deserve mention. A thorough review of the literature suggests that this is the first examination of the effects of relaxation training on symptoms and features of NES. Adherence to a script in laboratory sessions and use of taped instructions for at-home practice promoted consistency in implementation of APRT. Multiple self-report measures and one neuroendocrine measure of stress provided convergent validity for stress assessment. Additional measures of mood allowed assessment of broader psychological effects. Night-time and morning eating in the natural environment were assessed, albeit via self-report. Furthermore, to our knowledge, this was the first study of NES to incorporate hunger ratings at different points during the day.

There were, however, several limitations to this study. First, the small number of participants and the inclusion of only a single male limit generalization. Second, the short duration of the intervention/assessment period precluded examination of longer-term effects. Third, although short-term compliance to the protocol generally appeared to be high, the reliance on self-reporting does not provide a conclusive check of adherence. Subjects may have under- or over-reported their participation during the week or may have retroactively completed their eating diaries at the end of the week. Fourth, although this study was not designed to assess effects on sleep or total daily intake, such data would be useful in future studies. Fifth, an absence of data on menstrual cycle precludes ruling out menstrual phase as a potential confound.

A final potential limitation of this study is the lack of baseline measures of hunger and eating for the two groups. While these data would have been useful, their absence does not negate the significance of our findings that relaxation training was associated with lower evening hunger, higher morning hunger, and somewhat more frequent breakfast consumption and less frequent awakenings with eating. A 'Posttest-Only Control Group Design' has been recognized as adequate for demonstrating intervention effects so long as randomization is used to create Experimental and Control groups with no systematic differences.<sup>26</sup> The Experimental and Control groups did not differ on age, height, weight, BMI, NEQ score, or Trait Anxiety, nor did they differ on pretest measures of State Anxiety, Perceived Stress, Relaxation Rating Form, or POMS measures of Depression, Fatigue, Tension, Vigor, or Confusion. Thus, there is substantial evidence of the equivalence of the two groups at study entry and little reason to suspect that differences on eating and hunger reflect pre-existing differences.

Despite these limits, the present study suggests that an easy, inexpensive intervention targeting stress and anxiety (APRT) may have value for treating this clinical syndrome. By impacting all of the adverse factors associated with NES (stress, mood, eating patterns, hunger, and weight), APRT may prove able to break the negative cycle of irregular hunger and eating patterns, stress, and dysphoria that night eaters suffer. While the present study was not designed to assess the long-term efficacy of APRT as a treatment modality for the syndrome, further study with more subjects over a longer period of time is warranted.

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