Food, Mood, and Attitude: Reducing Risk for Eating Disorders in College Women

Debra L. Franko  
Northeastern University and Harvard Eating Disorders Center

Laurie B. Mintz  
University of Missouri—Columbia

Mona Villapiano  
Massachusetts Eating Disorders Association and Inflexxion, Inc.

Traci Craig Green, Dana Mainelli, Lesley Folensbee, and Stephen F. Butler  
Inflexxion, Inc.

M. Meghan Davidson and Emily Hamilton  
University of Missouri—Columbia

Debbie Little and Maureen Kearns  
Northeastern University

Simon H. Budman  
Inflexxion, Inc.

Food, Mood, and Attitude (FMA) is a CD-ROM prevention program developed to decrease risk for eating disorders in college women. Female 1st-year students (N = 240) were randomly assigned to the intervention (FMA) or control group. Equal numbers of students at risk and of low risk for developing an eating disorder were assigned to each condition. Participants in the FMA condition improved on all measures relative to controls. Significant 3-way interactions (Time × Condition × Risk Status) were found on measures of internalization of sociocultural attitudes about thinness, shape concerns, and weight concerns, indicating that at-risk participants in the intervention group improved to a greater extent than did low-risk participants. At follow-up, significantly fewer women in the FMA group reported overeating and excessive exercise relative to controls.

Keywords: eating disorders, prevention, risk, college women, risk factors

Excessive dieting, unhealthy weight loss practices, and disordered eating behaviors occur frequently among college women and can adversely influence physiological, psychological, and behavioral functioning (Hill, 2002). Only a small percentage of college women (1%–3%) have diagnosable eating disorders, although many (estimated at 10%–30%) appear to be at risk for developing an eating disorder over the course of their college years. Mintz, O’Halloran, Mulholland, and Schneider (1997) found in a sample of 1st-year college women that 4% had eating disorders and 19% had some risk factors (e.g., chronic dieting, use of appetite control pills) for the development of diagnosable eating disorders. In a study of 1st-year college women, 15% of those deemed to be at risk (10% of the sample) in the fall semester moved into the probable bulimia category by the spring semester (Drewnowski, Yee, Kurth, & Krahm, 1994).

Attention has thus turned to the prevention of risk factors for eating disorders (Franko & Orosan-Weine, 1998). On the basis of a meta-analysis of 38 eating disorder prevention studies conducted in various populations (e.g., adolescents, college students), Stice and Shaw (2004) reported that 61% of prevention programs resulted in significant reductions in at least one risk factor, such as body dissatisfaction, and one third of programs led to either decreases in eating pathology or prevention of increases seen in controls. Nearly half (18 of 38) of these prevention studies were conducted with college students. By and large, the approach of these programs (e.g., Martz & Bazzini, 1999; Mutterperl & Sanderson, 2002; Nicolino, Martz, & Curtin, 2001) were either universal (i.e., prevention programs in which the goal is to strengthen protective factors in symptom-free individuals; see Mrazek & Haggerty, 1994) or selective (i.e., prevention programs in which
the goal is to modify risk factors; e.g., Bearman, Stice, & Chase, 2003; Celio et al., 2000; Franko, 1998; Stice & Ragan, 2002; Stice, Trost, & Chase, 2003). Across college-specific programs, those that were effective tended to be interactive and consisted of multiple sessions (Bearman et al., 2003; Kaminski & McNamara, 1996; Stice & Ragan, 2002; Winzelberg et al., 1998, 2000) rather than being a “one-shot deal” (Mann et al., 1997; Martz & Bazzini, 1999; Mutterperl & Sanderson, 2002; Nicolino et al., 2001). Moreover, college-specific programs that were selective in nature had larger effect sizes than universal programs. Overall, the effective programs resulted in some reduction in risk factors, suggesting that eating disorder prevention programs designed for college students may be useful, given substantial prevalence rates in this age group (Drewnowski et al., 1994; Heatherton, Mahamedi, Striepe, Field, & Keel, 1997).

A series of studies conducted by a Stanford research group offers promise in the use of multimedia to reduce risk factors for eating disorders in college women (Celio et al., 2000; Winzelberg et al., 1998; Zabinski, Celio, Willfley, & Taylor, 2003). Winzelberg and colleagues (1998, 2000) investigated an 8-week Internet-based program (Student Bodies) designed to reduce risk factors and found greater decreases in body dissatisfaction in the intervention group than in the control condition. Celio et al. (2000) examined the effects of the same program relative to an eating disorders course and a waiting list control group. Decreases in body dissatisfaction were found for the intervention group at posttest (though not at follow-up), and dieting was reduced at both time points. In a study using the same program with high-risk individuals, Zabinski et al. (2001) reported that both participants using the program and those in a control group improved over time (i.e., no significant difference between high-risk participants in the intervention group relative to the control group). Nevertheless, Zabinski et al. (2001) also reported effect sizes that suggested some positive impact of the intervention.

The findings and conclusions from previous studies were central in the design and testing of Food, Mood, and Attitude (FMA), a 2-hr CD-ROM program developed to reduce risk factors for eating disorders. First, as was done by the Stanford group, our intervention used multimedia technology. Such technology is considered a recent innovation in health education and prevention and is appealing because it is accessible to large groups, cost-effective, and less labor intensive than traditional leader-led programs (Budman, 2000). Moreover, multimedia technology has the distinct benefit of providing a multisensory experience and actively engaging participants. Indeed, this active engagement of participants (i.e., interactive nature) is in line with conclusions reached by Stice and Shaw (2004). Also, consistent with Stice and Shaw’s findings, FMA (a) was designed especially for college women, (b) was relatively short in duration, and (c) consisted of multiple components. Finally, the shorter time span of the program is in line with suggestions from the Stanford researchers (Winzelberg et al., 1998, 2000).

FMA also was designed for both low-risk and at-risk groups (both universal and selective prevention) as a logical next step on the basis of findings from the Stanford group, which included a high-risk group only (Zabinski et al., 2001). We specifically developed and tested FMA for suitability with participants deemed to be at risk for developing eating disorders, as well as those at low risk who might benefit from the information provided by increasing their knowledge about risk factors. In addition, on the basis of Zabinski et al.’s (2001) self-critique of how they defined participants as high-risk (i.e., having high body-image concerns), we sought to both define risk more specifically and empirically examine our categorization of risk.

The theoretical conceptualization of eating disorder risk that underlies the development of FMA is the dual pathway model proposed by Stice, Nemeroff, and Shaw (1996). Although several other theories exist (Smolak, Levine, & Gralen, 1993; Striegel-Moore, Silberstein, & Rodin, 1986; Vohs, Bardone, Joiner, Abramson, & Heatherton, 1999), the model by Stice et al. (1996) has been the one most scrutinized and tested in the empirical literature. This model conceptualizes risk of eating disorder pathology in the following way. Sociocultural pressure to be thin leads to internalization of the thin ideal. Because this ideal is largely unattainable, body dissatisfaction results, which in turn leads to dieting and negative affect. Both dieting and negative affect increase the risk of one developing eating disorder behaviors, particularly bulimic symptoms such as binge eating and compensatory behaviors. These five factors (perceived pressure to be thin, thin-ideal internalization, body dissatisfaction, dieting, and negative affect) have been found to predict bulimic symptom onset in a number of studies (Stice & Agras, 1999; Stice, Killen, Hayward, & Taylor, 1998; Stice, Presnell, & Spangler, 2002) and received support for increasing risk for eating disorder behaviors in a recent meta-analysis (Stice, 2002).

In addition to the focus on the dual-pathway model, FMA also incorporated relevant aspects of interpersonal/relational theory as well as cognitive–behavioral theory, both of which have been widely used by eating disorder researchers and clinicians (Stein et al., 2001). Interpersonal/relational theory acknowledges the role of interpersonal needs and concerns in the acquisition of high-risk behaviors. It has been found that efforts to be accepted by one’s peers and to feel that one is attractive to others are powerful motivators with regard to eating and dieting (e.g., Wilfley et al., 1993). Paxton, Schutz, Wertheim, and Muir (1999) found that adolescent girls who had friends who dieted were much more likely to engage in eating pathology, and Stice, Maxfield, & Wells (2003) recently reported that exposure to social pressure to be thin increased body dissatisfaction. In addition, theoretically relevant cognitive–behavioral constructs, such as cognitive restructuring and cognitive distortions, were included in the program design and activities on the basis of a large body of literature supporting the use of cognitive–behavioral therapy in treating eating disorders (Stein et al., 2001).

We also considered recent conceptualizations of prevention theory in the design of FMA. Specifically, three theoretical conceptualizations were used in the development of FMA (Levine & Piran, 2001). One, the disease-specific social cognition theory (Perry, 1999), which focuses on eliminating risk factors seen as specific to a disorder, informed the overall content of FMA. Programs that follow this model use various agents of social influence (e.g., peers) to transmit information, teach skills, and increase knowledge. Two, the nonspecific vulnerability stressor model (Cowen, 2000) was used in developing program content that was not specific to eating disorders but focused on more general factors such as self-esteem and coping skills that are known to be important for prevention of eating disorders. Finally, given the relatively recent introduction of prevention theory specific to eating disorders, we also drew from harm reduction, a conceptual approach used to prevent other intractable behaviors, including the
successful prevention of alcohol misuse on college campuses (Marlatt, 1995). Specifically, this approach provides information and objective feedback about the dysfunctional behavior and its consequences, places responsibility for change on the respondent, provides suggestions about ways to make changes and build self-efficacy, and teaches skills for specific behavior change (Miller et al., 1995). In short, in developing the content of FMA, we translated theoretical ideas (e.g., dual-pathway model, interpersonal theory, cognitive–behavioral theory, and prevention theories such as harm reduction) into the program components.

Hypotheses

The current study examined the efficacy of FMA with 1st-year college women on measures of (a) knowledge; (b) internalization and awareness of the sociocultural ideal; and (c) weight concerns, shape concerns, and restrained eating. For the latter two measures (Items b and c), we hypothesized a significant three-way interaction of Time × Condition (FMA vs. control) × Screening Status (at risk vs. low risk), such that at-risk women in the FMA condition would show the most positive change. We predicted that low-risk women in the FMA condition would not evidence any iatrogenic effects with respect to Items b and c but would report an increase in knowledge over time equal to that of the high-risk women in the FMA condition.

Method

Design and Screening Participants

This study involved two phases: (a) a screening phase to identify participants for the efficacy study on the basis of inclusion and exclusion criteria and (b) a randomized controlled clinical trial comparing the FMA program to an attention control condition. The study was approved by the Institutional Review Boards of Northeastern University, University of Missouri—Columbia, and Inflexion, Inc. Screening participants included 827 first-year female students at the two university sites.

Screening Measures

Demographic and follow-up contact questionnaire. All participants completed a short demographic questionnaire and a form requesting future contact information.

The Questionnaire for Eating Disorder Diagnoses (Q-EDD; Mintz et al., 1997). The Q-EDD is a reliable and valid self-report measure that can be used as both a diagnostic tool and a screening tool to assess those at risk for developing eating disorders on the basis of current behaviors. For clarity, an understanding of the scoring of the Q-EDD is necessary. Scoring for the Q-EDD yields categorical labels. At the most general level are the categories of eating disordered (diagnosis from the Diagnostic and Statistical Manual of Mental Disorders [4th ed.; DSM–IV; American Psychiatric Association, 1994]: anorexia nervosa [AN], bulimia nervosa [BN], and four types of eating disorders not otherwise specified [EDNOS]) and non-eating disordered (non-ED; no DSM–IV diagnosis). The non-eating disordered category comprises two categories: asymptomatic (no symptomatic behaviors and/or behavioral risk factors) and symptomatic (no diagnosable disorder, including no EDNOS disorder, but some transient or mild symptomatic behaviors and/or behavioral risk factors such as chronic dieting).

Evidence for the Q-EDD as a diagnostic tool comes from studies comparing Q-EDD diagnoses and those yielded by clinical interview. Mintz et al. (1997) reported predictive validity statistics for the ED versus non-ED diagnostic differentiation: false-negative rate = .03, false-positive rate = .02, sensitivity = .97, specificity = .98, positive predictive power = .94, and negative predictive power = .99. In addition, accuracy rates ranged from 69% to 97% for the differentiation between different ED diagnoses, including between AN, BN, and subthreshold (EDNOS) versions of these disorders. Such findings supported the use of the Q-EDD to screen out women with a diagnosable ED for the current prevention study.

Evidence for the Q-EDD as a screening tool for those at risk for EDs but not possessing diagnosable EDs comes from validity studies of the Q-EDD and from findings explicitly examining the Q-EDD symptomatic group. First, Mintz et al. (1997) reported a high overall accuracy rate of 90% (k = .82), indicating a high agreement between Q-EDD categorization and clinician assessment that a woman was at risk for an eating disorder, as opposed to having either a diagnosable disorder or no behavioral symptoms or risk factors. Second, because the Q-EDD categorizes symptomatic women mainly on the basis of symptomatic behaviors and/or behavioral risk factors, studies have investigated whether these women also possess attitudinal and cognitive risk factors, as would be expected. Tylka and Sabich (1999) reported that the symptomatic women (as defined by the Q-EDD) differed as would be expected from DSM–IV eating-disordered and asymptomatic women on a number of cognitive and attitudinal variables specified in risk models such as Stice et al.’s (1996), including internalization of the thin ideal, body dissatisfaction, and perceived pressure to be thin. Such findings support the use of the Q-EDD to categorize at-risk and low-risk women for the current prevention study. Nevertheless, as a precaution, we also tested differences in risk factors between our Q-EDD-defined at-risk and low-risk groups to verify expected group differences (see Results).

Screening Procedure

Trained research assistants (RAs) used advertisements to recruit women around campus, in residence halls, and in student centers in the fall of 2001. The flyers read “Participate in a study to evaluate computer and video programs for women on health, nutrition, and women’s issues” and provided contact information to sign up for the study. Recruitment aimed to include at least 25% minority students, so recruitment efforts focused on ensuring an adequate pool of eligible minority women. Volunteers who agreed to participate gave informed consent, including a statement that they may be contacted to participate in the second phase of the study. They then completed the demographic and follow-up contact questionnaire and the Q-EDD. Participants were paid $5 for participation in the screening phase of the project.

Screening measures were scored for inclusion and exclusion criteria to determine eligibility for the efficacy study. Inclusion criteria were (a) female, (b) first semester of university, (c) between 18 and 22 years of age, (d) willing to sign informed consent and undergo initial and follow-up assessments, and (e) identification by the screening measure as being either at risk or of low risk for developing eating disorders. At risk were those participants categorized by the Q-EDD as “symptomatic” (no diagnosable disorder, including no EDNOS disorder, but some transient or mild symptomatic behaviors and/or behavioral risk factors), and low risk was categorized by the Q-EDD as those who were asymptomatic (no symptomatic behaviors and/or behavioral risk factors). Exclusion criteria included (a) being currently in treatment with a diagnosis of any type of eating disorder or (b) identification by the Q-EDD as meeting criteria for an eating disorder diagnosis. If a student met either exclusion criterion, she was sent a letter informing her that she was not chosen for the study that included referrals for counseling services.

Efficacy Study Participants and Measures

The efficacy study was conducted with 240 first-year female students from two universities (northeastern and midwestern United States), who were chosen from the screening participants (see Efficacy Study Procedure). Participants were equally divided between the two campuses. Table 1 summarizes the characteristics of the study sample. Except as noted, the following measures were administered at baseline, postintervention, and 3-month follow-up.
Note. Values vary slightly because of missing data. FMA = Food, Mood, and Attitude program.

Knowledge test. We developed a questionnaire to test knowledge expected to be gained after exposure to FMA. An initial pool of questions based on information provided in FMA was given to 59 first-year college women. Any item answered correctly by less than 20% of the sample was submitted to eating disorder experts, who rated them for importance and content validity. The best items composed the final version, consisting of 20 multiple-choice items.

Sociocultural Attitudes Toward Appearance Questionnaire (SATAQ; Heinberg, Thompson, & Stormer, 1995). This 14-item questionnaire includes two subscales: an Awareness subscale, measuring recognition of the societal influence on attitudes toward appearance, and an Internalization subscale, measuring acceptance or endorsement of those societal standards. Internalization of the thin-ideal standard has been shown across multiple studies to be a risk factor for eating disorders (Streigel-Moore & Cachelin, 2001) and is one of the five risk factors in the guiding model of risk that we used in the development of FMA (Stice et al., 1996). Acceptable internal consistency has been demonstrated for female undergraduates (.71 for Awareness and .88 for Internalization; Heinberg et al., 1995). Evidence for convergent validity has been demonstrated by significant correlations between both subscales and various measures of body image and eating disturbances (Heinberg et al., 1995).

Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994; Fairburn & Cooper, 1993). This questionnaire has 36 questions and four subscales (Shape Concerns, Weight Concerns, Restraint, and Eating Concerns), which assess cognitions, attitudes, and behaviors associated with eating disorder symptomatology and which are commonly used in efficacy studies of eating disorder prevention, including in studies evaluating other multimedia interventions (e.g., Zabinski et al., 2001). Respondents indicate whether the item has been true over the previous 28 days. The current study used the Shape Concerns, Weight Concerns, and Restraint subscales. The Eating Concern subscale was not included, as Fairburn and Beglin (1994) do not deem this a key subscale. A global score of the three subscales is also reported, following the scoring suggested by Fairburn and Beglin (1994). In addition, the EDE-Q behavioral items that correspond well with the symptoms of AN and BN were examined, including episodes of binge eating, episodes of overeating, use of compensatory behaviors (vomiting, laxatives, diuretics), and excessive exercise. Respondents answered these items using a yes/no format. We decided against creating a composite score of these behavioral items on the basis of their poor intercorrelations which, at baseline, ranged from a mere .16 to .26. The EDE-Q has good psychometric properties (Cronbach’s alpha ranged from .67 to .90; Luce & Crowther, 1999) and corresponds well with the EDE-Interview (Fairburn & Beglin, 1994). Because of the time frame of the EDE-Q (past 28 days), the EDE-Q was administered only at baseline and the 3-month follow-up.

Program satisfaction. Participants also answered a brief satisfaction questionnaire, developed by the research team, after completion of the program. This 28-item questionnaire asked participants to respond on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree) to a series of questions that centered on program design and content, relevance, usefulness, and overall satisfaction.

Efficacy Study Procedure

Of the 827 students who completed the screening measure, 110 (13.3%) women were screened out of the possible study sample (see Figure 1). Of these, 107 (12.9%) women had scores on the Q-EDD suggesting the presence of an eating disorder, and an additional 3 students indicated they were in treatment for an eating disorder but did not currently score as eating disordered on the Q-EDD. We stratified the 717 eligible women into at risk (n = 288) and low risk (n = 429) groups, and we then divided them into the following groups on the basis of Q-EDD categorization and ethnicity: low-risk nonminority, at-risk nonminority, low-risk minority, and at-risk minority. We then randomly selected those to be called for participation in the study, so that 75% were from the two nonminority groups, and 25% were from the two ethnic minority groups. After participants were selected across the four groups, we randomized them to condition (FMA or control) using a computerized urn randomization program. After stratified randomization, we divided the sample into the 25% from each ethnic minority group into the following groups on the basis of Q-EDD categorization and ethnicity: low-risk nonminority, at-risk nonminority, low-risk minority, and at-risk minority. We then randomly selected those to be called for participation in the study, so that 75% were from the two nonminority groups, and 25% were from the two ethnic minority groups. After participants were selected across the four groups, they were randomized to condition (FMA or control) using a computerized urn randomization program. After stratified randomization, we divided the sample into the 25% from each ethnic minority group into the following groups on the basis of Q-EDD categorization and ethnicity: low-risk nonminority, at-risk nonminority, low-risk minority, and at-risk minority. We then randomly selected those to be called for participation in the study, so that 75% were from the two nonminority groups, and 25% were from the two ethnic minority groups. After participants were selected across the four groups, they were randomized to condition (FMA or control) using a computerized urn randomization program.
participants were paid $20 after completion of the first session. The second session was scheduled for 1–2 weeks later, during which participants completed the 2nd hour of FMA or watched an additional two 30-min videos. After the second session, in which they completed FMA or watched two videos, all participants were administered the postintervention assessment battery and were paid $40. One week before the 3-month follow-up date, participants were mailed a packet containing the study measures and were paid $65 after the packet was returned. The study concluded in summer 2002.

**Intervention**

**Development of FMA.** FMA was developed by use of a two-step process. First, the following 2-hr focus groups were conducted: five with 44 undergraduate women from four universities; two with 9 undergraduate men from two universities; four with 34 staff members from four university health and student services, and one with 10 experts in the field of eating disorders. In the focus groups, participants were asked to discuss typical eating patterns and diet-related concerns of college women as well as their understanding of what constitutes a problematic eating habit. Participants were also presented with ideas for various components of FMA to get their opinions on design and structure. Finally, group members wrote down 10 questions that they thought would be important for the program to answer. After these data were collected, the results were discussed, and relevant literature was reviewed in weekly meetings that included all coauthors; program content and design was developed over the course of a year.

**Figure 1.** Flowchart based on Consolidation Standards of Reporting Trials (CONSORT) guidelines (Moher, Schulz, & Altman, 2001). Q-EDD = Questionnaire for Eating Disorder Diagnoses.
As noted earlier, the design of FMA was based on the dual-pathway model (Stice et al., 1996), cognitive-behavioral theory, interpersonal/relational theory, and other theories of prevention. For each of the five risk factors outlined in Stice et al.’s (1996) model, specific program components were designed to provide both information and an interactive experience centered on learning about and reflecting on that risk factor. In addition, program components that addressed interpersonal issues (e.g., family, peers) and cognitive behavior strategies (e.g., recognizing errors in thinking) were included throughout the program. Finally, relevant prevention theory topics were incorporated throughout the program, including reducing risk factors, increasing coping skills, and examination of consequences for harm reduction.

Description of FMA. At the start of the program, the user is asked to serve as a “peer counselor” to assist the virtual university in addressing the problem of disordered eating on campus. The peer counselor (the research participant) then meets “Jen,” who is thin and has some medical issues related to her body weight. She also is introduced to “Kate,” an athlete who overeats and overexercises, and “Naomi,” who is depressed and lonely and binges. It is important to note that the user does not see what these three women look like until the very end of the program, so that the possibility that the user would be influenced by their appearance is eliminated. Each of the three young women portrayed in the program has kept a “scrapbook” of information that covers various aspects of her life at college. Each scrapbook entry provides psychoeducational information and interactive tools to educate and develop participants’ skills in each of the five theoretically based risk factor areas and theoretically relevant topics (see Appendix).

In using FMA, participants must explore each aspect of all three scrapbooks (i.e., one for each woman portrayed in the program). The programming of the CD-ROM is such that a participant cannot “skip” content; she must complete each module before she is allowed to go on to the next. The presence of the RA in the room ensured that the participant was in fact in the program. Each of the three young women portrayed in the program has kept a “scrapbook” of information that covers various aspects of her life at college. Each scrapbook entry provides psychoeducational information and interactive tools to educate and develop participants’ skills in each of the five theoretically based risk factor areas and theoretically relevant topics (see Appendix).

At the start of the program, the user is asked to provide feedback and treatment suggestions (via a multiple-choice format) to each of the three hypothetical students in the program.

Data Analysis

We conducted preliminary analyses to assess the effects of potential moderators of outcome—including campus, age, ethnicity, marital status, socioeconomic status, athletic experience, and academic major (or expected major)—using a conservative Type I error of 0.10 to identify possible covariates. Preliminary analyses to verify that our at-risk and low-risk groups differed as expected were also conducted.

To examine our hypothesis predicting a significant three-way interaction of Time × Condition × Screening Status, we used a repeated measures analysis of variance (ANOVA) in an intent-to-treat design. The initial analysis conducted was an overall repeated measures ANOVA with two factors (condition and risk status at screening) at two levels (FMA vs. control and at risk vs. low risk of developing an eating disorder). Where our hypothesis was confirmed (i.e., a significant three-way interaction was detected), we then conducted separate repeated measures ANOVAs for each risk group. In all analyses, baseline levels of outcome measures were controlled.

Tests of significance were two-sided and performed at the α = .05 level. As an estimate of effect size in the repeated measures analysis, we present the partial eta squared (partial $\eta^2$), which describes the proportion of variance accounted for in the sample by a given factor for all significant interactions.

In addition to the analyses we conducted to examine our main hypothesis, we used exploratory multiple logistic regression analyses to examine group differences in the occurrence of problematic eating behaviors (dichotomously coded as present or not present), controlling for reported baseline behaviors. Because not all women reported problematic eating behaviors at baseline, this remained an exploratory analysis to verify that behaviors did not increase with the intervention. Note, because of the paucity of data on purging behaviors (e.g., vomiting, laxatives, diuretics), these categories were combined for analyses. However, these behaviors were infrequent, creating wide confidence intervals. Odds ratios (OR), 95% confidence intervals (95% CI) and $p$ values express these multivariate relationships.

Results

Baseline Characteristics

Demographic characteristics of the efficacy study participants can be found in Table 1. Bivariate analyses revealed no differences in the study samples from the two university sites. All primary outcome baseline measurements were similar between the experimental and control groups.
Comparing the sociodemographics of at-risk participants with that of low-risk study participants, two otherwise indistinguishable groups emerged. The at-risk and low-risk women were of similar age, body mass index, race, and income. They participated in athletics in an equivalent fashion and were represented equally at both universities. Their baseline knowledge of disordered eating also was comparable. However, all other baseline outcome measures were significantly different from one another (p < .005). At-risk women were differentiated from their low-risk peers by their greater recognition and internalization of societal influence on attitudes toward their appearance, more restrained eating tendencies, greater concerns about their weight and shape, and more frequent disordered eating behaviors, including excessive eating, exercising, and purging. The observed differences justify our risk-specific study design and analyses.

**Hypothesis 1a: Knowledge**

Tables 2 and 3 display the means and standard deviations for the intervention and control groups by risk status at each assessment. Repeated measures ANOVA revealed statistically significant gains in knowledge for the FMA group over time relative to the control group, \( F(1, 227) = 22.27, p < .001 \), partial \( \eta^2 = .09 \). The two-way interaction of knowledge by screening status was also significant, \( F(1, 227) = 4.40, p = .037 \); linear, partial \( \eta^2 = .02 \), suggesting that at-risk women (regardless of condition) increased their knowledge more over the study period than did low-risk women. No three-way interaction (i.e., Time \( \times \) Condition \( \times \) Risk Status) was observed, because of lack of differences at Baseline \( \times \) Risk Status.

**Hypothesis 1b: Awareness and Internalization of the Sociocultural Ideal**

On both subscales of the SATAQ (Awareness and Internalization), the FMA group showed greater improvements than did the control group, \( F(1, 223) = 4.67, p = .032 \), partial \( \eta^2 = .02 \) for Awareness; \( F(1, 218) = 10.02, p = .002 \), partial \( \eta^2 = .04 \) for Internalization. On the Internalization subscale, a significant three-way interaction (Time \( \times \) Condition \( \times \) Risk Status) revealed that at-risk women who used FMA experienced the most change, \( F(1, 218) = 4.54, p = .034 \), whereas at-risk women in the control group experienced no significant change on the Internalization subscale. In contrast, the three-way interaction of the Awareness Subscale \( \times \) Condition \( \times \) Risk Status was not significant.

**Hypothesis 1c: Weight Concerns, Shape Concerns, and Restraint**

Looking at the change in EDE-Q subscales between the two observations from baseline to follow up, significant three-way interactions were found for the Shape Concerns, \( F(1, 227) = 5.01, p = .03 \), and Weight Concerns subscales, \( F(1, 227) = 6.64, p = .01 \), again indicating that the at-risk FMA group improved relative to the at-risk control group. A general trend to decrease restrained eating behaviors, as evidenced by scores on the EDE-Q Restraint subscale, was observed over the study period. Nevertheless, reductions were similar in both conditions and both risk groups (i.e., no two- or three-way interactions were found). For the EDE global score, a significant three-way interaction was detected, \( F(1, 227) = 6.09, p = .01 \), suggesting that the at-risk FMA group reduced the overall severity of the eating disorder psychopathology in comparison with their at-risk control group counterparts.

A general pattern of the significant three-way interactions can be detected in Figures 2A, 2B, and 2C. These figures visually depict our initial observations that the at-risk and low-risk women represent very different groups with respect to these variables. In addition, women in the low-risk groups did not evidence significant change on these variables. Rather, the change that does occur is evident in the FMA at-risk group only.

**Exploring the Significant Three-Way Interactions by Risk Status**

Where significant three-way interactions in our repeated measures ANOVA were detected (i.e., SATAQ Internalization,

---

### Table 2

**Means and Standard Deviations for the Knowledge and Attitudes Measures, by Condition and Risk Status at Screening**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Baseline</th>
<th>Post-intervention</th>
<th>Follow-up</th>
<th>Baseline</th>
<th>Post-intervention</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>7.8</td>
<td>2.3</td>
<td>10.3</td>
<td>2.6</td>
<td>9.7</td>
<td>2.7*</td>
</tr>
<tr>
<td>At risk (n = 112)</td>
<td>7.8</td>
<td>2.7</td>
<td>10.6</td>
<td>2.8</td>
<td>10.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Low risk (n = 119)</td>
<td>7.7</td>
<td>2.1</td>
<td>10.0</td>
<td>2.6</td>
<td>9.3</td>
<td>2.5</td>
</tr>
<tr>
<td>SATAQ: Awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>20.5</td>
<td>3.8</td>
<td>20.4</td>
<td>3.8</td>
<td>21.3</td>
<td>3.5*</td>
</tr>
<tr>
<td>At risk</td>
<td>21.7</td>
<td>3.7</td>
<td>21.5</td>
<td>3.8</td>
<td>22.1</td>
<td>3.6</td>
</tr>
<tr>
<td>Low risk</td>
<td>19.5</td>
<td>3.9</td>
<td>19.4</td>
<td>3.3</td>
<td>20.6</td>
<td>3.2</td>
</tr>
<tr>
<td>SATAQ: Internalization†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>26.0</td>
<td>7.8</td>
<td>25.0</td>
<td>8.6</td>
<td>24.7</td>
<td>8.8*</td>
</tr>
<tr>
<td>At risk</td>
<td>28.9</td>
<td>7.2</td>
<td>27.9</td>
<td>8.4</td>
<td>26.1</td>
<td>8.7</td>
</tr>
<tr>
<td>Low risk</td>
<td>23.7</td>
<td>7.7</td>
<td>22.8</td>
<td>8.0</td>
<td>23.6</td>
<td>8.8</td>
</tr>
</tbody>
</table>

*Note. FMA = Food, Mood, and Attitude program; SATAQ = Sociocultural Attitudes Toward Appearance Questionnaire.

* p < .05 (two-way interaction, Time \( \times \) Condition).
† p < .05 (three-way interaction, Time \( \times \) Condition \( \times \) Screening Status).
Table 3
Means and Standard Deviations on the Eating Disorder Examination Questionnaire (EDE-Q) Subscales, by Condition and Risk Status at Screening

<table>
<thead>
<tr>
<th>Outcome</th>
<th>FMA group (n = 116)</th>
<th>Control group (n = 115)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Follow-up</td>
<td>Baseline Follow-up</td>
</tr>
<tr>
<td></td>
<td>M    SD M    SD</td>
<td>M    SD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EDE-Q: Shape Concerns†</th>
<th>All</th>
<th>At risk (n = 112)</th>
<th>Low risk (n = 119)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.7 1.5</td>
<td>2.3* 1.5</td>
<td>2.7 1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EDE-Q: Weight Concerns†</th>
<th>All</th>
<th>At risk</th>
<th>Low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.4 1.4</td>
<td>2.1* 1.4</td>
<td>2.4 1.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EDE-Q: Restraint</th>
<th>All</th>
<th>At risk</th>
<th>Low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.9 1.4</td>
<td>1.6 1.4</td>
<td>1.8 1.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EDE-Q: Global score†</th>
<th>All</th>
<th>At risk</th>
<th>Low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.3 1.4</td>
<td>2.3 1.3</td>
<td>2.3 1.4</td>
</tr>
</tbody>
</table>

Note. FMA = Food, Mood, and Attitude program.
† p < .05 (two-way interaction, Time × Condition).
* p < .05 (three-way interaction, Time × Condition × Screening Status).

EDE-Q Shape Concerns, EDE-Q Weight Concerns, EDE-Q global), we conducted separate repeated measures ANOVAs for the two risk groups. Table 4 presents these outcomes in the two separate analyses (one for at-risk women and one for low-risk women).

For the at-risk women, FMA produced significant change on the Internalization subscale, \( F(1, 105) = 13.25, p < .001 \). As Figure 2A depicts, the partial \( \eta^2 \) effect sizes (see Table 4) underscore, the women at risk for disordered eating who used FMA experienced a strong decrease in the internalization of negative social and cultural attitudes toward appearances, whereas at-risk women in the control group experienced no change in their internalization of these negative attitudes. Likewise, attitudes captured by the EDE-Q (Shape Concerns and Weight Concerns) also decreased among the at-risk women who used FMA. Shape Concerns among FMA participants decreased more over time than among their counterparts in the control group, \( F(1, 110) = 7.05, p = .01 \), as did Weight Concerns among the same FMA at-risk women, \( F(1, 110) = 5.70, p = .02 \).

Turning to the separate analyses for the low-risk women, as can be seen in Table 4, no condition-related differences in scores were evident for the SATAQ Internalization subscale (i.e., no deterioration of scores or increased internalization occurred, regardless of condition). Likewise, neither the EDE-Q Shape Concerns and Weight Concerns subscales nor the global score increased over time for low-risk women in the FMA or control conditions. In addition, all of the effect sizes that tested for iatrogenic effects (as estimated by partial eta squared values) were equal to or less than .01.

Exploratory Analysis of Disordered Eating Behaviors

In an exploratory analysis, we examined several behavioral items from the diagnostic items on the EDE-Q as a measure of disordered eating behaviors. The following analyses compared the intervention group with the control group, without regard to risk status, because there were too few women in each risk group who reported these behaviors (a natural consequence of screening out women with diagnosable eating disorders). A multiple logistic regression analysis taking their baseline behavior into account indicated that women in the experimental group were more likely to decrease their use of excessive purging methods (i.e., any use of vomiting, laxative, diuretics; OR = .27, 95% CI = 0.08–0.87, \( p = .03 \)) at follow-up, compared with the controls. This effect of FMA was also detected in the decline in reported overeating at follow-up (OR = .33, 95% CI = 0.14–0.79, \( p = .01 \)). Finally, a trend of decreasing excessive exercise behaviors favored FMA participation (OR = .60, 95% CI = 0.33–1.10, \( p = .098 \)).

Program Evaluation

The satisfaction survey conducted among students using FMA revealed extremely high ratings for overall satisfaction: 97% of students were “very satisfied” to “extremely satisfied” with the program. Most students found FMA to be an effective resource for education on disordered eating (90%); 82% found FMA useful for getting information if they were concerned about a friend’s dieting behaviors; and 89% believed that other college women would find FMA useful. Compared with the typical ways of educating students about eating disorders, 82% found the FMA program more effective.

Discussion

Consistent with our hypothesis, both at-risk and low-risk participants in the FMA group increased their knowledge relative to participants in the control group. Further, as predicted, significant three-way interactions were found for measures of internalization.
Figure 2. Graphical displays of significant three-way interactions from the overall analysis: Sociocultural Attitudes Toward Appearance Questionnaire (SATAQ) Internalization subscale (A), Eating Disorder Examination Questionnaire (EDE-Q) Shape Concerns subscale (B), and EDE-Q Weight Concerns subscale (C).
of the sociocultural ideal, shape concerns, and weight concerns. For the measures awareness of sociocultural ideals and restraint, the interaction of Time × Condition × Risk Status was not significant. Instead, we found that relative to the control condition, FMA positively affected awareness in 1st-year college women without regard to risk status. Although restrained eating behaviors were unexpectedly unaffected by FMA, exploratory analyses of reported overeating, excessive exercise, and purging behaviors at follow-up suggested that FMA had a positive effect with regard to these behaviors.

Results suggest that FMA may be safe and effective for both at-risk and low-risk college women. Programs that address both groups were recently recommended by Abascal, Brown, Winzelberg, Dev, and Taylor (2004). More specifically, for the at-risk group, internalization of sociocultural attitudes about thinness, as well as shape concerns, weight concerns, and the global score of the EDE were positively affected by the intervention. In other words, these risk factors for the development for eating disorders were minimized in an at-risk group exposed to FMA. In addition, as expected, women of low risk exposed to the FMA program, already presumably evidencing positive attitudes and behaviors, did not change on these variables; however, they—and their at-risk counterparts—did acquire greater knowledge about risk factors than did women in the control group. This result emphasizes that FMA can serve as a safe, educative prevention tool for women at low risk of developing eating disorders without inducing iatrogenic effects. The combination of both universal and selective prevention in a single program suggests that FMA can be used across a wide range of risk profiles and has applicability in a variety of settings.

Our findings regarding increased knowledge and greater awareness in the FMA group, relative to control participants, are worth further discussion. In this efficacy study, both at-risk and low-risk participants in the intervention group increased their knowledge over the course of the study, suggesting that regardless of risk status, participants learned about risk factors for eating disorders when using FMA. Similarly, regardless of risk status, awareness of sociocultural ideals about thinness increased in the FMA condition. These findings can be considered positive in terms of the preventative effect of FMA. Specifically, research has shown that augmenting knowledge and awareness can increase readiness to change for a variety of health-related behaviors (McComnaughy, Prochaska, & Velicer, 1983; Molaison, 2002), and thus, such increased knowledge could benefit both at-risk college women who have not yet pursued treatment (Geller, 2002) as well as low-risk women who simply want to know more about eating disorder risk.

Our research appears to be the first prevention study to find positive intervention effects without the benefit of a leader or facilitator. Previous work either has involved facilitation (Franko, 1998; Neumark-Sztainer, Butler, & Palti, 1995; Paxton, 1993; Steiner-Adair et al., 2002) or has used a facilitated multimedia format (Winzelberg et al., 1998, 2000). As a stand-alone program, FMA is less resource intensive and potentially more cost-effective. FMA also may be of interest to students who may not be ready to seek help (e.g., go for counseling, join a chat room) because the program can be completed independently and anonymously. In this way, FMA might be a useful tool for counseling centers or campus health services or even as part of an orientation tool kit, in which students could use the program in a confidential manner without assistance. Furthermore, because the program is not Internet based, privacy issues are less problematic (i.e., the data are not available on an accessible server).

There are both strengths and limitations to this study. Strengths include the relatively large sample, low attrition rate, the ease of use and short completion time of the program, and the clearly defined risk categories. An additional strength was that participants came from geographically diverse groups, with no site differences found on any of the baseline or outcome measures, suggesting that the program has some generalizability across different areas of the United States. In addition, our 27% minority sample is one of the largest in prevention studies to date. We also had a high recruitment and completion rate, likely related to the compensation received by participants. Finally, we used an attention control group to control for the effect of participation. Nevertheless, this attention control group had its limits in that it did not allow us to rule out demand characteristics or expectancy effects as alternative explanations for the intervention effects. Indeed, because only the intervention participants received any content about eating disorders, they may have experienced implicit pressure to report decreases in eating disorder attitudes and behaviors that the control group did not experience. Additional limitations include the self-report nature of the data and the relatively short follow-up period. Also, the relatively higher number of women screened out by the Q-EDD as having an ED than would be expected on the basis of epidemiological studies may have been a function of selection bias; those with eating disorders may have been more likely to choose to participate in the screening phase of the study on the basis of its advertised content area (i.e., women’s health issues).

Future studies are needed to determine whether gains can be sustained over a longer period and whether FMA is superior when compared with other prevention programs. Additional research will be useful in determining which components of FMA were most likely to be related to outcome and whether FMA prevents the onset of clinical eating disorders over time. It would be of interest to combine this program with some face-to-face interaction, either with professionals or with peers, or to add booster sessions to see whether the obtained program effects might be enhanced. Finally, the efficacy of this program for specific populations (e.g., athletes, advanced college students) remains to be examined.

Table 4
Estimates of Effect for Food, Mood, and Attitude by Risk Status Group for Outcomes

<table>
<thead>
<tr>
<th>Group</th>
<th>$F$</th>
<th>$p$</th>
<th>Partial $\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>At risk ($n = 112$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SATAQ: Internalization</td>
<td>13.25</td>
<td>&lt; .001</td>
<td>.11</td>
</tr>
<tr>
<td>EDE-Q: Shape Concerns</td>
<td>7.05</td>
<td>.01</td>
<td>.06</td>
</tr>
<tr>
<td>EDE-Q: Weight Concerns</td>
<td>5.70</td>
<td>.02</td>
<td>.05</td>
</tr>
<tr>
<td>EDE-Q: Global score</td>
<td>8.24</td>
<td>.005</td>
<td>.07</td>
</tr>
<tr>
<td>Low risk ($n = 119$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SATAQ: Internalization</td>
<td>0.57</td>
<td>.45</td>
<td>.005</td>
</tr>
<tr>
<td>EDE-Q: Shape Concerns</td>
<td>0.09</td>
<td>.76</td>
<td>.001</td>
</tr>
<tr>
<td>EDE-Q: Weight Concerns</td>
<td>1.44</td>
<td>.23</td>
<td>.012</td>
</tr>
<tr>
<td>EDE-Q: Global score</td>
<td>0.26</td>
<td>.61</td>
<td>.002</td>
</tr>
</tbody>
</table>

Note. SATAQ = Sociocultural Attitudes Toward Appearance Questionnaire; EDE-Q = Eating Disorder Examination Questionnaire.
In conclusion, FMA appears to be a brief and effective multimedia program for both at-risk and low-risk college women. FMA is likely to have wide applicability on university campuses in the efforts to stem the tide of increasing numbers of eating disorders in the college population.

References


### Appendix

**Components of Food, Mood, and Attitude CD**

<table>
<thead>
<tr>
<th>Jen</th>
<th>Kate</th>
<th>Naomi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time with boyfriend vs. friends&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Social interaction at meals&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Eating alone in cafeteria&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Get skinny before spring break&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Alcohol and food&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Missing friends from home&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Eating alone&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Aggressive vs. assertive with peers&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Not fitting in&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Feeling guilty about food&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Perfectionism quiz&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Friends who are like you&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Under/overeating with stress&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Cognitive distortions&lt;sup&gt;b&lt;/sup&gt;</td>
<td>A body different from media&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Eating in secret&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Ways of thinking&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Talking/lunch with Mom&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Perfectionism&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Parent pressure to do well&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Disappointed about part&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mom critical about weight&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Stress related to roommates&lt;sup&gt;b&lt;/sup&gt;</td>
<td>What do guys like?&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Emotional eating&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Traumatic/stressful events&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Dos and don’ts about body&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Food and mood diary&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Different types of identity&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Expectations of family&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Learning eating triggers&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Ballet dancer—death due to eating disorder&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Stressed in new situations&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Identity uncertainty&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Choose meals—get nutrient info&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Exercise if hurt&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dealing with stress&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td>Fitting in&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Recognizing emotions&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Stress meter—past 12 months&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>Stress to stress&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Talking directly to others&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>Personality type—Type A&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Food tray&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>Body is different than ideal&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bone health&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td>Power foods&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Media images 1890–1999&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>Freshman 15&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Altering bodies&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>Complications of eating disorder&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dieting/set point&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Addresses one of five risk factors (pressure to be thin, thin ideal internalization, body dissatisfaction, dieting, negative affect, or interpersonal/cognitive—behavioral theories.  
<sup>b</sup> Addresses theories of prevention (e.g., disease specific, nonspecific stress, harm reduction).