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Sustained Effects of Brief Electronic Self-monitoring as an
Early Intervention for Eating Pathology
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By

Lisa M. Smith
M.A., Emory University, 2008

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An Abstract of
A dissertation submitted to the Faculty of the James T. Laney School of Graduate Studies
of Emory University in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in Clinical Psychology
2013

Abstract
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By Lisa M. Smith, M.A.

Self-monitoring based on recording food is an intervention tool frequently utilized in eating disorders (EDs) treatment. Appetite monitoring provides an alternative form of self-monitoring based on noticing internal appetite cues, that we predicted might be particularly suitable for subclinical disordered eating pathology. The goal of the present study was to evaluate the effects of brief electronic self-monitoring as an early intervention for women at risk for eating and weight problems. Ninety women with eating and weight concerns were randomly assigned to either appetite monitor (AM-App, N=45) or food monitor (FM-App, N=45) for three weeks. Participants completed a follow-up assessment three weeks after the end of the intervention to evaluate the sustained effect once monitoring terminated. Results indicated similar reductions in both groups on primary outcome measures (binge eating, shape concerns, dietary intent, and BMI) at post-intervention. These changes were well maintained at follow-up. Notably, while neither intervention directly targeted body image, body satisfaction showed some improvement at post-intervention, which reached a significant level at follow-up, suggesting that improved regulation of eating behavior may have a delayed effect on body satisfaction. Results indicated a significant decrease in risk factors for eating pathology, including binge eating, dietary intent, shape concerns, and BMI) for both electronic appetite and food monitoring, and showed that these reductions were sustained for three weeks after monitoring was terminated. Baseline data were used to evaluate the relationships among the variables hypothesized to serve as risk factors within the dual pathway model of eating pathology (Stice, Ziemba, Margolis, & Flick, 1996). Support was found for the dieting pathway leading to binge eating but not for the hypothesized negative affect pathway.

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Sustained Effects of Brief Electronic Self-monitoring as an

Early Intervention for Eating Pathology

Eating disorder prevention and early intervention are important because acute symptoms often become chronic conditions that are associated with significant medical complications including bone density depreciation or osteoporosis, cardiac problems, and even death (Fairburn & Harrison, 2003; Sullivan, 1995; Treasure & Szmukler, 1995). Eating disorders (EDs) in general are associated with a high rate of comorbid psychopathology as well as an increased risk for future onset of depression, anxiety disorders, substance abuse, and obesity (Johnson, Cohen, Kasen, & Brook, 2002; Wilson, Becker, & Heffernan, 2002). Anorexia in particular is associated with increased risk for suicide and elevated mortality rates, (Lewinsohn, Striegel-Moore, & Seeley, 2000; Fairburn & Harrison, 2003).

Approximately 11-12% of young women have clinically significant disordered eating symptoms, including threshold and subthreshold bulimia nervosa (BN), binge eating disorder (BED), purging disorder, and anorexia nervosa (AN; Keel, Heatherton, Dorer, Joiner, & Zalta, 2006), while 3% of adolescent girls and college-aged women meet full criteria for eating disorders (Becker, Grinspoon, Klibanski, & Herzog, 1999; Hoek, 1995; Hoek & VanHoeken, 2003). Women comprise nearly 90% of individuals with EDs, with onset typically in middle to late adolescence (American Psychiatric Association, 1995). Furthermore, body dissatisfaction and subthreshold eating pathology are widespread among adolescents and young women and often extract a significant psychological cost as well as an increased risk for diagnosable eating disorders and negative health consequences related to weight status (Stice & Shaw, 2002). Therefore

early intervention for women experiencing distress related to body dissatisfaction and eating/weight concerns is likely to be the most effective and efficient way prevent more severe pathology.

Another reason to focus on prevention/early intervention is that while some disordered eating behaviors, primarily binge eating, show a relatively high rate of positive response to intervention (Dicker & Craighead, 2004), success rates in the treatment of extreme restriction (Fairburn et al., 2008) remain unacceptably low. Additionally, success in obesity treatment is quite limited. Obese individuals rarely return to or attain a weight in the normal weight range, and maintenance of weight loss is not typical even for those who have initial success. For those who do not respond to initial interventions and develop chronic conditions (anorexia or obesity), the long-term effects on health and psychosocial functioning are well documented (Orzano & Scott, 2004; Lewinsohn et al., 2000).

Because the consequences of EDs and obesity can be chronic and severe, prevention holds the best hope to address those problems. To date, most successful ED prevention programs have targeted reduction of established risk factors for EDs, most notably thin-ideal internalization (Shaw, Stice & Becker, 2008; Stice, Shaw, Becker, & Rhode, 2008), and they do not address obesity prevention. Ideally, prevention programs could be designed to promote healthy eating habits more generally and thus potentially prevent obesity as well as ED pathology. Research from Stice and colleagues (Stice et al., 2006; 2007) has demonstrated that a healthy weight management intervention was as effective as a well-established cognitive dissonance program (targeting the thin-ideal) in reducing ED pathology and had the added benefit of preventing obesity. Self-monitoring

was a core component of this intervention, and it is a well-established component of weight loss interventions in general. The present study evaluates two forms of brief self-monitoring that could be accessible and cost effective ways to encourage healthy weight management, potentially decreasing risk for ED pathology as well as weight gain in young women with high eating and weight concerns.

Risk Factors for Eating Disorders

A review of the risk factors that have been established for EDs is provided to explain the development of an etiologic model of eating pathology called the dual pathway model (Figure 1; Stice, Ziemba, Margolis, & Flick, 1996). This model was the foundation for best-validated current ED prevention programs targeting thin-ideal internalization. Risk factors are variables or constructs that have been shown to predict onset of eating disorders or the exacerbation of symptoms. The risk factors included in this model have been supported across independent, prospective trials: sociocultural pressures to be thin, internalization of the thin-ideal standard of beauty, body mass index, body dissatisfaction, and negative affect.

A risk factor is considered causal if, when increased or decreased, it leads to a subsequent increase or decrease in symptom levels and it is considered a proxy if it predicts a causal risk factor (Stice, 2002). Evidence suggests that high body mass index (Stice, Nemeroff, & Shaw, 1996), body dissatisfaction (Rosen, 1992), dietary restraint (Polivy & Herman, 1985), affect dysregulation (Heatherton & Baumeister, 1991), sociocultural pressures to be thin (Irving, 1990), and thin-ideal internalization (Stice, Shupak-Neuberg, Shaw, & Stein, 1994) are each positively related to eating pathology. Specifically, *body dissatisfaction* is considered the negative personal evaluation of one's

physical body (Stice & Shaw, 2002); *dietary restraint* refers to intentional restriction of caloric intake to achieve a desired weight (Stice, 1994); *sociocultural pressures to be thin* are those messages that thinness leads to positive social benefits transmitted by peers, dating partners, family, and media (Stice, 1994); *thin-ideal internalization* refers to the belief that attaining the culturally-defined thin-ideal body type will lead to positive social benefits (Stice & Shaw, 2002); *eating pathology* refers to threshold and subthreshold anorexia nervosa, bulimia nervosa, and binge eating disorder (Stice & Shaw, 2004). Other risk factors that have been established for EDs in prospective studies include negative affect, perfectionism, impulsivity, early menarche, and modeling of disordered eating behaviors.

Elevated body mass has been shown to predict ED symptoms in general, but not depression or onset of bulimic symptomatology (for review, see: Stice, 2002; Stice & Shaw, 2002). Elevated body mass has also been shown to act as a proxy variable, as it predicts increases in other established risk factors including perceived pressures to be thin, body dissatisfaction, dietary restraint, and binge eating. In a review, Stice (2002) found that social pressures to be thin predicted other risk factors including elevations in body dissatisfaction, dietary restraint, and binge eating as well as bulimic symptomatology, negative affect and overall eating pathology.

Heightened thin-ideal internalization exacerbates body dissatisfaction in theoretical models and per prior research findings (Stice & Shaw, 2002; Stice, Ziemba, Margolis, & Flick, 1996). Thin-ideal internalization has been shown to prospectively predict increases in body dissatisfaction, dietary restraint, negative affect, binge eating, and overall ED symptoms and thus qualifies as a causal risk factor (Stice, 2002; Stice,

Presnell, Gau, & Shaw, 2007; Seidel, Presnell, & Rosenfield, 2009). It is important to note that the effects of thin-ideal internalization were larger for bulimic symptomatology than overall ED symptoms and that this risk factor may be more specific to bulimic symptom onset (Stice, 2002).

Additionally, evidence indicates that dietary restraint predicts elevations in negative affect, bulimic symptoms, and eating pathology, while negative affect appears to have a small influence on increased bulimic symptoms and eating pathology. Perfectionism appears to be a risk factor for bulimic symptomatology, and there was some support for impulsivity as a risk factor for incitement of eating pathology (Stice, 2002). Lastly, evidence was lacking in support of early menarche as a risk factor for EDs. Although modeling of eating disordered behaviors and attitudes predicted onset of bulimic symptoms and binge eating only, it did not predict increases in body dissatisfaction or dieting (Stice & Shaw, 2002).

Women experiencing higher levels of dissatisfaction about their bodies are at a greater risk for developing eating disorders, as body dissatisfaction has been repeatedly linked to disordered eating habits (Attie & Brooks-Gunn, 1989; Heatherton, Mahamedi, Striepe, Field, & Keel, 1997; Killen, et al., 1996; Stice & Agras, 1998; Striegel-Moore, Silberstein, Frensch, & Rodin, 1989). Body dissatisfaction reliably predicted increases in dietary restraint, negative affect, bulimic symptomatology, and overall eating pathology across numerous studies (Stice, 2002; Stice & Shaw, 2002). Therefore, body dissatisfaction is a central construct in the dual pathway model (Figure 1, Stice et al., 1996; 2002).

ED Prevention Targeting Eating Regulation

Most ED prevention programs target cognitive or attitudinal constructs, such as body acceptance, reduction of body dissatisfaction, criticism of the thin ideal standard of beauty, and enhancing self-esteem (for review see Shaw, Stice, & Becker, 2008). However, one of the most efficacious ED prevention program to date, healthy weight management intervention (HWM), targets healthy weight and eating behaviors (Stice et al., 2006; 2007). The healthy weight management (HWM) was originally designed to be the active control condition in a trial of a cognitive dissonance-based intervention (Stice et al., 2006), but it turned out to be as effective and is now considered an empirically supported program (Stice et al., 2006; 2007). HWM resulted in reduced bulimic symptomatology, future onset of eating disorder symptoms and obesity, dieting, body dissatisfaction, negative affect, and thin-ideal internalization. Overall, results suggested that regulating eating behaviors also effectively reduced attitudinal variables, such as body dissatisfaction and thin-ideal internalization (Stice et al., 2006; 2007).

Additionally, results from HWM indicate that a single intervention can affect both eating pathology as well as obesity in high-risk participants. Notably, HWM participants demonstrated significantly lower risk for future onset of binge eating and compensatory behaviors, suggesting a prophylactic as well as an acute effect. A reduction in both eating pathology and obesity is rare in the ED prevention literature and yet is extremely important from a public health standpoint, as obesity is an even more common health problem in the United States (Stice et al., 2007). In fact, the decreased risk for obesity onset resulting from HWM was stronger than effects found in most obesity prevention programs and was approximately twelve times greater than assessment-only controls.

This finding is important because it provides the foundation for the hypothesis that regulating eating behaviors may be effective for preventing EDs as well as obesity. Previous prevention efforts did not focus on eating behaviors partly for theoretical reasons (intervening earlier in the developmental trajectory was hypothesized to be more efficient and/or effective), but also partly due to concerns that any intervention perceived as encouraging "dieting" might be iatrogenic and increase risk for EDs.

Self-monitoring in ED and Obesity Treatment

Self-monitoring is widely used in Cognitive Behavioral Therapy (CBT) to track many targets (behaviors, thoughts, feelings) and the initial effects of monitoring (usually called reactive effects) are well established. Self-monitoring is believed to interrupt over-learned automatized behavior patterns, allowing awareness of one's intentions to change the target to come into play and influence behavioral choices. However, there is debate about the quickness and the degree to which these reactive effects attenuate with continued monitoring and/or persist after terminating monitoring. Thus, it is necessary to evaluate both initial reactive effects of self- monitoring as well as the degree to which such effects are sustained after discontinuation of monitoring.

Self-monitoring has been used effectively in the treatment of eating issues in a number of ways: for weight restoration in underweight populations (Wilson & Vitousek, 1999), for eating regulation in individuals with dysregulated eating patterns such as bingeing and purging (Spangler, 2005), and for weight loss in obesity interventions (Yon, Johnson, Harey-Berino, Gold, & Howard, 2007). Recently, concerns have been raised regarding the potential for negative reactive effects of food monitoring, specifically the possibility of increasing preoccupation with food/eating since one is attending closely to

the characteristics of the food. Preoccupation with such thoughts is conceptualized as a measure of "over-evaluation of self-worth based on eating, weight, and shape" (also referred to as over-concern), which has been proposed as a risk factor in the CBT model of the development and maintenance of eating pathology (Fairburn, Marcus, & Wilson, 1993). Over-concern is defined as the belief that self worth is heavily dependent upon shape or weight and one's ability to control eating (Fairburn et al., 1993; Fairburn, Cooper, & Shafran, 2003; Fairburn, 2008).

Nonetheless, food monitoring is well accepted as a central component of the best-established treatment for eating disorders, CBT, (Murphy et al., 2010). Food monitoring is introduced early in the treatment and is maintained throughout the course of treatment. Individuals record information about the type and amount of food consumed, bingeing or purging behaviors, and restrictive episodes. Food monitoring theoretically plays a central role in achieving behavior change with respect to treatment goals, including reducing dietary restraint (restricted caloric intake, low daily meal frequency, avoidance of specific foods), reducing the frequency of bingeing and purging cycles, and establishing a regular eating pattern (e.g. three meals and two snacks per day) (Murphy, et al., 2010; Shah, Passi, Bryson, & Agras, 2005).

Although treatment outcome studies have not directly examined the short-term effects of self-monitoring in isolation, peripheral data suggest that food monitoring influences behavior change in individuals with EDs (Wilson, 1999). In CBT for Bulimia Nervosa (BN), most of the symptom improvement occurs in the first few weeks of treatment at which time food monitoring plays a central role in therapy. One interpretation is that this symptom improvement is at least partly a reactive effect of

monitoring (Jones, Peveler, Hope, & Fairburn, 1993), but that once new eating patterns are established they are maintained by positive consequences (e.g. reduced binge eating) hence food monitoring is not required long term. Other studies have shown that short-term food monitoring attenuates ED symptoms (Spangler, 2005), including a reduction in dietary restraint at 4 weeks (Wilson, Fairburn, Agras, Walsh, & Kraemer, 2002). Several studies also report that 60-70% of the reduction in binge eating and purging in patients with BN occurs over the first six sessions of CBT, during which time the focus of therapy is to establish a normal eating pattern (3 meals/2snacks); patients use self-monitoring of eating behaviors to track this pattern (Spangler, 2005). In CBT for bulimia food monitoring is discontinued at the termination of treatment, and the excellent maintenance of treatment effects suggests that the initial benefit of monitoring does not go away after discontinuation of monitoring (Murphy et al., 2010).

In obesity treatment, self-monitoring is used extensively and is an integral component in achieving weight loss (Yon, Johnson, Harvey-Berino, Gold, Howard, 2007). Research suggests that self-monitoring is a central element of successful weight loss programs and should be included in treatment (Wilson, 1999). Specifically, individuals in weight-loss interventions who consistently monitor their food consumption lose more weight than individuals who do not consistently food monitor (Boutelle & Kirschenbaum, 1998). Replications of this finding deduced that self-monitoring of food intake is necessary if weight loss is a treatment goal (Wilson & Vitousek, 1999). Food monitoring often continues for fairly long periods of time since weight loss is a slow process, but treatment expectations are that monitoring is not maintained permanently. Unlike with bulimia treatment, however, the initial effects of food monitoring on weight

loss do not appear to be as well maintained once monitoring is terminated. Weight regain is typical, with most of it occurring within the first 3 months after treatment (and self-monitoring) has ended (Grilo & Masheb, 2005).

One interpretation of this differential effectiveness is that self-monitoring effectively interrupts maladaptive eating patterns and allows for the establishment of an adaptive eating pattern. This normal eating pattern is sufficient in the case of bulimia because the normal eating pattern is maintained by natural consequences. In contrast, for successful weight loss a more restrictive eating pattern must be established. This pattern is not as easily sustained, thus it erodes more quickly once self-monitoring ends. Although the targets of self-monitoring for EDs (reduction of restriction, bingeing, and purging behaviors, and in some cases, weight gain) and of obesity intervention (weight loss) appear to be on opposite ends of the spectrum, the overarching goal is to promote healthy eating behaviors that can be maintained and thereby attain/maintain a healthy weight. Fortunately, for purposes of prevention and early intervention, the more restrictive pattern of eating is not necessary so we predict that food monitoring effects might be better maintained in obesity prevention interventions than in weight loss interventions.

Identifying a form of self-monitoring that could be used to prevent both EDs and obesity is highly desirable as such a program would likely be more cost effective. Food monitoring is one option, given its success in ED treatment. Furthermore, the recently developed appetite monitoring appears to be another, potentially even more acceptable or possibly less iatrogenic option. Some ED researchers have suggested that food monitoring may exacerbate preoccupation with food in populations who already have

some unhealthy or dysregulated eating behaviors even though those behaviors may be diagnostically subthreshold (Hildebrandt & Latner, 2006; Wilson & Vitousek, 1999). Preliminary research suggest that appetite monitoring may be a form of self-monitoring that achieves a similar improvement in eating behavior without as much risk of increasing preoccupation with food (Hill et al., 2006).

Research Support for Appetite Monitoring

Appetite monitoring was developed as the self-monitoring component of Appetite Awareness Training (AAT; Craighead, 2006), which is a CBT-based intervention that has demonstrated efficacy and acceptability for individuals with clinical and subthreshold EDs. Appetite monitoring involves recording an individual's perception of hunger and stomach fullness using a Likert scale on the Records of Eating Episodes-Highlighted (Craighead, 2006; Craighead & Allen, 1995). The goal of appetite monitoring is to make eating decisions based predominantly on internal appetite cues. Individuals attend to and record the degree of hunger and fullness (e.g. stomach distention) distinctly separate from psychological reactions to an eating episode (e.g. feelings of distress about a type or amount of food). This is an important distinction because focusing on the psychological distress is a type of continued evaluation of self worth based on eating, weight, and shape and can feed back into further dysregulated eating behaviors.

Prior research indicated that Appetite Focused CBT (CBT-AF) effectively reduced eating pathology in women with binge eating disorder (BED; Craighead & Allen, 1995) and in women with BN (Dicker & Craighead, 2004; Hill, Craighead & Safer, 2010). Notably, 75% of participants in the BED study and 100% of participants in

the BN study (of those who had a history of food monitoring) reported that appetite monitoring was more helpful than their past experiences with food monitoring. Hill and colleagues (2004) compared brief periods of food and appetite monitoring in a sample of college women with high eating concerns and found that both types of monitoring effectively reduced eating pathology. Food monitoring, however, led to a significant increase in the amount of time participants spent thinking about food, eating, weight, and shape while appetite monitoring did not exacerbate these preoccupations.

Short-term effects of food monitoring are important to address in at risk populations because women with elevated eating and weight concerns may be more inclined to seek help for weight loss than for their over-concern with weight/shape/eating. While food monitoring is the standard self-monitoring technique in ED treatment and effectively reduces eating pathology in clinical and even subthreshold populations, it may increase preoccupation with eating, weight, and shape in at risk populations. If it does, appetite monitoring may provide an alternative technique that preserves the benefits of self-monitoring while reducing the risks of increasing preoccupation.

Electronic Self-Monitoring

Most research on ED treatment utilizes the traditional paper and pen/written form of self-monitoring. Some studies have examined the feasibility of using portable computers and personal digital assistants (PDAs) for digital food monitoring (Norton et al., 2003; Shapiro et al., 2010; Shapiro et al., 2008). Electronic self-monitoring has many advantages, particularly its capacity to provide better data on compliance and potential for easy dissemination. Recent research evaluating compliance rates using electronic

monitoring (food or appetite) suggests high compliance as compared to rates of compliance with written monitoring (Jones, 2012; Schembre & Yuen, 2011).

Summary. The purpose of this study was to build on initial findings from the ED prevention literature that an intervention targeting regulation of eating behaviors (rather than thin-ideal internalization) not only reduced disordered eating behaviors, but also reduced attitudinal risk factors (e.g. body dissatisfaction), in individuals at high risk for developing an ED or obesity. Additionally, we aimed to further the clinical research utilizing technology by adapting previously studied methods of self-monitoring to a digital interface. Therefore, we sought to examine the intervention effects of two established forms of self-monitoring, appetite and food monitoring. To investigate self-monitoring as an avenue for ED prevention, we enrolled ninety young adult women (45 in appetite monitoring, 45 in food monitoring) to complete daily self-monitoring on an iPod touch device for 3 weeks. Participants completed measures at baseline, post-intervention, and 3-week follow-up. Based on past studies, we hypothesized that both interventions would significantly reduce global eating pathology and binge eating, and the proximal risk factors of dietary intent and negative affect. We hoped to demonstrate that these interventions would also reduce the more distal risk factors of body dissatisfaction, and thin-ideal internalization. We predicted that the food monitoring condition only, not the appetite monitoring condition, would report increases in preoccupation with eating and with weight/shape. Furthermore, we aimed to examine potential mediators of intervention effects. Lastly, we set out to explore the directionality of relationships between the variables in the dual pathway model.

Method

Participants

Young adult women associated with Emory University, either enrolled as a student or employed by the university, ($N = 90$) participated in this study. Age ranged from 18 to 30 ($M = 22.08$, $SD = 2.79$), and body mass index (BMI), calculated from self-report weight and height, ranged from 18 to 42 ($M = 23.36$, $SD = 3.91$). Fifty-nine percent (62.5%) of the sample self-identified as Caucasian, 11.4% as Hispanic, 19.3% as Asian, 12.5% as African American, and 5.7% as Other or Mixed Race. The ethnic diversity of the sample is comparable to the ethnic diversity of the university where the study was conducted.

Procedure

Recruitment. We recruited a total of 90 participants through the use of fliers placed on campus that described the study as an evaluation of two digital applications (apps) for healthy eating for young adult women who were concerned about eating, weight, and/or who feel at risk for weight gain. Individuals interested in participating contacted the research team and completed a phone screening for eligibility. The phone screening included information about study participation and assessed inclusion and exclusion criteria. All study procedures were reviewed and approved by the Emory University Institutional Review Board (IRB #00045500).

Inclusion and exclusion criteria. Individuals were considered eligible if they a) were female; b) completed the phone screening; c) were enrolled at Emory University and/or employed by Emory University; d) were between the ages of 18 and 30; e) self-identified as concerned about eating, weight and/or as being at risk for weight gain; f)

agreed to random assignment; g) agreed not to participate in other weight management/loss programs during the study; h) had email access. Individuals were excluded if they were pregnant or planning to become pregnant, and or if they were considered significantly underweight (self-reported BMI < 18), based on self-reported height and weight. The selection criteria used to determine eligibility were not disclosed to individuals, regardless of whether they were included or excluded from the study. Participants who met inclusion criteria and agreed to participate were randomly assigned to either appetite monitor (*n* = 45) or food monitor (*n* = 43). Of the 90 participants enrolled and randomized, we excluded two women from data analyses because their BMI calculated at pre-intervention was below 18. Both women were randomly assigned to the food-monitoring group.

      Interventions. All participants completed three assessment visits lasting approximately one hour each at baseline, post-intervention, and three-week follow-up. Participants completed a consent form and a baseline questionnaire packet during the first assessment visit. After completing the self-report packet, participants received their randomly assigned intervention group: appetite monitoring (AM-app) or food monitoring (FM-app). Random group assignment was determined prior to baseline visit. Participants received individual iPod training with a researcher, which included assignment of an iPod touch device with the preinstalled application software, instructions about how to operate the iPod touch device, and instructions on use of the app for electronic monitoring of either appetite levels or food intake with practice meal entries.

      Both interventions consisted of three weeks of self-monitoring of eating behaviors using an electronic application (apps) for an iPod touch device. Post-intervention

measures were administered at the end of the self-monitoring intervention. Participants returned their assigned iPod touch devices at the post-intervention visit. The follow-up occurred three weeks after the end of the intervention. Researchers offered referrals for psychiatric and nutritional services at the university student health center and the psychology clinic at post-intervention and at follow-up visits.

Electronic food monitoring (FM-app group). Food monitoring is the most common form of self-monitoring used in eating disorders (ED) treatment (Spangler, 2005) and served as our control group of standard of care in the community. In the current study, we provided instructions for food monitoring based on procedures developed by Fairburn and Wilson (1993) and Latner and Wilson (2002). We modified instructions for electronic monitoring and use with the FM-app for iPod touch. The FM-app provided participants with a food diary in an electronic format. Participants used iPod touch device to access the FM-app and enter food and/or beverage intake after each eating episode. They entered the type of food, general amount of food eaten, caloric intake, and identification as a meal or a snack. Participants completed food monitoring by recording the food or beverage consumed immediately following intake, or as soon as remembered, not recorded immediately after consumption. We instructed participants to try and eat within the guidelines of three meals and at least two snacks each day. These guidelines replicated the guidelines typically used in CBT for bulimia nervosa (Fairburn & Wilson, 1993; Apple & Agras, 1997).

Electronic appetite monitoring (AM-app group). We provided instructions based on appetite monitoring procedures developed by Craighead and Allen (1995) and Craighead (2006) in Appetite Awareness Training. We modified for use with the AM-app

for iPod touch. We translated the traditional form to record appetite levels, the Record of

Eating Episodes-Highlighted-Modified (REE-H-M; Craighead & Allen, 1995; Craighead,

2006). The REE-H-M provides a scale from 1 (very hungry) to 7 (very full) that

individuals use to mark their hunger and fullness levels before and after each eating

episode. Appetite monitoring instructions state to begin eating before hunger drops below

a level of 2.5, and to stop eating before passing beyond a fullness level of 5.5.

Instructions state to record hunger and fullness as soon as they remember if they forgot to

do so prior to and immediately after eating. Individuals also record whether the food

eaten was a meal or a snack. Participants followed the same guidelines and basic steps for

electronic appetite monitoring with the AM-app as with the original REE-H-M form by

rating hunger and fullness levels using the iPod touch.

Technical Equipment

Apple iPod touch mobile digital device. Participants monitored either their

appetite or their food intake using an iPod touch (3rd generation) mobile digital device.

Device specifications include: 3.5-inch (diagonal) widescreen multi-touch display; 8 GB

memory; release date 09-2009. AM-app and FM-app software were installed on the

device prior to Visit 1. We recorded each participant's student Emory ID number and

designated iPod Touch ID number in order to discourage theft. Participants were assigned

a dock connector, which allowed the device to connect to a wall outlet for battery

charging.

Prior to use, we set up each iPod touch device by connecting it to a desktop or

laptop computer (to which it is registered) running the most recent iTunes® application

program. Each of the iPod touch devices preparation included: 1) connecting the device

to a lab computer (via USB 2.0 port); 2) registering the device; 3) defining user specifications; 4) enabling connection to the Emory Unplugged wireless network; 5) downloading one of two applications that were developed for the purpose of the study (AM-app for monitoring appetite, or FM-app for monitoring food intake).

Data protection and storage. To protect participant privacy, each iPod touch device was assigned an identification (ID) number linked to the product serial number. When a participant received an iPod touch, the device ID number became the participant's subject ID number. We preprogrammed this ID number into the email feature of the AM-app or FM-app, so that any self-monitoring data that gets entered, stored, and emailed from the participant's device was linked to the participant ID only. Therefore, data storage and management did not include any participant personal information.

We developed and tested both the FM-app and the AM-app for use on an iOS® mobile digital device via the process of using Xcode® developer software (editing and debugging environment) and the iPhone Simulator®. For this study, we downloaded the apps onto iPod touch devices, and subsequently distributed to participants randomly assigned to the appropriate intervention group.

Measures

Demographics and background information. Individuals provided their contact information, age, date of birth, year in school, race/ethnicity, and reasons for signing up for the study. Participants reported current and lifetime eating disorder diagnoses, ideal weight, smoking and dieting history, and prior treatment.

Body Mass Index (BMI). Participants provided their height and weight at each visit. Actual weight has been found to correlate highly with self-reported weight (Smith, Hohlstein, & Atlas, 1992). We used self-reported height and weight to calculate body mass index (BMI), a measure of adiposity (Pietrobelli et al., 1998).

Eating behaviors and concerns. Participants completed self-report measures assessing various eating behaviors, including pathological eating patterns, at baseline, post-intervention, and 3-week follow-up.

Binge Eating Scale (BES; Gormally, Black, Dastin & Rardin, 1982). The BES is a self-report measure consisting of 16 items aimed at assessing behavioral concomitants of binge eating, as well as cognitions and feelings surrounding a binge. Total scores range from 0-46, with higher scores indicating more severe binge eating. Scores ≥ 27 typically indicate severe binge eating, whereas scores ≤ 17 suggest mild (or absent) binge eating (Greeno, Marcus & Wing, 1995). Test-retest reliability for the BES has been shown to be good ($r = .87$; Timmerman, 1999) and the measure demonstrates high internal consistency ($\alpha = .85$; Gormally et al., 1982).

Dietary Intent Scale (DIS; Stice, 1998). This 9-item self-report measure assesses dietary restraint on a 5-point scale from 1 (never) to 5 (always). For example, questions are asked about avoiding or limiting food and calories to control weight. Pilot studies have demonstrated that the DIS is internally and temporally reliable and is predictive of eating behavior (Stice, 1998).

Eating Disorder Examination - Self-Report Questionnaire Version (EDE-Q; Fairburn & Beglin, 1994). The EDE-Q is a survey taken from the Eating Disorder Examination clinical interview (Fairburn & Cooper, 1993). The EDE-Q uses a Likert-

type scale to assess eating disorder pathology. It is a validated measure of eating pathology, and questions are aimed at behaviors and attitudes experienced within the past 4 weeks (Fairburn & Beglin, 1994). The total scale is broken into 4 subscales: restraint, weight concern, eating concern, and shape concern. The subscales have acceptable internal consistency (Mond, Hay, Rodgers, Owen, & Beaumont, 2004) and two-week test-retest reliability, with Cronbach alphas and Pearson coefficients for all scales consistently exceeding 0.80 (Luce & Crowther, 1999).

Preoccupation with Eating, Weight, and Shape Scale (PEWS; Craighead & Niemeier, 1999; Niemeier, Craighead, Pung, & Elder, 2002). This 9-item self-report measure was adapted from the Modifying Distressing Thoughts Questionnaire (Clark, Feldman & Channon, 1989), and is used to assess cognitive preoccupation with food, and with weight/shape. The PEWS contains two subscales: preoccupation with food and preoccupation with weight/shape. Each subscale is comprised of 3 items. Respondents are asked to indicate on a scale of 1 (Not at all) to 6 (Extremely) how distressing the thoughts were, how difficult they were to stop, and how much they interfered with concentration. Higher scale scores indicate greater cognitive preoccupation with food, weight, and shape. Preliminary analyses suggest adequate sensitivity to change, convergent validity, discriminant validity, and internal consistency ($\alpha = .84$), (Niemeier et al., 2002).

Eating Concerns Composite. We created a composite construct for eating concerns using multiple measures in order to increase measurement reliability (Kazdin, 2003). In the current sample, the EDE-Q eating concerns subscale (Fairbrun & Beglin,

1994) and the PEWS food subscale (Niemeier et al., 2002) were highly correlated ($r =$ .744, $p < .0001$) so their scores were averaged.

Attitudinal and Affect Measures. Participants completed self-report measures assessing attitudinal constructs of body image and affectivity at baseline, post-intervention, and 3-week follow-up.

Satisfaction and Dissatisfaction with Body Parts Scale (SDBP; Berscheid, Walster & Bohrnstedt, 1973). Participants rate their level of satisfaction with body parts on a scale ranging from 1 = *extremely satisfied* to 6 = *extremely dissatisfied*. This scale has shown good internal consistency ($\alpha = .94$), test-retest reliability ($r = .90$), and predictive validity for bulimic symptom onset (Stice et al., 2004).

Ideal-Body Stereotype Scale – Revised (IBSS-R: Stice, Fisher, & Martinez, 2004). The IBSS-R presents statements regarding the thin ideal in society. The participant ranks the degree to which she agrees or disagrees with statements regarding thinness on a 5-point Likert scale. Research indicates internal consistency ($\alpha = .91$) and test-retest reliability ($r = .80$), and predictive validity for bulimic symptom onset (Stice et al., 2004).

Positive and Negative Affect Schedule – Expanded Form (PANAS-X), negative affect subscale (Watson & Clark, 1999). We used the fear, hostility, guilt, and sadness subscales of the PANAS-X to assess negative affect. These subscales combined include 23 negative emotional states using a Likert rating scale ranging from 1 (very slightly or not at all) to 5 (extremely). This scale has indicated good internal consistency ($\alpha = 0.82 – 0.87$), adequate test-retest reliability ($r = 0.57 – 0.68$), good discriminant validity ($r = 0.16 – 0.00$), and good convergent validity ($r = 0.92 – 0.95$; Watson & Clark, 1999).

Results

Analyses

We conducted 2 x 3 (group x time) repeated measure ANOVAs as our primary

analyses to examine differences between the two types of monitoring (AM-App versus

FM-App) over time (pre-intervention, post-intervention, and three-week follow-up) on

each of the dependent variables. Significant main effects for time were analyzed by single

degree of freedom, pairwise main effects contrasts between baseline and post-

intervention and between baseline and follow-up. We used eta-squared values for effect

sizes.

Dropout was modest: 5%(2/43) of FM-app and 4% (2/45) of AM-app did not

complete the intervention, and an additional 5% (2/43) and 9% (4/45) respectively did not

complete the 3-week follow-up, and the missing data appeared to be due to random

events. No significant differences were found between intervention completers and non-

completers on baseline dependent variable scores. Since the primary aim of this study

was to evaluate maintenance of intervention effects we conducted complete-case analyses

(used only participants with data for all three time points). Recent research suggests that

complete-case analysis produces an unbiased estimate of treatment effectiveness under

covariate-dependent missingness mechanisms, that complete-case analysis as compared

to multiple imputation and maximum-likelihood based methods was not profoundly

different, and that last observation carried forward is seriously biased and should not be

used (Salim et al., 2008). Table 1 shows dependent variable means by group and

assessment period.

One-way analysis of variance (ANOVA) tests revealed no significant differences between groups for age or baseline BMI. One-way ANOVAs indicated no significant baseline differences on dependent variables.

Eating Behaviors and Concerns Measures

Binge Eating. Repeated measures ANOVAs yielded significant main effects for time for the BES total scale ($F(2, 150) = 8.00$, $p < .0001$, $\eta^2 = .096$), and no group effect ($F(1, 75) = 0.58$, $p = .45$, $\eta^2 = .01$) or time by group interaction ($F(2, 150) = 1.66$, $p = .19$, $\eta^2 = .02$). We conducted single degree of freedom, pairwise main effects contrasts to assess the significant main effect for time for the BES total score. Pairwise main effects contrasts indicated a significant decrease in BES total scores from baseline to post-intervention ($F(1, 75) = 5.37$, $p = .023$, $\eta^2 = .067$) and from baseline to three-week follow-up ($F(1, 75) = 13.25$, $p < .0001$, $\eta^2 = .15$).

Dietary Intent. Repeated measures ANOVAS yielded a significant time effect for the DIS ($F(2, 150) = 6.71$, $p = .002$, $\eta^2 = .082$), and no group effect ($F(1, 75) = 1.26$, $p = .27$, $\eta^2 = .02$) or time by group interaction ($F(2, 150) = 0.02$, $p = .98$, $\eta^2 = .00$). Pairwise main effects contrasts investigating the significant main effect for time indicated a significant decrease in DIS total scores from baseline to post-intervention ($F(1, 75) = 8.33$, $p = .005$, $\eta^2 = .10$) and from baseline to three-week follow-up ($F(1, 75) = 10.86$, $p = .002$, $\eta^2 = .126$).

Eating Behaviors and Concerns. Results yielded a significant time effect for the EDE-Q total score ($F(2, 108) = 3.26$, $p = .042$, $\eta^2 = .057$), and no effects for group ($F(1, 54) = 0.25$, $p = .62$, $\eta^2 = .005$) or time by group interaction ($F(2, 108) = 0.96$, $p = .39$, $\eta^2 = .017$). Pairwise main effects contrasts analyzing the significant time effect did not find

a significant change from baseline to post-intervention ($F(1, 54) = 1.54$, $p = .22$, $\eta^2 = .028$), but did indicate significant change from baseline compared to follow-up ($F(1, 54) = 5.67$, $p = .021$, $\eta^2 = .095$). Since the effect for the EDE-Q total score was significant, we analyzed each subscale.

Repeated measures ANOVAs yielded a significant time effect for the EDE-Q shape concerns subscale ($F(2, 136) = 15.04$, $p < .0001$, $\eta^2 = .181$), but no group effect ($F(1, 68) = 1.21$, $p = .28$, $\eta^2 = .017$) or time by group interaction ($F(2, 136) = 1.44$, $p = 0.24$, $\eta^2 = .021$). Pairwise main effects contrasts assessing the significant main effect for time indicated a significant decrease from baseline to post-intervention ($F(1, 68) = 13.41$, $p < .0001$, $\eta^2 = .165$) and from baseline to three-week follow-up ($F(1, 68) = 22.57$, $p < .0001$, $\eta^2 = .25$). For the EDE-Q eating concerns subscale, results did not yield a time effect ($F(2, 122) = 1.02$, $p = .37$, $\eta^2 = .016$) or a group effect ($F(1, 61) = 0.66$, $p = .42$, $\eta^2 = .011$). The group by time interaction did not reach a conventional level of significance ($F(2, 122) = 2.75$, $p = .068$, $\eta^2 = .043$). There were also no significant effects for the EDE-Q restraint or weight concerns subscales.

In summary, results indicated that both groups achieved and then maintained improvement at 3-week follow-up on binge eating, dietary intent, and EDE-Q shape concerns.

Preoccupation. The two PEWS subscales were highly correlated at baseline ($r = .86$, $p < .001$), but they were analyzed separately to evaluate the hypothesis that food/eating concern specifically would respond differentially to the type of monitoring. For the PEWS food/eating subscale, results yielded a significant time effect ($F(2, 150) = 3.07$, $p = .05$, $\eta^2 = .039$), and no group effect ($F(1, 75) = 0.79$, $p = .38$, $\eta^2 = .010$) nor the

hypothesized time by group interaction ($F(2, 150) = 0.55$, $p = .57$, $\eta^2 = .007$). Pairwise

main effects contrasts analyzing the significant time effect for this subscale indicated no

significant effect from baseline to post-intervention ($F(1, 75) = 2.62$, $p = .11$, $\eta^2 = .034$);

however there was a significant reduction at three-week follow-up compared to baseline

($F(1, 75) = 4.98$, $p = .029$, $\eta^2 = .062$). Results did not indicate significant effects for the

PEWS weight/shape subscale.

Body Mass Index. Results indicated a significant main effect for time for BMI

($F(2, 146) = 4.50$, $p = .013$, $\eta^2 = .058$), and no group effect ($F(1, 73) = 1.24$, $p = .27$, $\eta^2 =$

$.017$) or time by group interaction ($F(2, 146) = 0.25$, $p = .78$, $\eta^2 = .003$). Pairwise main

effects contrasts analyzing the significant main effect for time indicated significant a

decrease in BMI from baseline to post-intervention ($F(1, 73) = 7.73$, $p = .007$, $\eta^2 = .096$)

and from baseline compared to three-week follow-up ($F(1, 73) = 4.77$, $p = .032$, $\eta^2 =$

$.061$), indicating that participants in both groups experienced a reduction in BMI.

Attitudinal and Affect Measures

Body Image. Results indicated a main effect for time for body dissatisfaction

($F(2, 144) = 2.98$, $p = .05$, $\eta^2 = .040$), and no group effect ($F(1, 72) = 0.07$, $p = .79$, $\eta^2 =$

$.001$) or time by group interaction ($F(2, 144) = 0.18$, $p = .83$, $\eta^2 = .003$). Pairwise main

effects contrasts analyzing the main effect for time indicated no significant change in

body dissatisfaction from baseline to post-intervention ($F(1, 72) = 2.35$, $p = .13$, $\eta^2 =$

$.032$), but a significant reduction in body dissatisfaction at three-week follow-up

compared to baseline ($F(1, 72) = 6.85$, $p = .011$, $\eta^2 = .087$). There were no significant

effects for thin-ideal internalization for time ($F(2, 150) = 0.22$, $p = .80$, $\eta^2 = .003$), group

($F(1, 75) = 0.08$, $p = .77$, $\eta^2 = .001$), or time by group interaction ($F(2, 150) = 0.07$, $p = .93$, $\eta^2 = .001$).

Negative Affect. For negative affect, Mauchly's test of sphericity indicated a violation of the sphericity assumption ($x^2(2) = 8.59$, $p = .014$). Therefore, we used a Greenhouse-Geisser correction. Repeated measures ANOVA with a Greenhouse-Geisser correction yielded a significant time effect for reduction in negative affect ($F(1.798, 131.231) = 4.34$, $p = .018$, $\eta^2 = .056$), and no group ($F(1, 73) = 0.07$, $p = .79$, $\eta^2 = .001$) or interaction effects ($F(1.798, 131.231) = 1.92$, $p = .15$, $\eta^2 = .026$). Inspection of the group means at each time point suggested that orthogonal polynomial single degree of freedom contrasts would provide the best fit to the pattern of means (Table 1, Figure 2). Within-subjects orthogonal polynomial contrasts indicated a significant linear trend for reduction in negative affect ($F(1, 73) = 3.97$, $p = .05$, $\eta^2 = .052$) and a significant quadratic trend for negative affect ($F(1, 73) = 4.99$, $p = .029$, $\eta^2 = .064$). Contrasts yielded a significant time by group interaction for the quadratic trend ($F(1, 73) = 5.19$, $p = .026$, $\eta^2 = .066$), but no interaction for the linear trend ($F(1, 73) = 0.003$, $p = .96$, $\eta^2 = .000$).

Further investigation of the significant time by group quadratic interaction using within-group orthogonal polynomial single degree of freedom contrasts indicated a significant quadratic trend in the FM-App group ($F(1, 36) = 7.93$, $p = .008$, $\eta^2 = .180$), but not a linear fit ($F(1, 36) = 1.42$, $p = .24$, $\eta^2 = .038$). Within the AM-group, contrasts indicated a trend for a linear fit ($F(1, 37) = 3.00$, $p = .09$, $\eta^2 = .075$), but not a quadratic trend ($F(1, 37) = .001$, $p = .97$, $\eta^2 = .00$). A quadratic trend best fits the data for the FM-App group; results indicated a decrease in negative affect at post-intervention, but this

decrease was not maintained at three-week follow-up. In comparison, the AM-App group showed a trend for a consistent decrease in negative affect across the three assessments.

Mediators of intervention effects

We had hypothesized that reverse mediation would be demonstrated such that, as originally proposed in the dual pathway model, the outcome variables (global eating pathology, dietary intent, and binge eating) would each independently mediate intervention effects on the more distal risk factors as proposed by the dual pathway model (body dissatisfaction and thin-ideal internalization). Given that there were no intervention effects on thin-ideal internalization, and no group by time interaction for body dissatisfaction, we did not proceed with the planned mediator analyses.

Exploratory Analyses: Correlations in the dual pathway model

We used the baseline data to conduct exploratory analyses to investigate the relationships between risk and outcome variables as proposed in the dual pathway model (Stice et al., 1996; 2002). Table 2 presents the correlations among the variables at baseline, and Figure 3 illustrates the dual pathway model with correlations as found in this sample. Of note, the DIS was not significantly correlated with body dissatisfaction or negative affect as would have been predicted, but all other relationships between variables in the dual pathway model were significantly correlated as proposed in the original model.

Since the DIS was not correlated with other variables, as would have been hypothesized by the dual pathway model, we explored the possibility that alternative measures might better reflect "dietary restraint". The relationship between restriction (i.e. actual restricted calorie) and intentions to restrict (that may or may not reflect lowered

intake) is not well established. Stice and colleagues (Stice, Fisher, & Lowe, 2004)

reviewed the various measures of dietary restraint and concluded that they do not

accurately assess acute caloric intake. These measures appear to assess intentions to

restrict intake rather than actual restriction of intake. The DIS did have a higher

correlation to actual caloric intake compared to other measures of dietary restraint, but

the correlations were only moderate (Stice et al., 2004). In any event, the DIS did not fit

the model and correlated only modestly with our other measure of restraint (the EDE-Q

restraint subscale). Thus, we explored the possibility that questions targeting worry about

eating might better reflect the aspect of "dieting" that might be even more problematic

than actual or intent to restrict. Our data set included two measures of "eating concerns"

that assess worry about what one is eating (or not eating). These measures (EDE-Q eating

concerns subscale and the PEWS food/eating concerns subscale) are both quite brief, but

are highly correlated ($r = .739$, $p < .0001$). Therefore, we combined them to create an

eating concerns composite measure (Kazdin, 2003)[1]. This eating concerns composite was

modestly correlated with the DIS ($r = .311$, $p = .004$) suggesting that it is assessing some

aspect of intention to diet but is somewhat different from the DIS. We tested the eating

concerns composite in place of the DIS and found that all relationships among the

variables in the dual pathway model were highly correlated as proposed by the model

(Figure 3).

Next, we evaluated the directionality of the relationships between the variables as

originally proposed by the model. We conducted a series of regression analyses to

examine mediational relationships (Baron & Kenny, 1986) between the variables in the

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[1] We tested the composite construct after standardizing each measure to ensure differences in the scales
were not notably impacting the significance tests; there were no differences in outcomes.

dual pathway model (Tables 3, 4, 5) based on the originally proposed directional

relationships between the variables. We initially established that all proposed mediators

were significantly related to the proposed independent variables, and this criterion was

met (Baron & Kenny, 1986; criterion 1). We then established that the proposed

dependent variables and independent variables were related; all variables were

significantly correlated. Thus, Baron & Kenny (1986) criterion 2 was met. The original

dual pathway model proposes that body dissatisfaction leads to eating pathology (binge

eating) through both the dieting pathway and the negative affect pathway, so we tested

both pathways.

  Dieting Pathway (Figure 4). To assess the original direction of the dieting

pathway of the dual pathway model, body dissatisfaction served as the independent

variable, binge eating served as the outcome variable, and the eating concerns composite

served as the mediator variable. The mediator (eating concerns composite) was

significantly related to the independent variable tested (criterion 1; body dissatisfaction),

and dependent variable (criterion 3; binge eating). Therefore, we proceeded to the fourth

criterion, which states that the previously significant effect of the independent variable on

the dependent variable (in criterion 2) must be attenuated or eliminated when controlling

for the mediator.

  Consistent with the originally proposed direction of relationships among the

variables in the dieting pathway of the dual pathway model (Figure 1; Stice et al., 1996;

2002), results for the fourth criterion indicated that the eating concerns composite fully

mediated the relationship between body dissatisfaction (variance attenuated from 26.7%

to 0.8%) and binge eating (dependent variable). Sobel test indicated significant complete

mediation in the model (z = -4.36, p < .0001). Also consistent with the originally

proposed direction of the model, the eating concerns composite fully mediated the

relationship between body dissatisfaction (variance reduced from 18.1% to 1.4%) and

negative affect (dependent variable) on the pathway that links the dieting pathway to the

negative affect pathway. Sobel test yielded significant complete mediation in the model

(z = -3.82, p < .001). Most notably, negative affect failed to mediate the link from eating

concerns to binge eating, as proposed in the original dual pathway model, because the

effect of negative affect (mediator) was no longer significant after controlling for eating

concerns (independent variable). Therefore, criterion 4 was not met. Sobel test was also

nonsignificant, providing further support that negative affect did not mediate the

relationship between eating concerns and binge eating (z = -0.63, p = .53).

Negative Affect Pathway (Figure 5). Regarding the negative affect pathway of

the dual pathway model, we tested the impact of negative affect (mediator) on the

relationship between body dissatisfaction (independent variable) and binge eating

(dependent variable). Results indicated that negative affect partially mediated the

relationship between body dissatisfaction and binge eating in the proposed direction

(variance reduced from 27% to 13%) because the effect of the independent variable

remained significant, although attenuated, when controlling for the mediator. Sobel test

indicated that the indirect effect of the independent variable (body dissatisfaction) on the

dependent variable (binge eating) was significantly different from zero (z = -2.19, p =

.03), providing further support for partial mediation. Furthermore, eating concerns fully

mediated the relationship between negative affect (variance attenuated from 18% to

0.2%) and binge eating (dependent variable). Sobel test yielded significant complete

mediation in the model ($z = 5.26$, $p < .0001$), suggesting that the proposed direct pathway between negative affect and binge eating may be better explained via eating concerns.

Additionally, body dissatisfaction partially mediated the relationship between negative affect and binge eating (variance attenuated from 18% to 5.5%), as the effect of the independent variable (negative affect) was attenuated but remained significant when controlling for the mediator (body dissatisfaction). Sobel test indicated that the indirect effect of the independent variable (negative affect) on the dependent variable (binge eating) was significantly different from zero ($z = 2.90$, $p = .004$), providing further support for partial mediation. This provides further preliminary support that the negative affect pathway originally proposed in the model may not independently and directly influence the inception of eating pathology, but rather is a more distal factor in the model.

Discussion

The present study evaluated the effects of two types of electronic self-monitoring, food monitoring and appetite monitoring, as early interventions for young adult women at risk for eating and weight problems. We had predicted that appetite monitoring would result in greater acute as well as sustained effects. Contrary to our hypotheses, results indicated that similar reductions in both appetite and food monitoring on measures of binge eating, dietary intent, shape concerns, negative affect, and BMI at post-intervention. Additionally, both interventions demonstrated good maintenance of these effects at follow-up with the exception of negative affect, which rebounded in the FM-App condition only. Furthermore, reductions in preoccupation with food and body dissatisfaction which had not reached significant levels at post-intervention, were significant when assessed at follow-up in both conditions, thus suggesting the possibility

that changes in those variables lag a bit behind the changes in eating pathology and negative affect.

Most importantly, these results demonstrate that the gains demonstrated from self-monitoring were not simply reactive effects of monitoring. The beneficial effects were maintained in both conditions three weeks after active monitoring was discontinued. Since both interventions elicited similarly positive results across various eating disorder risk factors, participant preference and/or acceptability will be important to evaluate. Results from a questionnaire assessing participant reactions to the monitoring (Jones, 2012) suggested that participants assigned to AM-App reported a more positive experience. Our findings from the negative affect measure add some support to this conclusion. Participants in the FM-App group reported a greater decrease in negative affect from pre-intervention to post-intervention, but that decrease was not maintained at follow-up. Participants in the AM-App reported a steady decrease in negative affect from baseline to follow-up. One interpretation is that participants in the food-monitoring group initially found it helpful in facilitating restriction so they felt quite positive, but had more difficulty maintaining that restriction once they stopped monitoring. Hence, there was some rebound at follow-up from their more positive mood at post-intervention; however negative mood still remained below baseline levels. In comparison, participants in the appetite-monitoring group may have had more difficulty initially since this type of monitoring is less familiar. Once learned, however, they may have felt better able to maintain their feeling of improved efficacy about eating after the electronic monitoring ended. This observation is consistent with clinical feedback that, while initially it takes some time to tune in to internal appetite cues, clients frequently report that they start to

see a mental representation of the scale and thus continue to use the strategy even when they stop written monitoring.

Although the two interventions were based on different theories for changing dysregulated eating behaviors, both interventions provide potentially helpful tools to regulate eating behaviors. Of note, food monitoring has been used as active control conditions in prior studies (e.g. Hill et al., 2004) and is the most common form of self-monitoring in the most efficacious ED treatment to date (Murphy et al., 2010). Therefore, it was used in the current study as a treatment-as-usual control condition. However in this study, when used as brief stand-alone interventions the two types of self-monitoring were not sufficiently different from each other to show hypothesized differential effects. Self-monitoring is believed to interrupt over-learned automatized behavior patterns, thus enhancing awareness and reflection upon intentions to change behaviors. Hence, it is possible that both interventions promoted awareness of and reflection upon dysregulated eating behaviors and subsequently reduced impulsivity around food and eating behaviors. In this case, the specific type of self-monitoring may be less influential than reducing impulsive eating and food-related behaviors. Thus, self-monitoring of eating behaviors more broadly may elicit decreased eating disorders risk factors via increased awareness of eating behaviors that previously seemed more automatic.

Sixty-nine percent of participants had used some form of food monitoring before the study, but only six percent had any exposure to the idea of appetite monitoring (Jones, 2012). The relative unfamiliarity of appetite monitoring may have attenuated its effectiveness. In previous intervention research appetite monitoring has involved more extensive instruction and feedback to participants as well as longer periods of monitoring

(Hill et al., 2007). Hence, future efforts to compare the acute effects may need to include more extensive instructions and feedback in the initial stages of learning appetite monitoring.

Although neither self-monitoring intervention directly targeted affect regulation nor the cognitive or affective aspects of body dissatisfaction, we had hypothesized that there might be some reverse mediation intervention effects. Specifically, that this intervention designed to modify eating behaviors very directly might also have some, perhaps weaker, effect on those variables as well as specific eating pathology. Such effects did not emerge as significant immediately after the intervention, but the reductions in negative affect and body dissatisfaction were significant at the three-week follow-up. This finding has some theoretical implications for the dual pathway model by indicating that these variables have reciprocal influences on each other over time. Thus, the pathways described in the dual pathway model are likely more bidirectional than was initially hypothesized.

Most importantly, these results provide support for the conclusion that regulating eating behaviors directly by promoting healthy, regular eating patterns may promote beneficial changes in related cognitive/affective constructs (body dissatisfaction and negative affect in particular) even though no changes were found on thin-ideal internalization. The participants reported small decreases in weight, which likely improved mood and body image even though thin-ideal internalization did not change over time. Further work is needed to determine if these beneficial effects would be maintained or if it turns out to be critical for longer-term success to reduce thin-idea internalization. If interventions to promote healthy eating prove to be equally effective in

the long term as targeting thin-ideal internalization, prevention interventions may be effective in reducing eating pathology as well future weight gain. Importantly, interventions to regulate eating may be more appealing to at-risk populations as such individuals are typically less invested in challenging their internalization of the thin-ideal than they are in learning more effective ways to regulate eating.

Interestingly, at baseline participants endorsed an ideal BMI that was on average lower than their current BMI. Thus, participants not only felt at risk for weight gain, but they also would prefer to lose weight. Since participants in both interventions experienced modest weight loss over the course of the intervention and through 3-week follow-up, it was not surprising that body satisfaction also improved by the follow-up. However, achieving desired weight loss over the course of the intervention potentially could have created an associated negative impact of reinforcing internalization of the thin ideal (Stice et al., 1996; 2002). While thin-ideal internalization did not decrease, it is important to note that it did not increase in either condition nor did concerns or preoccupation with weight/shape. These findings reduce potential concerns that direct intervention to teach adaptive weight management (e.g. self-monitoring) might have iatrogenic effects in subclinical or at-risk populations.

One previous investigation suggested that food monitoring elicited increases in preoccupation with food in nonclinical populations (Hill et al., 2004); however, we did not find this pattern in our sample of women with heightened eating and weigh concerns. The fact that FM-App did not lead to increased preoccupation with eating or weight/shape in this study was positive, but it is not clear why this study failed to replicate the prior finding. One possible explanation is that various food and weight self-

monitoring interventions (both digital and non-digital versions) have become increasingly popular and available to the public. Many of these interventions include components very similar to the food-monitoring intervention in the present study. Apps designed for weight loss or as dieting tools are highly publicized and available to the general public (Freudenheim, 2012).

The prior study (Hill et al., 2004) used written food monitoring, so it is possible that using an electronic format in the current study may have made food monitoring a more positive experience, thus mitigating some of the previous negative effects on preoccupation. The electronic interface, which closely resembles the format of sending text messages or emails on personal digital devices, may have reduced the time required for writing and recording food, which is one of the reasons often given by individuals who find food monitoring aversive. In either case, the current results demonstrated similar effects of both the food monitoring and appetite monitoring in the electronic format.

The only significant difference between the two types of monitoring was the initially greater reduction in negative affect for the food-monitoring group, but their greater improvement was not maintained at three-week follow-up. In contrast, participants in the appetite-monitoring group reported a consistent, linear reduction in negative affect even after discontinuing active monitoring. The quadratic pattern of negative affect in response to food monitoring may serve as a slight red flag warranting further investigation of the acute effects of food monitoring. Longer-term follow-up is needed to determine if the rebound in initially more positive affect remains stable or continues to deteriorate. It will be important to determine if food monitoring is more

helpful initially but turns out to be somewhat more difficult to maintain over time than does appetite monitoring. A recent study of family-based weight loss for overweight children showed that the beneficial effects of adding appetite monitoring to the standard food monitoring did not reach significance until the two-year follow-up (Gunnarsdottir, Njardvik, Olafsdottir, Craighead, & Bjarnason, 2011).

Although we were unable to proceed in investigating mediators of intervention group effects because there were no differences between intervention groups and our proposed mediators or dependent variables, we conducted exploratory analyses using the baseline data to evaluate the relationships among these variables at baseline as proposed by the dual pathway model (Stice et al., 1996; 2002). Results did not support the use of the DIS as a measure of dietary restraint (Stice et al., 1996; 2002). Recent research suggests that the DIS and other measures of dietary restraint or intent do not accurately assess acute caloric intake (Stice, Fisher, & Lowe, 2004), rather these measures appear to assess intentions to diet more than actual restriction. This begs the question of the role of dietary restraint in the dual pathway model as prompting binge eating or other eating pathology. Interestingly, we tested an alternative measure of "dieting" which reflected excessive preoccupation with food/eating rather than restraint per se. This measure of concerns about eating reflected fit within the model better than the measure of restraint that was used in this study. Notably, many prior studies examining the dual pathway model (e.g. Stice et al., 2006; 2007; Seidel et al., 2009) have used a different measure of dietary restraint (Dutch Restrained Eating Scale (DRES); van Strien, Frijters, Van Staveren, Defares, & Deurenberg, 1986). Of note, the DRES less accurately assessed acute caloric restriction than the DIS (Stice et al., 2004). Therefore, acute restriction of

caloric intake may be less influential in the pathway to eating pathology than over-concern about eating and food.

In addition, it may be important to consider that the mean age of the samples in prior research evaluating the dual pathway model were typically younger than in the current study. This factor may help explain the lack of relationship between the DIS and other variables in the dual pathway model in the current sample. Dietary intent and eating concerns may be qualitatively different in a sample of young adult women, as compared to younger samples of primarily adolescent girls. If women become more concerned/preoccupied with eating and food over time, after a longer period of time with intentions to diet, the preoccupation may become a more significant proximal trigger for binge eating than the actual caloric restriction.

Using the eating concerns composite in place of DIS, all relationships among the variables were highly correlated as proposed in the dual pathway model. For the dieting pathway of the dual pathway model, results indicated that the eating concerns composite fully mediated the pathway between body dissatisfaction and binge eating, and body dissatisfaction and negative affect. These results indicate that eating concerns, rather than dietary intent, is the more powerful mediator in the dieting pathway in this sample.

Additionally, the negative affect pathway did not hold up as an independent pathway linking distal eating disorders risk factors to binge eating. In this sample, negative affect served as a partial mediator in the relationship between body dissatisfaction and binge eating only, although it was originally proposed as a proximal risk factor for binge eating in the dual pathway model. In fact, body dissatisfaction partially mediated the relationship between negative affect and binge eating, which is

inconsistent with the pathways as proposed in the dual pathway model. Furthermore, the effect of negative affect on binge eating was mediated by eating concerns, again questioning the proposed direct pathway from negative affect to binge eating. Thus, in this sample, the negative affect pathway was not supported as originally proposed. Our results are in line with those of Seidel and colleagues (2009), which also indicated that negative affect and dietary intent may not be the exclusive pathways to the development of eating pathology or bulimic symptomatology.

Of note, although the negative affect pathway was not supported is this sample, we did observe group differences in results of self-monitoring on negative affect. This finding, in light of prior evidence suggesting increased preoccupation with food and weight/shape associated with food monitoring in a nonclinical sample (Hill et al., 2004), raises the possibility of a complex relationship between food monitoring, eating concerns, and negative affect over time.

It is important to note that the dual pathway model was developed as an etiological model and the typical age of onset of EDs falls in adolescence. Prospective studies suggest that eating pathology develops most commonly between the ages of 15-19 (Stice, Shaw, & Marti, 2007), not in young adulthood. Much of the evidence supporting the relationships among variables in the dual pathway model comes from adolescent and college-aged samples (e.g. Becker et al., 2005; Stice et al., 2006). Most recently, a study found reciprocal relationships among variables in the dual pathway model in a college-aged sample (Seidel et al., 2009). The sample in the present study was primarily college-aged students; however older young adults (up to age 30) were included. Therefore, in this slightly older sample of young adult women, a maintenance model may be more

appropriate. Hence, the likelihood of reciprocal relationships among many variables in the model and the prominent role of eating concerns above and beyond negative affect may be most applicable to young adult high-risk sample, rather than to younger age groups.

Limitations. There were several limitations of the current study. First, we did not include an assessment-only control group; therefore we were unable to assess natural change over time or the potential for regression to the mean effects. Second, the reliance on exclusively self-report data limits the quality of our findings. Self-report data, especially regarding participants' reporting of dieting and weight, may be biased. The use of observational and/or interview methods could enhance the validity of those findings in particular. Furthermore, because participants were recruited via response to study advertisements, our sample included only treatment-seeking individuals thus resulting in a sampling bias. We are unable to generalize findings to samples that are not treatment seeking or of whom do not endorse concerns about body image, eating, or weight loss/gain. Our sample included only female participants, which limits generalizability to male experiences or possible responses to treatment. Additionally, we only included participants associated with one collegiate environment hence limiting generalizability of findings. Lastly, we were unable to assess possible experimenter demand effects during assessment or iPod training and monitoring instruction sessions. All researchers involved in data collection were women; therefore the possibility of demand characteristics related to self-reported eating patterns, weight, and body image exists. The fact that results did not indicate universal change across all measures, however, provides some support that demand characteristics do not account for all change observed in this study.

Future Directions. Future research assessing intervention effects compared to no-intervention or waitlist control group will contribute valuable information accounting for possible natural change over time. Additionally, future studies may investigate possible moderating factors influencing the impact of different types of monitoring, such as baseline levels of body dissatisfaction and presenting eating concerns (e.g. level of binge eating, weight suppression, restriction). Compliance rates for self-monitoring in both groups were high (Jones, 2012), but future research examining the impact of adherence to self-monitoring on outcome variables would provide important information about the feasibility of such strategies in treatment settings. While the present study provided initial support for the utility of brief self-monitoring in a high-risk population, future studies should assess the effects of a longer-term self-monitoring intervention, as well as follow-up assessments over a longer period of time to better assess the potential for prophylactic effects especially for appetite monitoring. Future research might attempt to identify participant characteristics that predict more positive response to one type of monitoring. Alternatively, it may be useful to provide brief exposure to both types and then allow clients to choose whichever type seems more acceptable or useful to them. Future research may incorporate both preference and acceptability of self-monitoring type, potentially including an investigation of crossover effects.

Conclusions. Although evidence supporting a unidirectional etiologic model of eating disorders exists, investigation of the possibility of reciprocal relationships among these risk factors is limited. Initial evidence examining potential bidirectional associations provides a strong argument for further investigation into the nature of relationships among risk factors for EDs. Furthermore, theoretical models of the

cognitive-behavioral treatment model, which were developed to explain maintenance of ED symptoms, suggest that reciprocal relationships are probable in the development of eating pathology (Fairburn et al., 2003).

Results from the current study suggest that self-monitoring via electronic interface is a potential option for early intervention or prevention of eating disorders in a high-risk, female sample. In accordance with prior research and theory, results indicated a reduction of eating pathology, binge eating, and dietary intent in both interventions directly targeting the regulation of eating behaviors reduced. Furthermore, results supporting a reduction in body dissatisfaction at follow-up contribute to the limited available evidence that regulation of eating behaviors can improve body image over time.

Our exploratory findings suggest modification of the dual pathway model to include the role of eating concerns. Additionally, our exploratory results provide a basis for questioning the original unidirectionality proposed among variables in the dual pathway model. Modification of the dual pathway model to include bidirectional influences of risk factors may better elucidate the relationships between these variables; a feedback system that promotes the escalation of risk factors into more severe eating pathology is hypothesized rather than a unidirectional pathway. A better understanding of the etiology of EDs provides the opportunity for more efficacious and effective ED prevention programs, with the possibility of prophylactic effects that would reduce eating pathology as well as future obesity.

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Table 1. Means and Standard Deviations for Outcome Variables

	Baseline M (SD)	Post-intervention M (SD)	Follow-up M (SD)
BES			
AM-App	11.80 (5.52)	11.12 (6.33)	10.87 (7.29)
FM-App	11.62 (4.51)	10.24 (5.71)	9.13 (4.69)
DIS			
AM-App	22.25 (4.85)	21.18 (5.66)	20.77 (5.24)
FM-App	23.46 (5.02)	22.51 (6.00)	22.13 (5.91)
EDEQ-Total			
AM-App	1.57 (0.85)	1.58 (0.93)	1.45 (0.99)
FM-App	1.55 (1.10)	1.37 (1.13)	1.30 (0.82)
EDEQ-EC			
AM-App	0.86 (0.96)	0.82 (0.75)	0.95 (1.03)
FM-App	0.86 (0.82)	0.70 (0.97)	0.58 (0.60)
EDEQ-SC			
AM-App	2.79 (1.28)	2.61 (1.33)	2.38 (1.45)
FM-App	2.58 (1.45)	2.11 (1.30)	2.07 (1.29)
EDEQ-WC			
AM-App	2.15 (1.34)	2.06 (1.26)	2.11 (1.42)
FM-App	2.10 (1.22)	1.97 (1.28)	1.91 (1.17)
EDEQ-Restraint			
AM-App	0.78 (0.95)	0.89 (1.37)	1.05 (1.51)
FM-App	0.72 (1.43)	0.64 (1.35)	0.72 (0.88)
PEWS-food			
AM-App	1.58 (1.14)	1.37 (1.22)	1.40 (1.40)
FM-App	1.36 (0.99)	1.27 (0.92)	1.11 (0.86)
PEWS-w/s			
AM-App	1.91 (1.43)	1.88 (1.51)	1.86 (1.58)
FM-App	1.62 (1.07)	1.40 (1.12)	1.37 (1.05)
IBSS-R			
AM-App	3.75 (0.42)	3.80 (0.48)	3.74 (0.64)
FM-App	3.74 (0.36)	3.75 (0.43)	3.72 (0.61)
Body Satisfaction			
AM-App	2.85 (0.75)	2.93 (0.75)	3.01 (0.82)
FM-App	2.85 (0.94)	3.02 (0.93)	3.06 (0.85)
Negative Affect			
AM-App	1.68 (0.35)	1.63 (0.41)	1.57 (0.39)
FM-App	1.72 (0.60)	1.49 (0.45)	1.60 (0.55)
BMI			
AM-App	22.89 (2.66)	22.76 (2.63)	22.80 (2.71)
FM-App	23.96 (5.12)	23.75 (4.81)	23.78 (4.98)

Note: FM-App = Food-monitoring App; AM-App = Appetite-monitoring App; BES Total = Binge Eating Scale, Total score; DIS = Dietary Intent Scale; EDEQ Total = Eating Disorders Examination-Questionnaire Total score; EDEQ-EC = Eating Disorders Examination-Questionnaire Eating Concerns subscale; EDEQ-SC = Eating Disorders Examination-Questionnaire Shape Concerns subscale; EDEQ-Res = Eating Disorders Examination-Questionnaire Restraint subscale; PEWS food = Preoccupation with Eating, Weight, and Shape Scale food concerns subscale; PEWS w/s = Preoccupation with Eating, Weight, and Shape Scale weight/shape concerns subscale; Body Satisfaction = Satisfaction and Dissatisfaction with Body Parts Scale; IBSS-R = Ideal-Body Stereotype Scale – Revised; Negative Affect = Positive and Negative Affect Schedule – Expanded Form negative affect subscale

Table 2. Correlations Among Dependent Variables at Baseline

	BES Total (87)	DIS Total (88)	EDEQ Total (82)	EDEQ-EC (85)	EDEQ-SC (84)	EDEQ-WC (87)	EDEQ-Res (87)	PEWS food (88)	PEWS w/s (88)	Body Sat (87)	IBSS-R (88)	Neg Aff (86)
BES Total	1											
DIS Total	.213*	1										
EDEQ Total	.635**	.404**	1									
EDEQ-EC	.647**	.244*	.832**	1								
EDEQ-SC	.569**	.303*	.895**	.679**	1							
EDEQ-WC	.562**	.335*	.909**	.699**	.871**	1						
EDEQ-Res	.380**	.381**	.643**	.343*	.384**	.400**	1					
PEWS food	.737**	.314*	.736**	.739**	.685**	.670*	.441**	1				
PEWS w/s	.661**	.323*	.803**	.734**	.796**	.765**	.409**	.863**	1			
Body Sat	-.517*	-.168	-.498**	-.396**	-.604*	-.571*	-.143	-.572*	-.608**	1		
IBSS-R	.160	.230*	.207	.090	.149	.187	.306**	.141	.163	-.209	1	
Neg Affect	.425**	.069	.532**	.542**	.532**	.522**	.229*	.623**	.623**	-.425**	.021	1

Note: BES Total = Binge Eating Scale, Total score; DIS = Dietary Intent Scale; EDEQ Total = Eating Disorders Examination-Questionnaire Total score; EDEQ-EC = Eating Disorders Examination-Questionnaire Eating Concerns subscale; EDEQ-SC = Eating Disorders Examination-Questionnaire Shape Concerns subscale; EDEQ-Res = Eating Disorders Examination-Questionnaire Restraint subscale; PEWS food = Preoccupation with Eating, Weight, and Shape Scale food concerns subscale; PEWS w/s = Preoccupation with Eating, Weight, and Shape Scale weight/shape concerns subscale; Body Sat = Satisfaction and Dissatisfaction with Body Parts Scale; IBSS-R = Ideal-Body Stereotype Scale – Revised; Neg Aff = Positive and Negative Affect Schedule – Expanded Form negative affect subscale ** *p* ≤ 0.01 level (2-tailed), * *p* ≤ 0.05 level (2-tailed)

Table 3. Tests of Mediation in the Dieting Pathway

Criteria	B	SE B	β	t	Sig.
1. Effect of IV on mediator					
I. Body Sat → EC	-0.60	0.12	-.50	-5.22	$p < .0001$
II. Body Sat → EC	-0.60	0.12	-.50	-5.22	$p < .0001$
III. EC → PANAS-NA	0.33	0.05	.63	7.26	$p < .0001$
2. Effect of IV on DV					
I. Body Sat → BES	-3.47	0.27	-.52	-5.53	$p < .0001$
II. Body Sat → PANAS-NA	-0.25	0.06	-.43	-4.28	$p < .0001$
III. EC → BES	4.04	0.43	.72	9.50	$p < .0001$
3. Effect of mediator on DV					
I. EC → BES	4.04	0.43	.72	9.50	$p < .0001$
II. EC → PANAS-NA	0.33	0.05	.63	7.26	$p < .0001$
III. PANAS-NA → BES	4.80	1.12	.43	4.27	$p < .0001$
4. Effect of IV on DV with control for mediator					
I. Body Sat → BES	-0.69	0.58	-.10	-1.20	$p = .235$
| EC	3.82	0.48	.69	7.90	$p < .0001$★
II. Body Sat → PANAS-NA	-0.09	0.06	-.14	-1.35	$p = .18$
| EC	0.29	0.05	.56	5.60	$p < .0001$★
III. EC → BES	4.21	0.55	.76	7.63	$p < .0001$
| PANAS-NA	-0.67	1.06	-.06	-0.63	$p = .53$

Note: | = controlling for; ★ = complete mediation; [†] = partial mediation; IV = independent variable;

DV = dependent variable; Body Sat = Satisfaction and Dissatisfaction with Body Parts Scale; EC = Eating Concerns composite; BES = Binge Eating Scale; PANAS-NA = Positive and Negative Affect Scale, negative affect subscale

Table 4. Tests of Mediation in the Negative Affect Pathway

Criteria	B	SE B	β	t	Sig.
1. Effect of IV on mediator					
Body Sat → PANAS-NA	-0.25	0.06	-.43	-4.28	*p* < .0001
2. Effect of IV on DV					
Body Sat → BES	-3.47	0.27	-.52	-5.53	*p* < .0001
3. Effect of mediator on DV					
PANAS-NA → BES	4.80	1.12	.43	4.27	*p* < .0001
4. Effect of IV on DV with control for mediator					
	-2.69	0.68	-.40	-3.96	*p* < .0001
Body Sat → BES	2.93	1.15	.26	2.55	*p* = .013[†]
| PANAS-NA					

Note: | = controlling for; ★ = complete mediation; [†] = partial mediation; IV = independent variable; DV = dependent variable; Body Sat = Satisfaction and Dissatisfaction with Body Parts Scale; EC = Eating Concerns composite; BES = Binge Eating Scale; PANAS-NA = Positive and Negative Affect Scale, negative affect subscale

Table 5. Hypothesized mediators in bidirectional pathways

Criteria	B	SE B	β	t	Sig.
1. Effect of IV on mediator					
a. PANAS-NA → EC	1.21	0.17	.63	7.26	$p < .0001$
b. PANAS-NA → Body Sat					
2. Effect of IV on DV					
a., b. PANAS-NA → BES	4.80	1.12	.43	4.27	$p < .0001$
3. Effect of mediator on DV					
a. EC → BES	4.04	0.43	.72	9.50	$p < .0001$
b. Body Sat → BES	-3.47	0.27	-.52	-5.53	$p < .0001$
4. Effect of IV on DV with control for mediator					
	-0.67	1.06	-.06	-0.63	$p = .53$
a. PANAS-NA → BES	4.21	0.55	.76	7.63	$p < .0001★$
⎸EC					
b. PANAS-NA → BES	2.930	1.148	.260	2.553	$p = .013$
	-2.693	.680	-.403	-3.962	$p < .0001^{†}$
⎸Body Sat					

Note: ⎸ = controlling for; ★ = complete mediation; [†] = partial mediation; IV = independent variable; DV = dependent variable; Body Sat = Satisfaction and Dissatisfaction with Body Parts Scale; EC = Eating Concerns composite; BES = Binge Eating Scale; PANAS-NA = Positive and Negative Affect Scale, negative affect subscale

Figure 1. Dual-pathway model for the development of bulimia nervosa (Stice & Shaw, 2002)
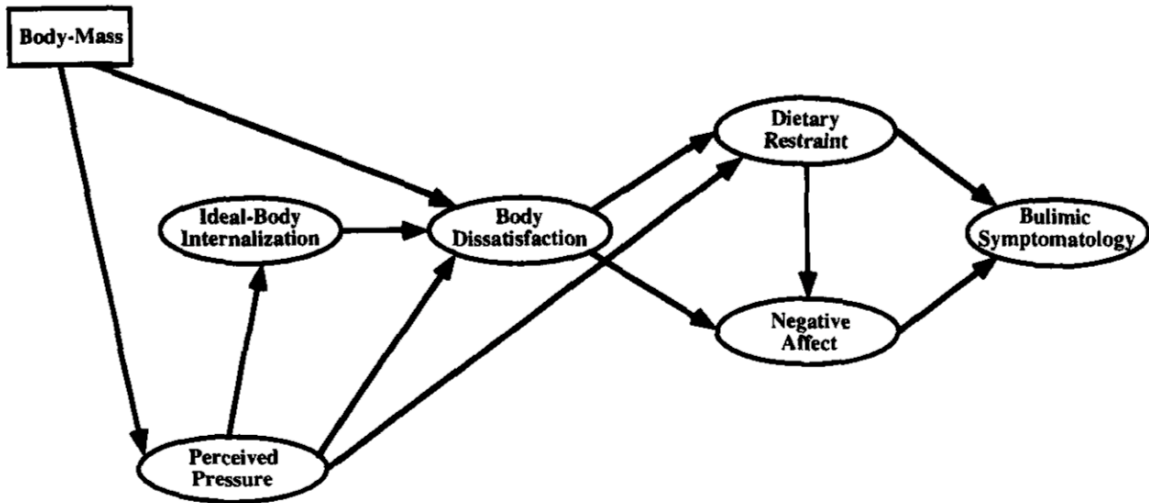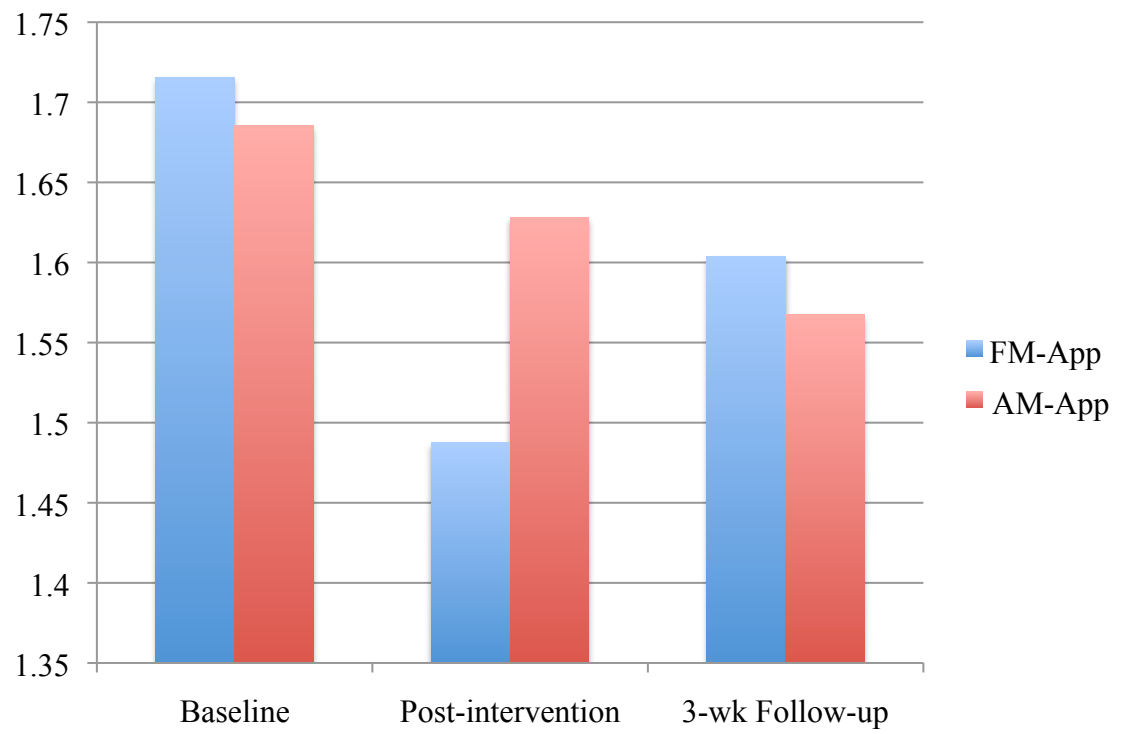
Figure 2. Negative Affect Means Over Time

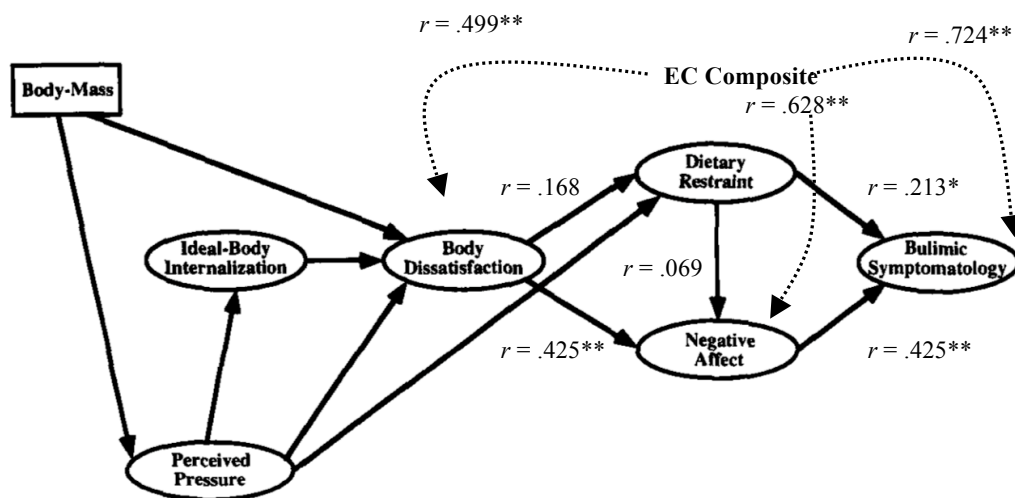Figure 3. Correlations Among Baseline Variables in the Dual Pathway Model

* p < .05; ** p < .01

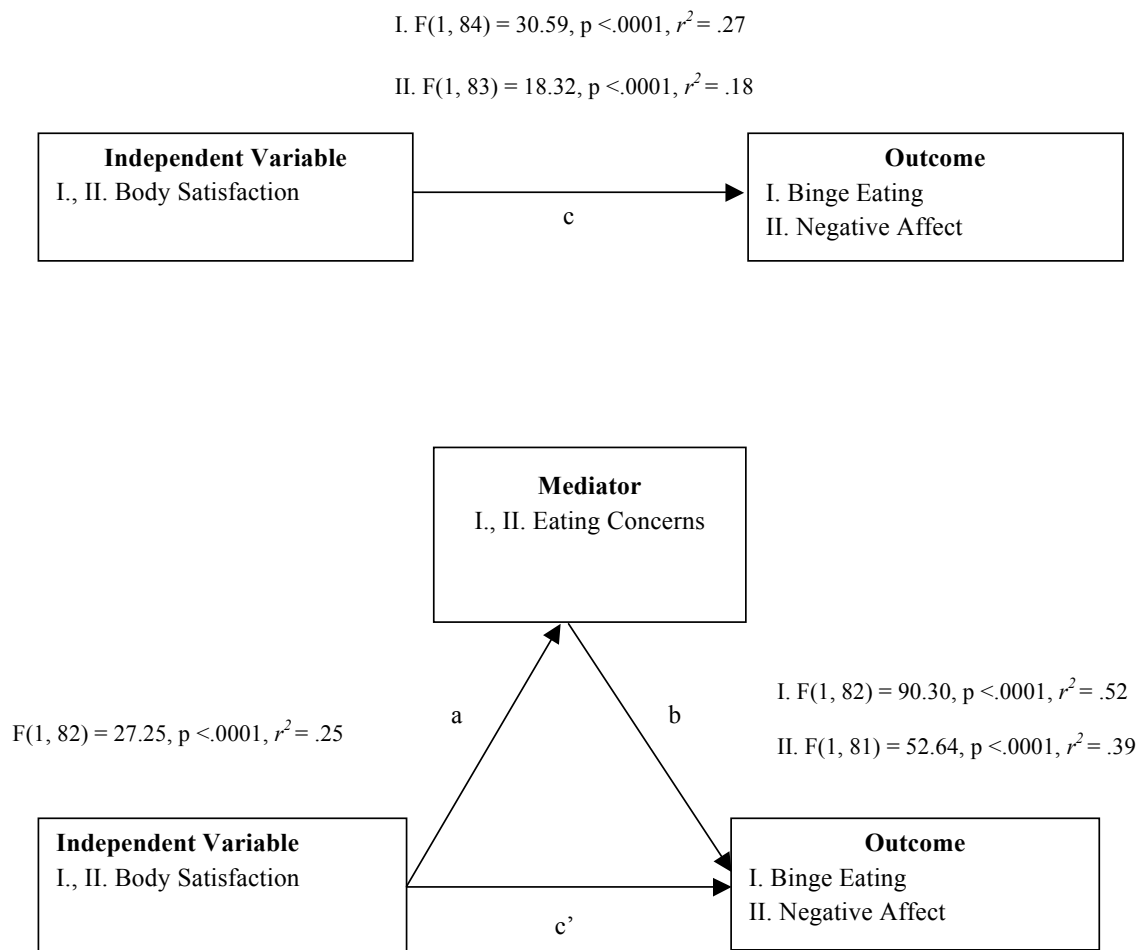Figure 4. Hypothesized Dieting Pathway (Sections I and II)

I. $F(1, 84) = 30.59$, $p < .0001$, $r^2 = .27$

II. $F(1, 83) = 18.32$, $p < .0001$, $r^2 = .18$

Figure 4. Hypothesized Dieting Pathway (Section III)

$F(1, 82) = 90.30, p < .0001, r^2 = .52$

| **Independent Variable**
III. Eating Concerns | → c → | **Outcome**
III. Binge Eating |

Mediator
III. Negative Affect

$F(1, 81) = 52.64, p < .0001, r^2 = .39$ $F(1, 83) = 18.26, p < .0001, r^2 = .18$

a   b

Independent Variable
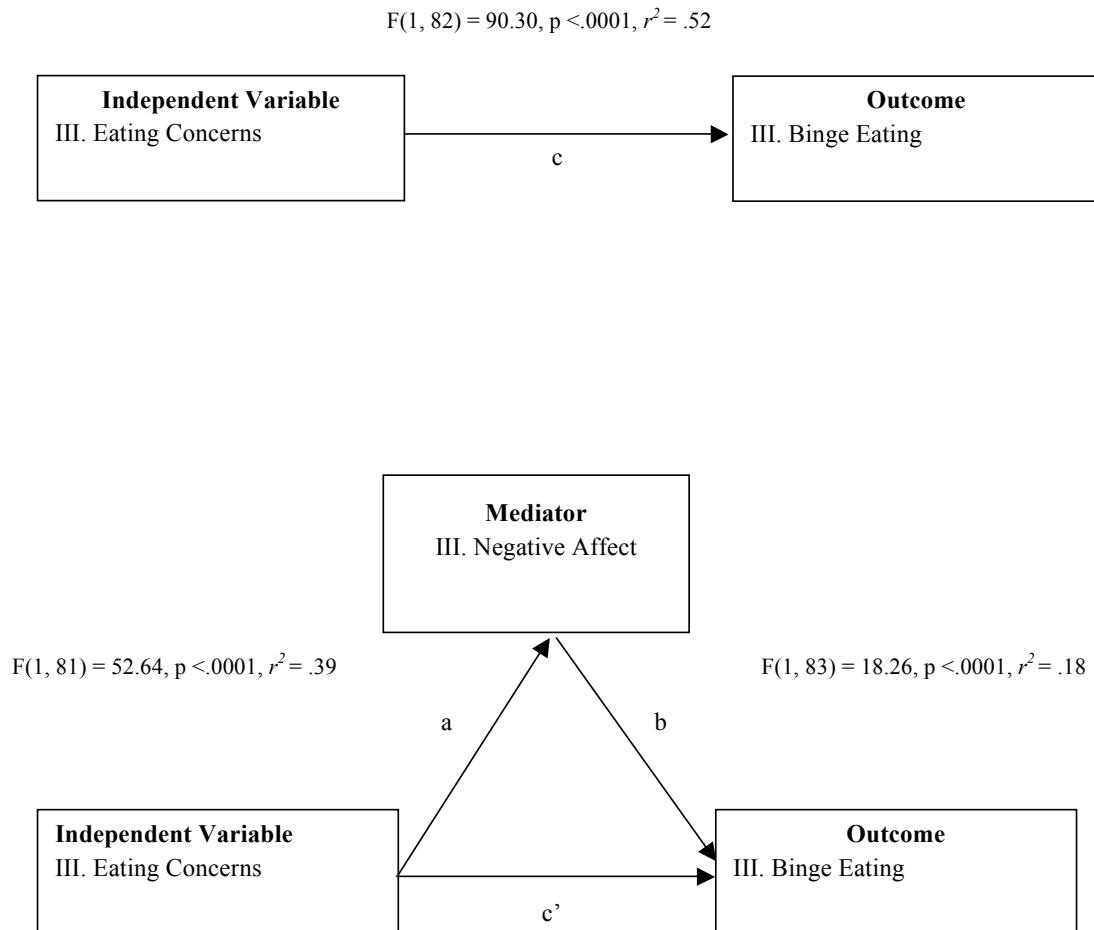III. Eating Concerns

c'

Outcome
III. Binge Eating

Figure 5. Hypothesized Negative Affect Pathway

$F(1, 84) = 30.59$, p $<.0001$, $r^2 = .27$

| **Independent Variable**
Body Satisfaction | → c → | **Outcome**
Binge Eating |

| | **Mediator**
Negative Affect | |

$F(1, 83) = 18.32$, p $<.0001$, $r^2 = .18$ a   b $F(1, 83) = 18.26$, p $<.0001$, $r^2 = .18$

| **Independent Variable**
Body Satisfaction | → c' → | **Outcome**
Binge Eating |