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Abstract

Negative effects of restrained eating (i.e. concerns about dieting and weight control) have been observed in eating behaviors. Such findings underscore the need to develop more positive approaches to promote healthy eating behaviors. The objectives of this pilot randomized controlled trial were to investigate and determine whether sensory-based intervention influenced eating-related attitudes and behaviors among restrained women, as well as reliance on physical signals for hunger and satiety. Between January and September 2011, data were collected using validated questionnaires (Restraint Scale, Three-Factor Eating Questionnaire [TFEQ], Mindful Eating Questionnaire [MEQ] and Intuitive Eating Scale [IES]) at baseline (T=1), the end of the intervention period (T=2), and 12 weeks post-intervention (T=3). At T=1, women (n=50) from Quebec City, Canada were randomly assigned to an intervention group (sensory-based intervention) or a waiting list control group. Statistical analyses were conducted using mixed models, including the group, time, and group-by-time interaction. Women from the intervention group showed a significant decrease in TFEQ–Disinhibition and a significant increase in MEQ–Disinhibition at T=2 versus T=3 (p=0.02 and p=0.02, respectively) and at T=3 versus T=1 (p=0.003 and p=0.002, respectively). Women from the intervention group also showed a significant increase in IES–Unconditional permission to eat at T=2 versus T=1 (p<0.0001) and at T=3 versus T=1 (p<0.0001). These preliminary data suggest that sensory-based intervention may be a promising approach to improve eating-related attitudes and behaviors among restrained women, without exacerbating other behaviors such as restrained eating.

Introduction

In recent decades, the prevalence of obesity worldwide has increased[1] and excess weight has been identified as a risk factor for chronic diseases[2]. Current recommended weight control strategies focus mainly on energy-restricted diets and increased physical activity[3], as these strategies have proven short term effects in achieving clinical weight loss of 5% to 10% from initial weight[4,5]. However, a majority of individuals do not maintain weight loss over time[6], and many well-intentioned weight-loss interventions seem to disrupt hunger and satiety signals[7]. Restrained eating (i.e. concerns about dieting and weight control) may compromise the ability to maintain weight loss by triggering obsessive thoughts about food and eating[8], cravings and overeating episodes[9], and perceptions of deprivation and preoccupation with food[10-13]. The current idealization of thinness among women has led to an increase in the number of dieters as a result of which dieting is more prevalent among women than men[14,15]. It is therefore important to identify new healthy eating strategies that use a positive approach rather than a restrictive one focused solely on weight.

Intuitive and mindful eating have been proposed as holistic alternatives to dieting and restrictive eating. These holistic approaches focus on internal hunger cues to help regulate food intake[16-18] and they stress the use of the senses while eating, to encourage people to eat foods that are both pleasing and nourishing[18]. Higher intuitive eating scores have been associated with a lower eating disorder symptomatology, a lower body mass index (BMI)[19,20], a greater sense of well-being, and fewer concerns with ideal body type[21]. Mindful eating has also been negatively associated with BMI[16]. Since these approaches may be helpful for long-term healthy weight management[22,23], research is needed to identify the best ways to help individuals eat more

intuitively and mindfully[21].

Due to a possible disruption by dieting of the physiological controls governing food intake[7], dieters may be guided primarily by concerns about dieting and weight control (i.e. restrained eating), rather than the flavor of the food. However, it might be suggested that such sensory stimulation helps recognize internal cues of hunger and satiety, which may help achieve a more internalized food intake regulation among dieters who are showing concerns about dieting and weight control (i.e. restrained eaters). In clinical interventions using taste, dietitians in France have reported positive results to help patients control food intake without experiencing frustration[24]. Based on these observational data, the use of sensory-based intervention to enhance intuitive and mindful eating could have a beneficial effect on eating-related attitudes and behaviors, which may pave the way for alternatives to dieting. However, the efficacy of this approach has not yet been scientifically tested among restrained eaters.

The objectives of this randomized controlled trial were to investigate and determine whether sensory-based intervention influenced eating-related attitudes and behaviors among restrained women, as well as reliance on physical signals for hunger and satiety. It was hypothesized that restrained women from the intervention group would have fewer negative eating-related attitudes and behaviors (restrained eating, disinhibition and susceptibility to hunger), and higher overall levels of mindful and intuitive eating then restrained women from the control group. Restrained women from the intervention group would also eat more often for physical rather than emotional reasons, and be more confident about using internal hunger and satiety cues to determine when and how much to eat.

Methods

Participants

Between January and September 2011, women between the ages of 25 and 60 from Quebec City, Canada were recruited through various media (i.e. university Web site, mailing list, local newspapers, etc.). In a telephone screening interview, women with stable weight in the two months prior to the study were considered for participation regardless of BMI status. All women wishing to take part completed the Restraint Scale[25], a questionnaire to assess dieting and weight concerns levels, and were classified as restrained eaters (scores of 15 or higher for women[26]). Exclusion criteria included pregnancy or lactation, smoking, food allergies, use of certain medications (i.e. corticosteroids and tricyclic antidepressants) and various chronic health conditions (eating disorders, types 1 or 2 diabetes and hyperthyroidism). All participants provided written informed consent. The protocol was approved by the institutional review board of Université Laval (#2010-215 A-2/27-07-2011) and was registered in the ClinicalTrials.gov registry (NCT01535846).

Study Design

In this randomized controlled trial, women were randomly assigned to an intervention group (n=24: six weekly 90-minute workshops) or a waiting list control group (n=26), for an 18-week period. Baseline measurements were collected at T=1, at the end of the six-week intervention period (T=2), and 12 weeks post-intervention (T=3).

Intervention and the Waiting-List Control Group

Each intervention group consisted of 12 women. A registered dietitian conducted six free weekly 90-minute workshops on specific themes (Table 1). These workshops included activities from ÉquiLibre[27], a non-profit organization supporting the development of programs and activities for health professionals and the public. Food tasting activities took place during workshops three-six, after which a registered dietitian led a discussion on appetite sensations and on emotions and memories associated with the foods in question. After the last intervention group activity, volunteers from the control group were invited to take part in a sensory-based intervention.

Measurements of Dependent Variables

In addition to the 10-item Restraint Scale[25], eating-related attitudes and behaviors were measured by the validated 51-item Three-Factor Eating Questionnaire (TFEQ) at T=1, T=2 and T=3[28-30]. The three subscales of TFEQ are: dietary restraint (intent to control food intake); disinhibition (overconsumption of food in response to cognitive or emotional cues); and susceptibility to hunger (food intake in response to feelings and perceptions of hunger)[30]. Other eating-related attitudes and behaviors, as well as the reliance on physical signals for hunger and satiety, were measured with the validated Mindful Eating Questionnaire (MEQ)[16] and Intuitive Eating Scale (IES)[21]. The five subscales of the 28-item MEQ are: disinhibition (inability to stop eating, even when full); awareness (appreciation of food's effects on the senses and on internal states); external cues (eating in response to environmental cues); emotional response (eating in response to negative emotional states); and distraction (focus on other activities while eating)[16]. The three subscales of the 21-item IES are: unconditional permission to eat (whenever hungry, and whatever is desired); eating for physical rather than emotional reasons; and reliance on

internal hunger and satiety cues (to determine when and how much to eat)[21].

Weight, Height, and BMI

Height was measured to the nearest millimeter with a stadiometer (Stadiometer HR-100, Tanita, Arlington Heights, IL), and body weight was measured to the nearest 0.1 kg on a calibrated balance (BWB-800S Digital scale, Tanita), using standardized procedures[31]. These two measurements, taken by the experimenter after the completion of questionnaires at T=1, T=2 and T=3, were then used to calculate BMI.

Statistical Analysis

Each component was tested separately as a dependent variable in a repeated measures ANOVA (PROC MIXED, SAS) including group, time, and group-by-time interaction as independent variables. Effect sizes were also calculated for within and between-group differences (*d*=standardized difference)[33,34]. Taking into account a small effect size of 0.25, power analyses indicated that a sample size of n=44 allowed the detection of significant differences in studied outcomes with an alpha level of 0.05 and a power of 0.95. Assuming a drop-out rate of 10% in the intervention group and 20% in the waiting list control group, as previously observed[32], the sample size was adjusted to a total of 50 women. A p value of <0.05 was considered statistically significant. All statistical analyses were conducted using Statistical Analysis Software (version 9.2, 2009, SAS Institute Inc).

Results and Discussion

A total of 159 women were assessed for eligibility, and 50 women were randomized in

the study (24 were allocated to the intervention group and 26 to the control group). In both groups, the main reasons for dropping out were: lack of time (n=7), and unknown (n=5). On the whole, participants were middle-aged (mean age of 47.5 ± 10.0 years old), and slightly overweight (mean BMI of 27.7 ± 5.9 kg/m^2), and showed high levels of restrained eating (mean of 17.5 ± 4.7). Most women had a university degree (56.0%) and annual family income higher than $59,999 (50.0%). For baseline characteristics, no significant differences were observed between both groups. A total of 19 out of 24 intervention group participants (79.2%) and 18 out of 26 control group participants (69.2%) completed the study. There were no significant differences in baseline characteristics between the women who completed the study and those who dropped out. Results are thus presented for everyone who completed the measurements at each point in time (i.e. T=1, T=2 and T=3). Of the women in the intervention group, 16 of 24 (66.7%) took part in at least five out of six workshops. No group effect (p=0.70), time effect (p=0.52), nor group-by-time interaction (p=0.65) was found for BMI.

Women from the intervention group showed a significant decrease in disinhibition (p=0.02; d=0.48) and situational susceptibility to disinhibition (initiated by specific environmental cues, such as social occasions) (p=0.01; d=0.61), as measured by TFEQ at T=3 versus T=2 (Table 2). Moreover, women from the intervention group showed a significant decrease for disinhibition (p=0.003; d=0.54) and situational susceptibility to disinhibition (p=0.002; d=0.58) at T=3 versus T=1. At the same time, women from the intervention group showed a significant increase in disinhibition at T=3 versus T=2 (p=0.02; d=0.40), and at T=3 versus T=1 (p=0.002; d=0.36), as measured by MEQ (Table 3). Interestingly, sensory-based intervention had a significant impact on both types of disinhibition, as measured by TFEQ and

MEQ. This change remained over time (at T=3 versus T=2), suggesting that some changes in eating behaviors can occur even after the intervention period. Disinhibition measured by TFEQ is related to overeating and involves a range of eating disinhibitors[30], while disinhibition measured by MEQ is defined as an inability to stop eating even when full[16]. While there were few differences between the questionnaires, the two measures of disinhibition appeared quite consistent at T=1 (r=-0.79; p<0.0001), suggesting that they both measured a similar construct. Previous studies have shown disinhibition as measured with TFEQ to be positively associated with weight gain[35], a higher BMI[35,36], less success at weight loss and higher weight regain after weight loss[37], and weight cycling[38]. Moreover, disinhibition as measured with TFEQ, has been negatively associated with self-esteem[37] and psychological well-being[39]. While less studied, disinhibition measured by MEQ has also shown strong inverse associations with BMI[16]. These results demonstrate the importance of identifying interventions aimed at reducing disinhibition levels.

It may be argued that weight loss diets are also associated with a decrease in disinhibition[40,41], though observed changes are often closely related to an increase in dietary restraint. The important role of this external control suggests disinhibition may once again increase when people stop dieting. On the other hand, combined with high restraint as measured by TFEQ, disinhibition has been associated with problem eating behavior and a higher incidence of dieting[42]. Given the potential negative impacts of restrained eating[8-13], it is interesting that the sensory-based intervention has proven effective in decreasing disinhibition without increasing dietary restraint. Accordingly, in contrast with messages to restrict high-fat foods consumption, a positive weight-loss approach based on greater fruit and vegetable consumption may reduce

disinhibition without increasing dietary restraint[43]. This study's findings suggest that non-restrictive approaches that focus on positive messages may in the long run effectively reduce disinhibition without increasing dietary restraint.

Intervention group women also showed a significant increase in unconditional permission to eat at T=2 versus T=1 (p<0.0001; d=0.59), and at T=3 versus T=1 (p<0.0001; d=0.63), as measured by IES (Table 3). People who give themselves unconditional permission to eat tend to pay attention to hunger signals, do not classify foods as "good" or "bad", nor attempt to avoid "bad" foods[21]. In contrast with restrained eating, unconditional permission is defined as the eating of desired foods when hungry. Classifying foods as "good" or "bad" may lead to dichotomous thinking and promote unhealthy eating behaviors[44]. Unconditional permission thus appears to be a healthy approach, and sensory-based intervention may be an innovative strategy to help individuals (especially restrained women), abandon dieting rules and eat more intuitively.

This study is a first step to making clinicians and researchers aware of the potential beneficial effects of sensory-based intervention on eating-related attitudes among restrained women. Through innovative and science-based intervention, this research can enhance the clinical practice of dietitians. A proactive, positive and practical approach like sensory-based intervention can help clients adopt healthy behaviors[44], and dietitians may use it in their practice, by educating patients about the sense of taste[24].

Study limitations include a relatively short time frame, small sample size and homogeneous sample. To draw firm conclusions, a larger sample size would be needed. Since

significant changes occurred or were maintained after the intervention period, the current results suggest sensory-based intervention may affect eating related attitudes and behaviors in the long term. As disinhibition is associated with a higher BMI[35,36], it would be interesting to see if longer intervention or follow-up periods influence body weight regulation.

Conclusions

These preliminary data suggest sensory-based intervention is a promising strategy which, if implemented in clinical practice, can promote healthy eating in a positive way rather than through restrictive strategies that focus mainly on weight and calories. Such intervention seems to effectively reduce overeating episodes and promote the eating of desired foods when hungry. These findings support the need to further explore the impact of sensory-based intervention, using a larger sample, to see if strategies are indeed effective in helping restrained women develop healthier eating patterns.

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Table 1. Overview of the six workshops included in the sensory-based intervention.

Theme of the workshop	Content of the workshops
Workshop 1 “My relationship with food”	Global concept of health vs. body weight Potential physical and psychological side-effects of diets
Workshop 2 “Hunger and satiety cues: valuable guides”	Hunger and satiety cues Weight management
Workshop 3 “Sense and food tasting: sight, smell and touch”	Vocabulary related to tasting and texture of foods Importance of the five senses in food-tasting
Workshop 4 “Sense and food tasting: taste”	Sensitivity to the basic taste thresholds (sweet, salty, sour, and bitter) Identification of tastes in a variety of foods
Workshop 5 “Sense and food tasting: hearing and taste”	Identification of tastes in a variety of foods Vocabulary related to hearing
Workshop 6 “Pleasures associated with the eating”	Food pleasures (such as biological, social, emotional, and cultural)

These workshops include activities from ÉquiLibre[22], a non-profit organization that support the development of programs and activities intended for health professionals and the public.

Table 2. Eating-related attitudes and behaviors in both groups before and after the sensory-based intervention, as measured by Restraint Scale and Three-Factor Eating Questionnaire.

Variables (score range)	Intervention Means ± SD	Control Means ± SD	Differences between groups	
			Effect	*P* value
Restraint Scale (0-35)				
T=1	16.7 ± 4.4	18.3 ± 4.8	Group	0.11
T=2	15.5 ± 3.9	18.0 ± 3.8	Time	0.29
T=3	15.3 ± 4.2	17.9 ± 4.5	Group-by-time	0.89
Cognitive dietary restraint (0-21)				
T=1	10.6 ± 5.3	11.4 ± 4.2	Group	0.51
T=2	9.7 ± 4.9	11.2 ± 5.6	Time	0.14
T=3	9.0 ± 5.3	10.2 ± 5.2	Group-by-time	0.69
Cognitive dietary restraint (flexible control) (0-7)				
T=1	3.8 ± 2.0	3.7 ± 1.8	Group	0.74
T=1	3.7 ± 1.8	3.9 ± 1.8	Time	0.57
T=2	3.6 ± 2.2	3.8 ± 2.3	Group-by-time	0.63
Cognitive dietary restraint (rigid control) (0-7)				
T=1	3.2 ± 2.0	4.0 ± 1.9	Group	0.23
T=2	3.0 ± 1.6	4.1 ± 2.0	Time	0.16
T=3	2.8 ± 2.0	3.3 ± 1.9	Group-by-time	0.11
Disinhibition (0-16)				
T=1	6.3 ± 2.7	8.2 ± 4.1	Group	**0.04**
T=2	6.2 ± 2.8	7.8 ± 4.0	Time	**0.005**
T=3	5.0 ± 2.1	7.9 ± 4.4	Group-by-time	**0.03**
Habitual susceptibility to disinhibition (0-5)				
T=1	1.2 ± 1.0	1.7 ± 1.6	Group	0.10
T=2	0.7 ± 0.9	1.4 ± 1.4	Time	**0.04**
T=3	0.7 ± 0.8	1.4 ± 1.4	Group-by-time	0.84
Emotional susceptibility to disinhibition (0-5)				
T=1	1.3 ± 1.3	1.7 ± 1.3	Group	0.10
T=2	1.3 ± 1.3	1.7 ± 1.3	Time	0.13
T=3	0.8 ± 1.0	1.7 ± 1.4	Group-by-time	0.06
Situational susceptibility to disinhibition (0-5)				
T=1	2.6 ± 1.3	3.0 ± 1.8	Group	0.16
T=2	2.6 ± 1.2	2.8 ± 1.9	Time	**0.004**
T=3	1.9 ± 1.1	2.8 ± 2.1	Group-by-time	**0.02**
Susceptibility to hunger (0-14)				
T=1	4.3 ± 2.7	5.1 ± 3.7	Group	0.13
T=2	3.7 ± 2.7	5.9 ± 4.0	Time	0.09
T=3	3.0 ± 2.1	5.4 ± 4.2	Group-by-time	0.46
Internal locus for hunger (0-6)				
T=1	1.7 ± 1.5	2.2 ± 1.9	Group	0.24
T=2	1.3 ± 1.5	2.2 ± 1.9	Time	0.33

T=3	1.3 ± 1.2	2.2 ± 2.1	Group-by-time	0.87
External locus for hunger (0-6)				
T=1	1.7 ± 1.1	2.0 ± 1.9	Group	0.10
T=2	1.7 ± 1.4	2.8 ± 2.0	Time	**0.04**
T=3	1.2 ± 1.0	2.4 ± 2.0	Group-by-time	0.18

Values are the mean ± standard deviation (SD) and are unitless score. T=1: intervention group (n=24); control group (n=26). T=2: intervention group (n=20); control group (n=19). T=3: intervention group (n=19); control group (n=18).

Table 3. Eating-related attitudes and behaviors, and reliance on hunger and satiety in both groups before and after the sensory-based intervention, as measured by Mindful Eating Questionnaire and Intuitive Eating Scale.

Variables (score range)	Intervention	Control	Differences between groups	
	Means ± SE	Means ± SE	Effect	*P* value
Mindful Eating Questionnaire (0-4)				
T=1	2.9 ± 0.4	2.8 ± 0.4	Group	0.19
T=2	3.0 ± 0.3	2.8 ± 0.4	Time	**0.001**
T=3	3.0 ± 0.3	2.8 ± 0.5	Group-by-time	0.44
Awareness (0-4)				
T=1	2.7 ± 0.7	2.7 ± 0.6	Group	0.76
T=2	3.0 ± 0.4	2.9 ± 0.6	Time	< **0.0001**
T=3	3.1 ± 0.5	3.0 ± 0.6	Group-by-time	0.53
Distraction (0-4)				
T=1	2.7 ± 0.7	2.7 ± 0.6	Group	0.81
T=1	2.8 ± 0.6	2.7 ± 0.6	Time	0.79
T=2	2.8 ± 0.7	2.7 ± 0.6	Group-by-time	0.85
Disinhibition (0-4)				
T=1	3.0 ± 0.6	2.7 ± 0.7	Group	0.06
T=2	3.0 ± 0.5	2.7 ± 0.8	Time	**0.006**
T=3	3.2 ± 0.5	2.7 ± 0.7	Group-by-time	**0.02**
Emotional response (0-4)				
T=1	3.2 ± 0.6	3.0 ± 0.6	Group	0.20
T=2	3.3 ± 0.5	3.1 ± 0.6	Time	0.09
T=3	3.4 ± 0.5	3.1 ± 0.6	Group-by-time	0.90
MEQ – External cues (0-4)				
T=1	2.7 ± 0.6	2.6 ± 0.7	Group	0.82
T=2	2.7 ± 0.4	2.7 ± 0.7	Time	0.77
T=3	2.6 ± 0.7	2.7 ± 0.7	Group-by-time	0.93
Intuitive Eating Scale (0-5)				
T=1	3.1 ± 0.5	2.9 ± 0.8	Group	0.08
T=2	3.5 ± 0.5	3.1 ± 0.7	Time	< **0.0001**
T=3	3.5 ± 0.5	3.1 ± 0.8	Group-by-time	0.11
Unconditional permission to eat (0-5)				
T=1	2.7 ± 0.8	2.6 ± 0.7	Group	0.27
T=2	3.2 ± 0.9	2.8 ± 0.5	Time	< **0.0001**
T=3	3.2 ± 0.8	2.9 ± 0.7	Group-by-time	**0.04**
Eating for physical than emotional reason (0-5)				
T=1	3.4 ± 0.9	3.0 ± 1.1	Group	0.09
T=2	3.7 ± 0.8	3.3 ± 1.1	Time	< **0.0001**
T=3	3.8 ± 0.7	3.1 ± 1.1	Group-by-time	0.37
Reliance on internal hunger and satiety cues (0-5)				
T=1	3.5 ± 0.6	3.3 ± 0.9	Group	0.14

T=2	3.8 ± 0.6	3.4 ± 0.7	Time	**0.03**
T=3	3.8 ± 0.5	3.5 ± 0.9	Group-by-time	0.56

Values are the mean ± standard deviation (SD) and are unitless score. T=1: intervention group (n=24); control group (n=26). T=2: intervention group (n=20); control group (n=19). T=3: intervention group (n=19); control group (n=18).