Hypnosis Reduces Food Impulsivity in Patients with Obesity and High Levels of Disinhibition: HYPNODIET Randomized Controlled Clinical Trial

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Fabienne Delestre[1], Guillaume Lehéricey[1], Candice Estellat[2], M Hassimiou Diallo[3], Boris Hansel[4], Philippe Giral[5]

[1] Dietetics Department, Pitié Salpêtrière University Hospital, Assistance Publique - Hôpitaux de Paris, Paris, France

[2] Sorbonne Université, INSERM, Institut Pierre Louis d'Epidémiologie et de Santé Publique, équipe PEPITES, AP-HP, Hôpital Pitié-Salpêtrière, URC & Centre de Pharmacoépidémiologie (Cephepi), CIC-1901, F75013, Paris, France

[3] Unité de Recherche Clinique, Pitié Salpêtrière University Hospital, Assistance Publique - Hôpitaux de Paris, Paris, France

[4] Université de Paris, Bichat-Claude Bernard Hospital, Assistance Publique - Hôpitaux de Paris, INSERM U1148, Paris, France

[5] Endocrinology-Metabolism Department, Pitié Salpêtrière University Hospital, Assistance Publique - Hôpitaux de Paris, Paris, France

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Corresponding author: Fabienne DELESTRE, Dietetics Department, Pitié Salpêtrière University Hospital, Assistance Publique - Hôpitaux de Paris, 75013 Paris, France. Telephone: +330660740693. Email: fabienne.delestre@aphp.fr

Abbreviations: AP-HP, Assistance Publique - Hôpitaux de Paris; BMI, body mass index; DSM-IV-TR, Diagnostic and Statistical Manual of mental disorders Text Révision; DXA, dual-energy X-ray absorptiometry; FCR, flexible cognitive restraint; IPAQ, international physical activity questionnaire; ITT, intention-to-treat; RCR, rigid cognitive restraint; TFEQ: Three Factor Eating Questionnaire.

Abstract

Background: The obesogenic environment of Western countries raises questions about its current management. Some clinical studies explore hypnosis, although the current state of knowledge does not lead to definitive conclusions about its efficacy.

Objective: We assessed the impact of Ericksonian hypnosis and self-hypnosis on disinhibition of eating in adults with obesity and high food impulsivity levels compared to standard nutritional education.

Design: From September 2014 to July 2015, adults with body mass index of 30–40 kg/m^2 and a high disinhibition score (>8 on the Three Factor Eating Questionnaire, TFEQ-51) were included in a randomized controlled trial. The control and hypnosis groups received the same standard nutrition education in eight workshops. In the hypnosis group, subjects had eight sessions of hypnosis combined with training in self-hypnosis. Disinhibition (primary outcome) and other scores from the TFEQ-51 as well as anthropometric, food intake, cardiometabolic, and physical activity variables were collected at inclusion and at 8 months.

Results: Of 82 randomized adults, 70 participated in all session, 80 participated in at least one session and were included in the main analysis (hypnosis group n=41; control group n=39). After 8 months of follow-up, disinhibition scores adjusted for baseline values were lower in the hypnosis group with a mean between-group difference of 4.2; 95% CI: 2.8, 5.5; p<0.001; 67.7% of adults in the hypnosis group had normalized their disinhibition (versus 11.1%; p<0.0001). Differences for weight (1.8 kg; 95% CI: -0.1, 3.7; p=0.052), body mass index (0.8 kg/m²; 95% CI: 0.1, 1.4;

p=0.028), susceptibility to hunger score (2.2; 95% CI: 1.0, 3.3; p<0.001) and its two subscales also favored the hypnosis group.

Conclusions: In the management of adults with obesity and high disinhibition score, hypnosis and self-hypnosis can significantly improve the deep mechanisms of eating behaviors and seems to have a beneficial effect on weight loss.

Keywords: Compulsive behavior, Disinhibition, Eating behavior, Feeding behavior, Hypnosis, Nutrition disorders, Obesity, Randomized controlled trial.

Introduction

The pathophysiology of obesity is complex, as it involves psychobehavioral, biological, neurological, and genetic factors (1). Beyond hunger and satiety, which are the best-known mechanisms regulating food intake, authors talk about the "vicious circle" of Western weight gain that results from excessive excitatory stimulation and defective inhibitory mechanisms (2,3).These phenomena are especially reinforced when both psychological distress and disinhibition of eating are present (4,5). In the Three Factor Eating Questionnaire (TFEQ-51) (6), disinhibition score refers to uncontrolled overeating in response to cognitive or emotional signals. Compared to other measures of eating behavior, it has been found to be most systematically correlated with obesity (7–12).

Considering the numerous psychological, physical, social, organizational, and economic obstacles, the usual guidelines for the management of obesity may not be sufficient or only in the short term (13–15). New approaches such as clinical hypnosis have been explored for its management with a focus on psychobehavioral factors.

Clinical hypnosis can be defined as a procedure in which the therapist activates the patient's resources and suggests changes to the patient's sensations, perceptions and thoughts (16). Subsequent behavior is supposed to be different and more suitable. The hypnotic processes are defined in neuroscience using cerebral imaging (17) and in psychology using social cognitive and dissociative theories (18).

Recent reviews and meta-analyses suggest that hypnosis is effective in weight loss. Nevertheless, the heterogeneity of studies and their many methodological

limitations (e.g., uncontrolled trials, lack of long-term follow-up, choice of selection criteria for hypnosis and intervention methodology allowing for replication and clinical application) are barriers to evaluating the effectiveness of hypnosis (19, 20). However, several authors have provided methodological guidelines for researchers (21-22).

We studied hypnosis and self-hypnosis, as described by Milton Erickson, as a complementary approach to standard obesity management. But contrary to other studies and in line with these methodological guidelines, we chose to target a population with high levels of disinhibition and with class I and II obesity (16).

Our objective was to evaluate the impact of Ericksonian hypnosis combined with self-hypnosis training on disinhibition of eating in adults with obesity and characterized by high disinhibition score compared to standard nutritional education. We hypothesized that hypnosis may reduce disinhibition of eating. In addition, we evaluated the effect of hypnosis on other eating behaviors (cognitive restraint and hunger), bodyweight, cardiometabolic risk, and patients' involvement in their healthcare pathway.

Methods

Design

The HYPNODIET study was an open, randomized, comparative effectiveness clinical trial conducted between September 2014 and July 2016 in our university hospital in Paris, France (for the study design, see **Supplementary Figure 1**). Participants were recruited via media advertising or referred directly by their caregivers.

Preselection took place in three stages: by email, then telephone interviews, and finally an information meeting where the inclusion and exclusion criteria and study organization were described in greater detail. After the meeting, consenting adults participated in the inclusion phase from September 2014 to July 2015.

Candidates were informed about the study objectives, organization, and procedures during the preselection period and then again before providing informed consent in writing at the first study visit. They were all informed that after the end of the study, any individuals randomized to the control group could also undergo the hypnosis program.

A computer-generated random attribution sequence was used for randomization, with a 1:1 ratio and fixed blocks of 2 (modalities only known by the statistician to preserve allocation concealment). The study staff had knowledge of the assigned study group only after the web server confirmed the patient's inclusion and group.

This open-label, single-center, randomized, controlled study included patients with class I and II obesity (30 kg/m² ≤ body mass index (BMI) <40 kg/m²) and high disinhibition score. The study was registered at clinicaltrials.gov (NCT02292108).

Given the methodological limitation identified in the literature on hypnosis efficacy, this trial followed the most rigorous methodological guidelines used for research in hypnosis (21,22). The study was approved by the ethics committee, Comité de Protection des Personnes Ile-de-France VI, in Paris, France (No. 214-A00606-41).

Patients

The study included French-speaking male or female subjects aged 18-70 years with class I and II obesity (30 kg/m² ≤ BMI < 40 kg/m²), who had a disinhibition score of > 8 in the TFEQ-51 (6), who had previously received treatment for weight

loss with a professional nutritionist, and who had maintained a stable body weight for the past 3 months (weight change ≤ 3 kg peak to peak). In addition, patients had to have no experience with hypnosis and be covered by the French national health insurance. Exclusion criteria were the following: refusal to undergo hypnosis; known psychiatric illness; disease or treatment with a strong influence on weight or eating habits (e.g., unstable, hyperthyroidism or uncontrolled hypothyroidism, bariatric surgery, corticotherapy); major eating disorders according to DSM-IV-TR (Diagnostic and Statistical Manual of mental disorders Text Révision) criteria; auditory, visual, or cognitive impairments hindering the completion of the assessment scales; pregnancy; and participation in another study.

Interventions

Patients were included at the end of the first visit. They completed questionnaires and underwent a brief medical examination as well as an interview with a psychologist. After providing written informed consent, they were randomized into one of the two groups. The final visit took place after 8 months and included the same questionnaires, a medical examination, and an interview with a psychologist. The hypnosis group participated in eight nutrition workshops (8 to 10 persons), which included group hypnosis training at the same sessions; the control group only took part in the eight nutrition workshops. The first seven workshops took place at 2-week intervals and the eighth workshop 4 weeks later. After the final visit, members of the control group could sign up for hypnosis workshops (Supplementary Figure 1).

Nutrition Intervention

The patient education workshops in nutrition (1 hour/session) were led by one of the two dietitian-nutritionists trained in patient therapeutic education (FD or GL). Each workshop began with a discussion period in which the patients talked about their dieting, weight history, and experiences, as well as their knowledge and beliefs, thus providing the necessary information for the nutritionist to adapt the education strategy to each patient's real life and needs. Next, the nutritionist presented the current guidelines of the French National Public Health Agency along with information about applying them. Reference documents about the French national nutritional health program were provided at the end of each session (15). Homework was proposed between workshops such as finding and testing new recipes or collecting dietary information about the packaging of recently tested foods.

Hypnosis and Self-Hypnosis Training

For the hypnosis group, the eight hypnosis workshops (2-hour/workshop), led by a dietitian (GL) trained and certified in clinical hypnosis based on the Ericksonian technique, took place immediately after each nutrition workshop (1-hour/workshop) led by another dietitian (FD). The dietitian briefly defined the organization, procedures, and pedagogical objectives of the workshop. Through their actions and words, all participants were required to adhere to the group rules, outlined at the first workshop, to ensure the integrity of the group and show respect for each other. No analysis or interpretation was formulated about any patient's experiences. The therapist validated patients' skills in letting go, self-hypnosis, and thus self-care; he also promoted their progress. At the beginning of the workshop and between every 2 or 3 exercises, each participant could share his or her own experience of

hypnosis and different self-hypnosis exercises to encourage introspection. When patients expressed themselves during conversations or in their responses to questions asked in the previous workshops, the therapist identified any key words associated with emotional resources and then integrated them into his discourse to personalize the exercises and potentiate change.

At each workshop, the treatment objectives associated with hypnosis, learning self-hypnosis, and risk factors for obesity were identified. Several exercises could meet a single objective, and each workshop allowed the application of previous knowledge and the development of these new skills.

The program for the eight workshops was as follows: 1) definition of the treatment framework and introduction to hypnosis; 2) patients' conscious and unconscious assessment of their obesity issues; 3) patients' exploration of their resources and obstacles; 4) development of self-esteem and appropriate responses to stress; 5) exploration of balance; 6) redevelopment and adaptation strategies; 7) development of self-confidence and the success of change; and 8) consolidation of gains and empowerment.

Hypnosis was conducted in a seated position on a chair, not to relax but in a dynamic process with a straight back and the eyes open or closed. A common structure was followed at each hypnosis session: 1) presentation of the objectives and main stages; 2) hypnotic induction guiding patients to feel safe and developing the hypnotic process according to a specific pre-established scenario; 3) consolidation of the process; 4) therapeutic suggestions with a metaphor of change compared to nature to promote psychological and bodily changes; 5) reorientation; 6) suggestions for post-hypnotic comfort and use of self-hypnosis. Reinduction was performed by summarizing the instructions given for self-hypnosis.

A pocket notebook was provided to each patient in which they could note their ideas or the therapist's suggestions during the workshop and detail any instructions for the self-hypnosis exercises at the end of the session.

Measures

Data were collected at inclusion and at the end of the study 8 months later.

The primary outcome was the change in the disinhibition score, which corresponds to one of three scores defining eating impulsivity from the results of Stunkard and Messick's TFEQ-51 questionnaire, initially known as the Three Factors Eating Questionnaire (6). According to the literature, this was the most relevant questionnaire for predicting the specific influence of disinhibition on weight (9).

Exploratory outcomes:

In addition to the disinhibition score based on 16 items, the questionnaire calculated a cognitive restraint score from 21 other items, and a hunger susceptibility score from 14 further items for a total of 51. Cognitive restraint defined the conscious control of eating in relation to concerns about body shape and weight. Susceptibility to hunger was proportional to the difficulties encountered in limiting eating or when eating in response to intense hunger. Subscales were also calculated from some of these 51 items: flexible cognitive restraint (FCR) (7 items), rigid cognitive restraint (RCR) (7 items), internal hunger (6 items), and external hunger (6 items) (4,23).

At baseline, fasting weight, fat mass, and lean body mass were measured using dual-energy X-ray absorptiometry (DXA) with the calculation of BMI. In addition, blood pressure was measured, and a blood sample was taken to measure lipids, blood sugar, and HbA1c. We also planned to measure waist circumference but the

investigators did not strictly follow the standardized method proposed in the protocol for this measurement (some measured it at the level of the umbilicus and others at the iliac crest), we do not present the results obtained for the waist circumference because they have no clinical significance.

Dietary intake was assessed for 3 days representative of the subject's usual eating habits: two weekdays and one weekend day. An interactive self-administered food journal from the internet enabled the collection of these data during the week prior to the inclusion visit and the week before the final visit at 8 months (24).
Physical activity was assessed with the abridged version of the International Physical Activity Questionnaire (IPAQ) (25), also completed online before the inclusion visit and before the final visit. The number of daily steps was measured with a pedometer for a week prior to the second and final visits. All self-administered questionnaires were verified and validated with the patient by the dietitians responsible for the study (FD and GL).

Statistical Methods

We conducted a preliminary unpublished study of eight patients who had received standard management and were assessed with the TFEQ-51. This study enabled us to estimate the change and SD in the disinhibition score to be 1.16 ± 2 over 7 months for the control group . With a loss-to-follow-up rate of up to 10% and a standard deviation of 2, the inclusion of 40 patients in each group would provide a study power of 80% with an alpha risk of 5% to detect an effect size of 0.3 (between small and medium), corresponding to a between- group mean difference of 2.4 points.

Consistent with the protocol, the principal analysis for the primary outcome considered the modified intention-to-treat (ITT) population, defined as all randomized patients who participated in at least one group workshop. The missing data for the primary outcome were imputed using the multiple imputation technique. Sensitivity analyses for the standard ITT and complete case populations were also performed for the primary outcome.

Continuous variables were described by their mean and standard deviation. Categorical variables were described as frequency (percentages) and compared between groups using a Pearson's Chi-squared test. After assessing and confirming of the assumptions of linearity, homoscedasticity, and normal distribution of the residuals, the difference in scores between groups was compared using an analysis of covariance (ANCOVA) adjusted for the baseline score. The analyses of anthropometric and laboratory values were adjusted for sex. The impact of sex on the treatment group effect on disinhibition score or weight loss were assessed by calculating the p-value associated with the interaction terms. The results were expressed in terms of adjusted means estimated from the least squares method accompanied by their 95% Confidence Interval (95% CI). Exploratory analyses of the correlations between variations in the different scores was based on the Spearman correlation coefficient.

For all tests, statistical significance was set at $p<0.05$. All statistical analyses were performed using R statistical software (https://www.rstudio.com/). R version 4.1.2.

Results

Participants

Supplementary Figure 2 shows the flow chart of participants. Of the 813 candidates who applied by email, 394 were selected during the preselection phase and contacted by telephone for an initial verification of the inclusion and exclusion criteria. At the end of this preselection phase, 139 candidates were invited to an information meeting. We finally included and randomized 82 participants, as 53 people declined to participate and 4 no longer met the inclusion criteria. In the control group, 2 patients were lost to follow-up after randomization without attending any workshop. In the hypnosis group, all patients participated in at least 1 workshop. For the principal analysis, the population comprised 39 individuals in the control group and 41 in the hypnosis group.

Baseline characteristics (**Table 1**) were similar between the two arms. The majority of participants were female with a mean age of 47 years. On average, participants were severely obese (mean (SD) BMI for hypnosis group: 35.6 (2.4) kg/m² and for control group: 35.1 (2.8) kg/m²).

Adherence was very high. Overall, in the two groups, 86% of patients attended at least six of the eight proposed sessions.

Primary Outcome

Principal analysis showed a greater reduction in the disinhibition score after 8 months in the hypnosis group compared to the control group (mean between-group difference 4.2; 95% CI: 2.8, 5.5; $p<0.001$). Overall, 88% of patients in the hypnosis

group had a reduction in their disinhibition score of at least 2 points compared to 42% in the control group.

Sensitivity analyses for the standard ITT and complete case populations also showed statistically significant differences (p<0.001). After adjustment for the baseline score, the mean disinhibition score at 8 months was 6.0 in the hypnosis group and 10.2 in the control group (p<0.001) (**Table 2**). The application of Lesdema's recommendations (26) to identify high and low disinhibition scores (low disinhibition score ≤ 6) showed that 67.7% of the hypnosis group had a low disinhibition score at 8 months compared to 11.1% in the control group (p<0.001) . Sex did not modify the treatment group effect on disinhibition score (interaction, p=0.89).

Exploratory Outcomes

After 8 months, the weight also tended to be lower but at the limit of significance (1.8 kg; 95% CI: -0.1, 3.7; p=0.052) and the BMI was significantly lower in the intervention than in the control group (0.8 kg/m²; 95% CI: 0.1, 1.4; p=0.028) (Table 2). Changes in body composition did not differ between the hypnosis and control groups: mean difference in fat mass at 8 months was 1.1 kg (95% CI: -0.4, 2.6; p=0.115) and mean difference in lean body mass was 0.7 kg (95% CI: -0.2, 1.8; p=0.127), respectively. Changes in the anthropometric data were not correlated with changes in disinhibition score (**Table 3**). Sex did not modify the treatment group effect on weight loss (interaction, p=0.22).

For eating behavior, at 8 months, the adjusted means of susceptibility to hunger and its subscales — whether the individuals tended to react to internal or external signs of hunger — were significantly lower in the hypnosis group than in the control

group (mean differences for susceptibility of hunger score: 2.2; 95% CI: 1.0, 3.3 ; p<0.001; internal hunger score: 1.0; 95% CI: 0.3,1.6; p=0.002; external hunger score: 1.3; 95% CI: 0.5, 2.0; p=0.001). Another exploratory finding was that the decrease in the disinhibition score was associated with a decrease in the hunger score and its subscales (Table 3).

The groups did not significantly differ for cognitive restraint (p=0.445) and its subscales: RCR and FCR. Nonetheless, exploratory analysis showed an inverse correlation between changes in the disinhibition and restraint scores (Table 3).

For food intake, at 8 months, saturated fatty acid intakes dropped in the hypnosis group compared to the control group (mean difference: -5.7 g/day; 95% CI: -11.3, -0.1; p=0.044). Exploratory analysis revealed that the decrease in the calories and carbohydrate intake for the hypnosis group was associated with a decrease in disinhibition score (Table 3).

No difference at 8 months was observed between the groups for laboratory findings, blood pressure, or physical activity, as measured by the IPAQ. Patients in the control group did not walk significatively more than those in the hypnosis group (mean difference: 644 steps/day; 95% CI: -1867, 569; p=0.293).

Discussion

We showed that our hypnosis program reduces disinhibition of eating and seems to have a positive impact on body weight and body composition. In addition, the hypnosis intervention group reached the favorable conditions for maintaining weight loss, because their disinhibition score and susceptibility of hunger decreased, and external hunger signals were better controlled.

The HYPNODIET was a randomized controlled trial that brings complementary methods and results to the already published studies on hypnosis (20). Furthermore, our population with obesity was selected because of their high level of disinhibition, while the 8-month follow-up period was longer than most studies on this topic. In this trial, hypnosis and self-hypnosis targeted the mechanisms of eating impulsivity with the aim to reduce disinhibition of eating. We demonstrated that hypnosis had a significant effect on reducing disinhibition of eating: 67.7% of those in the hypnosis group had low disinhibition scores 8 months after beginning hypnosis compared to only 11.1% in the control group. In the literature, high disinhibition of eating is a strong predictor of regaining lost weight, regardless of whether the loss was due to dietary changes, physical exercise combined with diet, behavioral therapy, or bariatric surgery (9,27,28). In individuals who maintain their weight loss over the long term, a mechanism inhibiting the intake of calorie-rich appetizing food was observed (29,30). We suggest that hypnosis favors the long-term maintenance of weight loss by reducing disinhibition of eating. Many studies have examined the impact of hypnosis on weight loss (19,21,22,31) but not on eating impulsivity like disinhibition. Moreover, the techniques used are often inadequately described, the psychological phenomena targeted by the intervention are not clearly defined, and the study populations are heterogeneous. It is therefore difficult to reach definitive conclusions about the efficacy of hypnosis in obesity (22,32). Under methodologically rigorous conditions and with an impulsive population, our study showed a positive trend in weight loss between the two groups.

A recent study found that in the brief management of class II and III obesity using hypnosis (three 20- to 30-minute sessions over 15 weeks) combined with training in

self-hypnosis, weight loss was not significant except when self-hypnosis was used very frequently, i.e., at least once a day (16). Our therapy had a similar duration of intervention (18 weeks), but it included more sessions of a longer duration (eight 2-hour sessions), while adherence was very high.

Cognitive restraint increased with the decrease in disinhibition of eating, although its course at 8 months did not differ significantly between the groups. Studies suggest that strong restraint can be a protective factor, as it attenuates the associations between disinhibition of eating and weight among women and especially those with a very disinhibited diet (8,33). Other studies have also shown that the relation between weight control and cognitive restraint of eating might be positive but only effective in the short term, or at least, not necessarily in the long term (34). Cognitive restraint is therefore necessary at the start of obesity management, and the protocol of hypnosis used in the present study may be useful to obtain prolonged weight loss. Studies show that susceptibility to hunger is higher among people with obesity. When a high disinhibition score is accompanied by a higher hunger score, BMI is usually higher (28,35,36). This corresponds to our baseline population, which had high scores of susceptibility to hunger. Several articles suggest that hunger and its subscales appear to have less influence on BMI than disinhibition of eating does (12,26,28,37). Nonetheless, in our study, hypnosis group control these variables better (susceptibility to hunger, $p<0.001$; internal hunger, $p=0.002$; external hunger, $p=0.001$). We hypothesize that hypnosis allowed them to set up mechanisms to inhibit external hunger stimuli and thus be less sensitive to these signals. They also had less appetite with less internal hunger. We hypothesize that hypnosis helped patients to be more closely attuned to their bodies, allowing them to better manage physiological hunger and have

weaker sensations of hunger. In our study, patients in the hypnosis group compared to the control group improved the quality of their diet with lower intakes of calories and carbohydrates, which are associated with lower disinhibition score. Long-term overconsumption of sugar-rich foods increases food dependence and contributes to the development of obesity (38).

Limitations

Our study has several limitations. First, in a pragmatic approach to enhance its external validity, it was un unblinded trial. We could have set up a sham intervention for patients in the control group, allowing them to be partially blinded regarding the study hypothesis, but this would have added complexity to the selection process and decreased the representativeness of patients.
Second, we know that the effectiveness of Ericksonian hypnosis is linked to patient involvement, the therapist's conviction, and the quality of the patient-therapist relationship. There is thus a risk that the study measures the impact of this psychological management with high-quality patient-therapist interactions rather than that of hypnosis itself. Nonetheless, from an Ericksonian viewpoint, this comment is irrelevant, because Milton Erickson did not consider a specific definition of hypnosis to be important. He instead aimed for the patient's improvement above all else, regardless of the name attached to the method. Third, our proof-of-concept study was not powered to detect a difference in weight loss but rather a difference in the disinhibition score. Our results on exploratory outcomes should be confirmed in further trials. A fourth limitation is unequal intervention time between the groups. Nevertheless, according to the literature, in the management of obesity, the frequency and content of interventions as well as

the duration of follow-up (short or long term) are more important than the duration of the sessions themselves (39–41). Indeed, a 3-hour nutrition session in the control group would not be consistent with clinical practice. Furthermore, during the last 2 months, all patients in the study did not attend any sessions. A final limitation of the study is that participants without mental illness were included. Given that many people with disinhibition of eating also suffer from mental illnesses such as depression, anxiety, and post-traumatic stress disorder, we cannot generalize the results to all people for whom this intervention is likely to be of interest.

Conclusions

These results suggest that in the management of adults with obesity, hypnosis and self-hypnosis can significantly improve disinhibition of eating and even normalize it, with a tendency toward effective weight loss. The hypnosis sessions are clearly defined in this study and have been made available and reproducible for future research; they can be performed in hospital settings as part of routine care. A long-term study is nevertheless needed to verify the effect of this additional treatment approach on weight in the long term, on all dynamic indicators of eating impulsivity, and specifically, on changes in the composition of food intake.

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Contributions: 1) designed research (GL, FD, BH, PG); 2) conducted research (GL, FD, PG); 3) analyzed data or performed statistical analysis (GL, FD, PG, HMD, CE); 4) wrote paper (GL, FD,); 5) had primary responsibility for final content(GL, FD). All authors have read and approved the final manuscript.

Data Sharing: Data described in the manuscript, code book, and analytic code will be made available upon request and pending approval.

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Table 1: Baseline characteristics of the study participants

Variable	**Control group n = 39**	**Hypnosis group n = 41**
Age, mean (SD) (year)	47.0 (10.4)	47.5 (10.9)
Sex, N (%) female	34 (87)	35 (85)
TFEQ-51[1], mean (SD)		
Disinhibition of eating	12.0 (2.2)	12.2 (2.0)
Cognitive restraint	7.2 (3.4)	8.7 (3.9)
Flexible cognitive restraint	2.0 (1.2)	2.5 (1.4)
Rigid cognitive restraint	2.1 (1.5)	2.7 (1.5)
Susceptibility to hunger	7.6 (2.8)	7.0 (2.4)
Internal hunger	2.8 (1.6)	2.4 (1.7)
External hunger	3.6 (1.7)	3.5 (1.4)
DXA[2]		
Weight, mean (SD) (kg)	96.0 (12.2)	96.3 (11.2)
Body mass index, mean (SD) (kg/m²)	35.1 (2.8)	35.6 (2.4)
Fat mass, mean (SD) (kg)	43.4 (7.2)	42.6 (6.1)
Lean body mass, mean (SD) (kg)	50.0 (9.0)	51.0 (8.7)
Blood pressure, mean (SD) (mm Hg)		
Systolic	123 (18)	125 (13)
Diastolic	73 (12)	75 (10)
Lipids, mean (SD) (g/l)		
Total cholesterol	5.39 (1.01)	5.57 (1.08)
LDL cholesterol	3.49 (0.93)	3.65 (0.99)
HDL cholesterol	1.35 (0.38)	1.28 (0.37)
Triglycerides	1.20 (0.51)	1.40 (0.75)
Glucose, mean (SD) (mmol/L)	5.13 (0.43)	5.39 (0.68)
HbA1c, mean (SD) (%)	5.6 (0.3)	5.8 (0.5)
Cardiovascular disease, n (%)		
Hypertension	11 (28)	12 (29)
Dyslipidemia	8 (21)	5(12)
Diabetes	2 (5)	0 (0)
Smoking, n (%)	9 (23)	5 (12)
Energy and macronutrient intake, mean (SD)		
Energy (kcal/day)	1793 (717)	1980 (555)
Protein (g/day)	79.0 (45.1)	88.4 (29.9)
Fat (g/day)	75.0 (30.0)	82.0 (25.8)
Carbohydrates (g/day)	189.5 (81.0)	215.2 (69.3)

Saturated fatty acids (g/day)	30.6 (14.9)	32.8 (12.9)
Calcium (mg/day)	823.7 (346.4)	1007.9 (525.4)
Dietary fiber (g/day)	16.9 (6.2)	19.1 (5.8)
IPAQ[3], mean (SD)		
Walking (min/week)	45.3 (89.0)	53.4 (81.1)
Physical activity, moderate (min/week)	60.3 (98.6)	66.1 (154.7)
Physical activity, vigorous (min/week)	26.3 (80.8)	28.3 (48.5)
Sedentary (min/day)	400.7 (195.6)	413.4 (177.0)
Walking (pedometer), mean (SD) (number of steps/day)	6 514 (2 140)	7 084(2 607)
Existence of obesity, mean (SD) (years)	13.2 (11.9)	15.9 (10.1)

[1]TFEQ: Three Factor Eating Questionnaire; [2]DXA: dual-energy X-ray absorptiometry; [3]IPAQ: International Physical Activity Questionnaire.

Table 2: Mean scores and difference at 8 months adjusted for baseline score by analysis of covariance (ANCOVA).

Variables	Control group		Hypnosis group		Adjusted difference	95% CI	p.value[1]
	n	Adjusted means (SE)	n	Adjusted means (SE)			
TFEQ 51[2]							
Disinhibition of eating	36	10.2 (2.7)	34	6.0 (3.2)	4.2	2.8, 5.5	<0.001
Cognitive restraint	36	9.7 (0.6)	34	10.4 (0.6)	-0.6	-2.3, 1.0	0.445
Rigid cognitive restraint	36	3.0 (0.3)	34	3.1 (0.37)	-0.1	-0.9, 0.7	0.811
Flexible cognitive restraint	36	2.9 (0.2)	34	3.2 (0.24)	-0.3	-1.0, 0.3	0.317
Susceptibility of hunger	36	6.3 (0.4)	34	4.2 (0.4)	2.2	1.0, 3.3	<0.001
Internal hunger	36	1.9 (0.2)	34	0.9 (0.2)	1.0	0.3, 1.6	0.002
External hunger	36	3.0 (0.3)	34	1.8 (0.3)	1.3	0.5, 2.0	0.001
DXA[3]							
Weight (kg)	36	96.2 (0.8)	32	94.3 (0.8)	1.8	-0.1, 3.7	0.052
Fat mass (kg)	36	42.9 (0.6)	32	41.7 (0.6)	1.1	-0.4, 2.6	0.115
Lean body mass (kg)	36	51.0 (0.5)	32	50.3 (0.5)	0.7	-0.2, 1.8	0.127
Body Mass Index (kg/m²)	36	35.4 (0.3)	32	34.7 (0.3)	0.8	0.1, 1.4	0.028
Blood pressure(mm Hg)							
Systolic	36	124 (2)	32	121 (2)	3.0	-2.6, 8.6	0.282
Diastolic	36	71 (1)	32	69 (1)	1.4	-2.1, 4.9	0.433
Lipids (g/L)							
Total cholesterol	36	5.31 (0.11)	32	5.13 (0.11)	0.18	-0.09, 0.44	0.192
HDL cholesterol	36	1.21 (0.03)	32	1.26 (0.04)	-0.05	-0.13, 0.04	0.242
LDL cholesterol	36	3.46 (0.10)	32	3.29 (0.10)	0.17	-0.07, 0.41	0.154
Triglycerides	36	1.45 (0.08)	32	1.39 (0.08)	0.06	-0.13, 0.26	0.506
			32				
Glucose (mmol/L)	36	5.24 (0.13)	32	5.40 (0.14)	-0.16	-0.48, 0.17	0.343
HbA1c (%)	36	5.6 (0.04)	32	5.6 (0.04)	-0.01	-0.1, 0.1	0.816
Energy and macronutrient intake							
Energy (kcal/day)	34	1608 (61)	34	1458 (60)	-150	-322, 22	0.082
Protein (g/day)	34	75.1 (3.2)	34	67.3 (3.2)	-7.8	-16.8, 1.2	0.084
Saturated fatty acids (g/day)	34	27.5 (2.0)	34	21.8 (2.0)	-5.7	-11.3, -0.1	0.044
Calcium (mg/day)	34	767.4 (35.1)	34	750.9 (35.4)	-16.5	-117.3, 84.4	0.744
Dietary fiber (g/day)	34	16.8 (0.8)	34	17.5 (0.8)	0.7	-1.6, 3.0	0.539
Fat (g/day)	34	65.8 (3.8)	34	59.0 (3.7)	-6.8	-17.5, 3.9	0.205
Carbohydrates (g/day)	34	165.2 (6.5)	34	158.8 (6.4)	-6.4	-24.8, 12.0	0.487
Protein (%energy)	34	19.1 (0.6)	34	19.0 (0.6)	-0.1	-1.8, 1.7	0.952
Fat (%energy)	34	36.0 (1.1)	34	36.4 (1.1)	0.3	-2.8, 3.5	0.823
Carbohydrates (%energy)	34	41.8 (1.2)	34	42.9 (1.1)	1.1	-2.2, 4.3	0.504
IPAQ[4]							
Walking (min/week)	36	93.1 (17.0)	31	95.5 (18.4)	-2.3	-52.4, 47.7	0.926
Physical activity, moderate(min/week)	36	70.0(21.2)	31	88.9 (22.9)	-18.9	-81.2, 43.3	0.544

Variables	Control group		Hypnosis group		Adjusted difference	95% CI	p.value[1]
	n	Adjusted means (SE)	n	Adjusted means (SE)			
Physical activity, vigorous(min/week)	36	42.5 (11.9)	31	45.0 (12.8)	-2.6	-37.5, 32.4	0.884
Sedentary (min/day)	36	421.6 (27.9)	31	370.6 (30.2)	51.0	-31.1, 133.2	0.214
Walking (pedometer) (number of steps/day)	36	7 537 (419)	34	8 181 (437)	644	-1 867, 569	0.293

[1] *P*-value for analysis of covariance between groups, adjusted at baseline for all variables, and adjusted for sex for anthropometric (DXA) and laboratory variables.

[2]TFEQ: Three Factor Eating Questionnaire

[3]DXA: dual-energy X-ray absorptiometry

[4]IPAQ: International Physical Activity Questionnaire

Table 3: Correlations between changes in the disinhibition score and changes in the TFEQ subcategory for anthropometric, laboratory, or food intake variables in hypnosis group

For Disinhibition	Hypnosis group	
	Correlation coefficient	P value*
TFEQ-51 (n=34)		
Cognitive restraint	-0.398	0.020
Flexible cognitive restraint	-0.361	0.040
Rigid cognitive restraint	-0.362	0.040
Susceptibility to hunger	0.784	<0.0001
Internal hunger	0.676	<0.0001
External hunger	0.623	<0.0001
Energy and macronutrient intake (n=34)		
Energy	0.466	0.005
Protein	0.147	0.408
Fat	0.236	0.180
Carbohydrates	0.541	0.001
Saturated fatty acids	0.328	0.060
Calcium	0.075	0.670
Dietary fiber	0.234	0.180
DXA (n=32)		
Weight	-0.037	0.839
Fat mass	0.074	0.686
Lean body mass	-0.083	0.652
Body mass index	-0.027	0.884

*Spearman's test