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Motivational interviewing as a way to promote physical activity in obese adolescents: A randomized-controlled trial using self-determination theory as an explanatory framework

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Abstract

Using Self-Determination Theory (SDT; Deci & Ryan, 2002) as an explanatory framework, this randomized-controlled study evaluates the effect of a motivational interviewing-based intervention (MI; Miller & Rollnick, 2002) as an addition to a standard weight loss program (SWLP) on physical activity (PA) practice in obese adolescents over a 6-month period. Fifty-four obese adolescents (mean age = 13 years, mean BMI = 29.57 kg/m²) were randomly assigned to an SWLP group (n = 28) or SWLP + MI group (n = 26). Both groups received two SWLP sessions, supplemented for the SWLP + MI group, by 6 MI sessions. Perceived autonomy support, perceived competence, motivational regulations, PA and BMI were assessed at baseline, 3- and 6-months (i.e., the end of the program). MLM analyses revealed that compared to SWLP, the SWLP + MI group had a greater BMI decrease and a greater PA practice increase over time. Moreover, the SWLP + MI group reported greater autonomy support from medical staff at the end of the program, greater increase in integrated and identified regulations, and a stronger decrease in amotivation. MI appears as an efficient counseling method as an addition to an SWLP to promote PA in the context of pediatric obesity.

Running title: Motivational interviewing and adolescent obesity

Key-words: Motivational interviewing, Self-determination theory, Obesity, Adolescence, Physical activity
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Introduction

Adolescent obesity is a major public health problem that has increased at a dramatic pace over the last few years (Lobstein, Baur, & Uauy, 2004). Ten percent of the school-aged children in the world are presently considered as overweight (Lobstein et al., 2004). Such a trend is disturbing given the physical (e.g., type 2 diabetes) and psychosocial (e.g., low self-esteem) risks associated with overweight during adolescence (Reilly, 2007). Thus, the management of pediatric obesity and weight control appears as a health priority. Regular physical activity (PA) is one of the key elements in the management of adolescent obesity, along with changes in eating behavior (Parizkova & Hills, 2001). Moreover, in addition to its important role in the maintenance of weight loss, PA may also improve cardiovascular fitness and psychological well-being (Reilly, 2007).

Despite the well-known benefits of regular PA, obese adolescents tend to adopt a less active lifestyle than their non-obese counterparts. Specifically, some studies (e.g., Olds, Ferrar, Schranz, & Maher, 2011) report a daily PA practice shorter by 20 minutes. Recent reviews and meta-analysis (Cliff, Okely, Morgan, Jones, & Steele, 2010; Gourlan, Trouilloud, & Sarrazin, 2011) revealed that although interventions implemented to promote PA in obese populations demonstrated positive effects on average, there is a high variability in the effectiveness between these studies (Gourlan et al., 2011). Moreover, the explicative processes involved in the behavioral changes generated by those interventions remain largely unknown (Annesi & Withaker, 2010). It thus seems important to (1) continue to identify the characteristics of efficient interventions promoting PA among this population, and (2) better understand the psychosocial factors involved during those interventions.
Motivational interviewing (MI) is nowadays considered as a suitable approach to promote health behaviors (Rollnick, Miller, & Butler, 2008). The primary purpose of this study was to assess the effectiveness of an MI-based intervention in addition to a standard weight loss program (SWLP) on PA and body mass index (BMI) of obese adolescents. Moreover, drawing upon Self-Determination Theory (SDT; Deci & Ryan, 2002), the second purpose was to explore some of the underlying motivational processes accompanying these effects. The next section presents the main postulates of MI and SDT and their interest for understanding PA and health behavior change among obese adolescents.

Motivational Interviewing: a promising approach to promoting physical activity

MI can be defined as a “collaborative, person-centered form of guiding to elicit and strengthen motivation for change” (Miller & Rollnick, 2009, p. 137). Its goal is to create an atmosphere in which the patient, rather than the counselor, becomes the main advocate for change as well as the primary agent for change. Expressing empathy (i.e., the counselor’s attitude of acceptance), developing discrepancy (i.e., amplifying discrepancy between the patient’s present behavior and his/her important goals), avoiding argumentation (i.e., assuming that the patient is responsible for change), rolling with resistance (i.e., acknowledging and exploring the patient’s arguments against changing) and supporting self-efficacy (i.e., helping the patient to find resources to implement new behaviors and overcome barriers) are the general principles upon which MI is based (see Miller & Rollnick, 2002).

Research globally supports the view that MI provides a promising framework for enhancing adherence to health behaviors. Meta-analyses report medium-to-large effects of MI on treatment adherence and small-to-medium effects on treatment outcomes (e.g., drug consumption, psychological well-being) (Hettama, Steele, & Miller, 2005; Lundhal, Kunz, Brownell, Tollefson, & Burke, 2010). Regarding weight loss, MI has also been recognized as an efficient approach among adults to improve PA and regime adherence (e.g., Hardcastle,
Taylor, Bailey, & Castle, 2008) as well as reduce body mass in obese populations (Armstrong et al., 2011). Some authors have suggested that MI could also be a promising approach for pediatric obesity (Resnicow, Davis, & Rollnick, 2006). However, the impact of MI among obese adolescents has received very little attention in the scientific literature. Despite some promising results on eating habits (MacDonell, Brogan, Naar-King, Ellis, & Marshall, 2012), the effectiveness of MI on health behaviors such as PA for this population still has to be determined.

**Self-determination theory: a heuristic framework for understanding health behavior change**

SDT (Deci & Ryan, 2002) is a broad psychological theory of motivation particularly suited to understand health behavior (see Ng et al., 2012, for a review). One of its basic tenets is that human motivation varies in the extent to which it is autonomous (when individuals engage in a behavior with a full sense of volition and choice) or controlled (when individuals engage in a behavior while experiencing internal or external pressure) along a continuum. Identified regulation (i.e., engaging in an activity because it is perceived as personally important and useful), integrated regulation (i.e., engaging in an activity because it is perceived as coherent with his/her values and identity) and intrinsic motivation (i.e., engaging in an activity because of the inherent satisfaction it conveys) represent increasingly autonomous forms of motivation. In contrast, introjected regulation (i.e., engaging in an activity to avoid negative emotions such as anxiety or guilt), external regulation (i.e., engaging in an activity to obtain a tangible reward, to avoid a punishment or to comply with an external authority) represent increasingly controlled forms of motivation. In addition to autonomous and controlled forms of motivation, SDT also considers amotivation (i.e., individuals see no relationship between behavior and outcomes) which represents the absence of motivation (see Deci & Ryan, 2002).
While the differentiation between autonomous versus controlled motivation is central to SDT, perceived competence (i.e., individuals’ feeling of efficacy with respect to the behavior) is an important variable of the theory too presumed to facilitate autonomous motivation (Deci & Ryan, 2002). Furthermore, SDT suggests that the social context – in particular, the degree of autonomy support provided by healthcare supervisors (i.e., active listening, collaboration, respect and thorough support) – may improve patients’ autonomous motivation, perceived competence and health-relevant behaviors (Patrick & Williams, 2012). Research has shown that perceived autonomy support, autonomous forms of motivation and perceived competence are related to positive health outcomes (see Ng et al., 2012, for a review), such as a reduction in BMI (Silva et al., 2010) and an increase in PA among obese or overweight patients (Fortier, Sweet, O’Sullivan, & Williams, 2007; Silva et al., 2010).

The present study

The primary purpose of this study was to evaluate the effectiveness of an MI-based intervention as an addition to a standard weight loss program (SWLP) in order to improve PA and BMI in obese adolescents. Based on the transmission of knowledge and skills to generate behavior change (Cooper, Fairburn, & Hawker, 2003), SWLP has been found to have a positive – but modest – impact on PA and BMI of obese adolescents (Gilles, Cassano, Shepherd, Higgins, Hecker, & Nangle, 2008). One of the viable explanations is that this kind of intervention does not formally address ambivalence about change. Sustained motivation for PA may yet be especially difficult for obese participants (Gourlan, Trouilloud, Sarrazin, in press). That is why the addition of MI could be valuable during an SWLP because it could increase participants’ self-determined motivation toward PA when motivational barriers arise and thus complement the acquisition of behavioral change skills (e.g., Burke, 2011; Westra & Arkowitz, 2011). A recent meta-analysis on adult obesity pointed out that the addition of MI-based sessions to weight-loss interventions has a beneficial impact on treatment outcomes.
(Armstrong et al., 2011). As very few studies have dealt with the impact of MI on obesity management in adolescents (i.e., MacDonell et al., 2012), less is known about the potential benefits of this strategy, and its complementarity with SWLP, among this population. The participants of this study were randomly assigned to a group participating in an SWLP (SWLP group) or to a group receiving the same SWLP supplemented with 6 phone MI sessions oriented toward the promotion of PA (SWLP + MI group). Recent research reported that phone may be an interesting media to implement MI, particularly in order to limit time constrains or transportation problems for participants (van Keulen et al., 2011). While both groups were expected to benefit from the intervention received, it was hypothesized that adolescents in the SWLP + MI group would report a greater increase in PA and a greater decrease in BMI over time as compared to those in the SWLP group.

Based on SDT tenets, the second purpose was to explore some potential mechanisms involved in the changes generated by the interventions, in particular perceived autonomy support, motivational regulations and perceived competence. Because an SWLP is based on the promotion of skills and knowledge of health behaviors, it is believed to promote perceived competence (Annesi & Withaker, 2010). Thus, it was hypothesized that adolescents in both groups would report an increase in perceived competence over time. However, because MI is specifically designed to support perceived competence, the increase was expected to be greater in the SWLP + MI group. In addition, as advocated by some scholars (e.g., Markland et al., 2005; Vansteenkiste & Sheldon, 2006), the MI intervention should improve autonomous forms of motivation, notably by supporting participant autonomy. The four MI principles presented above should generate an autonomy-supportive climate, thus promoting autonomous motivation and hindering amotivation toward PA. Thus, it was hypothesized that adolescents in the SWLP + MI group would report (1) higher perceptions of autonomy
support, (2) greater increase in autonomous forms of motivation, and (3) greater decrease in amotivation over time as compared to those in the SWLP group.

Methods

Study Design

Power analysis, assuming an effect size of $d = 0.74$ (Hettema et al. 2005), a power of 80% and an alpha level of 0.05, indicated an average sample size of 30 participants per condition. Sixty-two obese adolescents (41% female) were thus recruited over a two-year period in a French hospital. All had been referred to the hospital by their general practitioner because of their extreme obesity. Eligible participants were between the ages of 11 and 18 years old (Mean age=13, SD=1.66), had a BMI over the 90th age and gender specific percentiles (Mean BMI=29.57 kg/m², SD= 5.34), and did not have any unstable or uncontrollable diseases. Judgment of eligibility of the adolescents was made by the healthcare provider of the study (see below) and was done without foreknowledge of the randomization sequence. The project manager assigned each adolescent randomly and independently to the SWLP group (n = 34) or the SWLP + MI group (n = 28) (see figure 1 for the CONSORT flowchart of participants). Participants, the health care provider and data collectors were blinded to the group (SWLP or SWLP+MI) the adolescents were assigned to. The study was approved by the research ethics committee of the specific academic institution. Parents provided informed consent, and adolescents provided written assent for study participation.

In the SWLP group, participants received an intervention consisting of 2 individual face-to-face sessions of 30 minutes at the hospital with a healthcare provider over a three-month period. In the MI condition, participants received the same intervention by the same healthcare provider plus 6 MI phone sessions with a PA trained counselor of 20 minutes over a 6-month period (3 MI between the two SWLP sessions and 3 after the last SWLP session).

Interventions
This program was delivered by a doctor of medicine specialized in pediatric obesity and certified in Behavioral and Cognitive Therapies. The goal was to promote a balance diet, a healthy lifestyle and PA. The Healthcare provider led the session by providing and transmitting knowledge and skills. Logical and rational arguments can be used to convince the adolescent to adopt new behaviors. The main ‘active ingredients’ of this intervention listed in the CALO-RE taxonomy (Michie Ashford, Sniehotta, Dombrowski, Bishop, & French, 2011) consisted of: providing information on consequences of behavior in general (e.g., relationship between PA and physical and mental health, based on epidemiological studies), providing information on consequences of behavior to the individual (e.g., benefits and costs of doing or not doing PA on weight loss among obese adolescents), prompting goal setting (behavior) (e.g., 30 minutes of PA per day, five or more days per week), providing information on where and when to perform the behavior (e.g., tips on places and times adolescent can do PA), prompting self-monitoring of behavior (e.g., self-monitoring habitual weekly PA), and providing feedback on behavior (e.g., comparing current PA practice with recommendations).

MI. A sport and exercise sciences doctoral student delivered MI sessions. He received an MI training including 40 hr of reading (Arkowitz, Westra, Miller, & Rollnick, 2008; Miller & Rollnick, 2002; Rollnick et al., 2008) and 32 hours of training formation with the French Association of Motivational Interviewing. The main ‘active ingredient’ of this intervention consisted of MI, namely to elicit and reinforce the adolescent’s change talk in order to minimize resistance and resolve ambivalence to change (Michie et al., 2011). For each session, the four MI principles developed above and basic techniques (e.g., using open-ended questions, affirming the patient’s freedom of choice) were used to encourage adolescents to articulate their concerns and goals, and develop their autonomy (Miller & Rollnick, 2002).
Sessions followed a semi-structured format and were likely to include the four following aspects (see Appendix 2 for a further presentation of MI intervention).

**Phase 1, making the participant’s acquaintance and building awareness:** The counselor’s role was to elicit the participant’s thoughts and increase his/her awareness of them. First, the counselor aimed to create a confident relationship by discussing what was important in the participant’s life (e.g., hobbies, friends, projects for the future). Second, the counselor introduced weight and PA-related concerns (e.g., body image, present PA practice). Change talk was encouraged by exploring ambivalence and conflicting beliefs about behavior change.

**Phase 2, Alternatives and problem solving:** Once the adolescent had begun to evoke the discomfort of the present situation and the possibility, the necessity or the importance of making some change(s), alternatives to current behaviors were considered. All options were first discussed (e.g., kind of activities, time of the day). Then one or several alternative behaviors were selected depending on the participant’s needs and aspirations.

**Phase 3, Goal setting and agenda setting:** When alternative behavior had been chosen, the counselor and participant set some goals that were realistic and achievable. Potential barriers to accomplishing the plan and strategizes to overcome these barriers were also discussed.

**Phase 4, Behavior modification consequences and perspectives:** Behavior adoption consequences (e.g., unexpected barriers, feelings toward behavior) were considered. Finally, behavior maintenance and possibilities of adopting new PA habits were also discussed.

**MI integrity.** All MI sessions were audio-taped. To assess fidelity to MI principles, 25 randomly selected interviews were evaluated by a Sport and Exercise Sciences doctoral student trained in the Motivational Interviewing Treatment Integrity code, Version 3.1.1 (MITI; Moyers, Martin, Manuel, Miller, & Ernst, 2010). Percent complex reflections (CR), percent open-ended questions (OC), reflection-to-question ratio (R:Q), percent MI adherent (MiA) and a Global MI Spirit rating (GMIS) were calculated (the last indicator with a 5-point
Means for the behavioral counts were as follows: CR = 40.65 (SD = 13.12), OQ = 54.58 (SD = 12.99), R:Q = 0.78 (SD = 0.36), MiA = 86.57 (SD = 16.31). Mean for GMIS was 3.76 (SD = 0.47). Scores were above proficiency guidelines for CR, OQ, GMIS, and slightly below proficiency for R:Q and MiA (see Moyers et al., 2010).

**Assessment intervals**

Perceived competence, motivation for PA and self-reported PA were administered three times: at baseline, 3- and 6-months. At 6 months participants also completed a questionnaire about perceived autonomy support from medical staff during the intervention. Because self-reported PA is deemed to be biased in this population (Buchowski, Townsend, Chan, Acra, & Sun, 1999), a randomized subsample of adolescents wore an accelerometer for one week to assess PA at the baseline and at 6 months. Combining objective measures with self-report of PA is believed to achieve greater measurement accuracy (Cliff et al., 2010).

**Measurement**

**Motivations for PA.** Motivation for PA was assessed with a French version of the Behavioral Regulation Exercise Questionnaire (BREQ-2) (Markland & Tobin, 2004). This 20-item scale assesses the reasons why people exercise or participate in PA. The BREQ-2 includes subscales assessing intrinsic (e.g., “I exercise because it’s fun”), identified (e.g., “I think it is important to make the effort to exercise regularly”), introjected (e.g., “I feel guilty when I don’t exercise”), external (e.g., “I take part in exercise because my friends/family say I should”) regulations, and amotivation (e.g., “I don’t see why I should have to exercise”). Following the stem “Why do you engage in exercise?” participants respond to each item on a 7-point scale ranging from 1 (“not true for me”) to 7 (“very true for me”). In addition, integrated regulation was assessed through 4 items (e.g., “I consider exercise to be part of my identity”; Wilson, Rodgers, Loitz, & Scime, 2006). Previous research supports the BREQ-2’s multidimensional structure and the internal consistency of each subscale (e.g., Markland &
Perceived competence. Perceived competence was measured using a scale that was created based on recommendations by Bandura (1997). This four-item questionnaire assesses participants’ degree of confidence in their ability to complete at least 30 minutes of moderate-intensity activity at frequencies of one, two, three, and four occasions per week. For each item the participants recorded the strength of their self-efficacy beliefs on a 100-point scale using a scale ranging from 0% (“absolutely not confident”) to 100% (“absolutely confident”), increasing in ten-point increments. A perceived competence toward exercise score was calculated by averaging the answers to the four items.

Perceived autonomy support. At 6-months, participants completed a French version of the Health Care Climate Questionnaire (HCCQ) (Fortier et al., 2007) to assess perceived autonomy support from the medical staff during the intervention. Participants responded to 6 items (e.g., “I feel that healthcare providers in the hospital provided me with choices and options about PA”) on a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”). “Medical staff” represented the healthcare provider in the SWLP condition and both the healthcare provider and MI counselor in the SWLP + MI condition. Reliability and validity of the HCCQ has been demonstrated in previous studies (e.g., Fortier et al., 2007).

Self-reported PA. Self-reported PA was assessed using the 7-day PA recall interview (Gross, Sallis, Buono, Roby, & Nelson, 1990). The interviewer ascertained the participants’ estimated duration in activities of low, moderate, high and very high intensity, during the previous week. Total PA length was calculated by adding the PA duration for each intensity level (in hours per day). Total energy expenditure (in kilocalories) was calculated by multiplying each intensity level by an intensity factor (1.5 for light intensity, 4 for moderate intensity, 6 for...
hard intensity, and 10 for very hard intensity). The reliability and validity of the 7-day PA recall have been established elsewhere (e.g., Pereira et al., 1997).

Objective PA. Objective measurement of total energy expenditure (in kilocalories per day), and length (in hours per day) associated with PA was done via an accelerometer, the SenseWear® Pro2 Armband (BodyMedia, INC., PA, USA). The validity of this accelerometer’s suitability for estimating the PA of adolescents has been reported elsewhere (e.g., Welk, McClain, Eisenmann, & Wickel, 2007). Because of the methodological unwieldiness of accelerometer use, a randomized subsample 20 adolescents were asked to wear an accelerometer (10 in the SWLP + MI group and 10 in the SWLP group). At the baseline and at 6-months they were instructed to wear it continuously, including during sleep, for 3 consecutive days (i.e., two weekdays and one weekend day), except while showering or swimming. Previous work indicates that 3 days appears as an acceptable sampling period for an accelerometer (e.g., Trost, McIver, & Pate, 2005). After removing incomplete data (e.g., incomplete wear-time and breakdown), 15 adolescents effectively wore the accelerometer (6 in the SWLP + MI group and 9 in the SWLP group).

Body mass index. BMI was calculated as body weight (in kilograms) divided by height (in meters, squared). Body weight was recorded with the adolescents wearing light clothes and without shoes (digital balance scale; Tanita® Model BC-532) to the nearest 0.1 kg. Height was measured to the nearest 0.5 mm using a wall-mounted stadiometer (Seca®). BMI is accepted as a valid and suitable index for the assessment of obesity over time among children and adolescents (Cole, Faith, Pietrobelli, & Heo, 2005).

Statistical analyses

First, independent samples t-tests were carried out to evaluate whether the MI and SWLP groups had differences at baseline on psychosocial, behavioral and demographic variables. All primary outcomes analyses are based on an intention to treat analysis, with all
adolescents included in the condition they were assigned. Then, various analyses were
carried out using MLwin software version 1.1 (Rasbash, Brown, Healy, Cameron, & Charlton, 1999). As with standard regression analyses, the aim of MLM is
to express the dependent variable as a function of predictor variables. However, MLM can
incorporate two levels of analyses: a within-person equation (Level 1), which concerns over
time within-individual change, and a between-person equation (Level 2), which concerns
inter-individual differences in change (i.e., that predicts differences between individuals in
their rate of change over time) (Steele, 2008). Indeed, for each variable with 3 measurements
(i.e., self-reported PA, BMI, motivational regulations, perceived competence) a conditional
growth model was tested to examine the effects of experimental condition (a dummy variable
was created where SWLP = 0 and SWLP + MI = 1) on the intercept and rate of change (i.e.,
the slope). In these models, the slope represents the change in the dependent variables scores
in the SWLP group, whereas the interaction between the slope and condition shows the
difference in the rate of change of scores between the SWLP and the SWLP + MI groups over
the 6 months. Time measure was centered at month 6. Consequently, the intercept reflects the
mean level of the dependent variable at month 6 for the SWLP group, whereas the main effect
for condition represents the difference in scores between the two conditions.
Results

Attrition analysis and missing data

Fifty-four (28 in the SWLP group, 26 in the SWLP + MI group) participants completed the interventions (attrition rate = 13%) (see Figure 1 for the CONSORT flowchart of participants). Among the completers, three missing data (i.e., participants not completing all assessments) were identified. This did not appear as a concern given that MLM allows for missingness on some variables, assuming data are missing at random (Steele, 2008). T-tests and chi-square tests revealed that dropouts did not differ from completers with regard to gender, BMI, motivational regulations, perceived competence and PA ($p > .05$). Dropouts were, however, significantly older (Mean age = 14 vs. 12.5 for dropouts and completers respectively; $p < .01$).

Baseline differences between groups and descriptive statistics

T-tests and chi-square tests revealed no baseline differences between the MI and the SWLP groups on demographic variables, motivational regulations, perceived competence and objective PA ($p > .05$) for participants initially enrolled (n = 62, see Figure 1) and for completers (n = 54). However, baseline differences existed for self-reported PA length and energy expenditure. As compared to those in the SWLP group, participants in the SWLP + MI group reported lower PA length and energy expenditure at the baseline ($p < .05$).

Descriptive statistics were computed for all variables at each measurement point for completers (n=54) (see Table 1).

Change in BMI

MLM analyses revealed that participants in the SWLP group did not report significant change over time for BMI ($p = .47$). As compared to those in the SWLP group, participants in the SWLP + MI group demonstrated a significant decrease for BMI ($B = -0.89, p < .001, d =$
.59). However, they did not differ from the SWLP group on this variable at the end of the intervention ($p = .17$) (see Figure 2).

Change in PA

Concerning self-reported PA, MLM analyses revealed no change among participants in the SWLP group for PA length (hours per day) ($p = .22$) and energy expenditure (kilocalories per day) ($p = .91$). As compared to those in the SWLP group, participants in the SWLP + MI group reported a significant increase over time for both PA length ($B = 2.75, p < .001, d = .57$) and energy expenditure ($B = 135.22, p < .001, d = .38$). Moreover, they reported higher levels of PA length ($B = 3.31, p < .01, d = .39$) and energy expenditure ($B = 2.64, p < .01, d = .36$) than the SWLP group at 6 months (see Figure 2).

Concerning objective PA, repeated measure ANOVAs revealed significant time × group interaction for PA length [$F(1, 13) = 4.5, p < .05, d = 1.11$], and PA energy expenditure [$F(1, 13) = 4.92, p < .05, d = 1.16$]. Fisher’s LSD post-hoc analyses revealed that contrary to the SWLP group, the SWLP + MI group increased its total PA length and energy expenditure over time ($ps < .001$) (see Table 1).

Change in motivational regulations

Concerning autonomous forms of motivation, MLM analyses revealed a significant increase in intrinsic motivation for the SWLP group ($B = 0.22, p < .05, d = .57$). No differential change over time was found for the SWLP + MI group as compared to the SWLP group ($p = .87$), suggesting a similar increase for both groups on this variable. At 6 months, participants of the two groups did not differ on this variable ($p = .08$). Moreover, participants in the SWLP group reported no significant change for integrated regulation ($p = .98$) and identified regulation ($p = .92$). As compared to those in the SWLP group, participants in the SWLP + MI group reported a significant increase over time for both integrated ($B = 0.39, p < .01, d = .43$) and identified regulations ($B = 0.33, p < .01, d = .36$). Moreover, they
reported significant higher levels of integrated ($B = 0.8, p < .001, d = .34$) and identified
regulations ($B = 0.67, p < .01, d = .31$) at 6 months, compared to the participants in the SWLP
group (see Figure 2 for results related to identified and integrated regulations).

Concerning controlled forms of motivation, no significant changes were found for the
SWLP group on introjected ($p = .69$), and external regulations ($p = .69$). No differential effect
was found for the SWLP + MI group as compared to the SWLP group on those two
motivational regulations ($p = .43$ and $.97$, respectively), suggesting an absence of change for
both groups on these variables. At 6 months, the SWLP + MI group did not differ from the
SWLP group on introjected ($p = .57$) and external regulations ($p = .68$).

Lastly, no significant change was found for the SWLP group on amotivation ($p = .90$).
As compared to those in the SWLP group, participants in the SWLP + MI group reported a
significant decrease over time for amotivation ($B = -0.40, p < .01, d = .44$). Moreover, they
reported a significant lower level of amotivation at 6 months ($B = 0.42, p < .05, d = .29$) (see
Figure 2).

Change in perceived competence

The analyses revealed a significant increase in perceived competence ($B = 6.90, p <
.001, d = .81$) for the SWLP group. No differential change over time was found for the SWLP
+ MI group as compared to the SWLP group, suggesting a similar increase for both groups on
this variable ($p = .34$). Moreover, the SWLP + MI group did not differ from the SWLP group
on this variable at 6 months ($B = 3.52, p = .50$).

Differences in perceived autonomy support at the end of the program

Independent samples $t$-tests revealed a difference between groups in perceived
autonomy support at the end of the program [$t (52) = 3.02, p<.01, d=.83$]. At 6 months,
adolescents in the SWLP + MI condition perceived medical staff as more autonomy
supportive ($M=6.47$) than those in the SWLP condition ($M=5.78$).
Discussion

The primary purpose of this study was to assess the impact of an MI-based intervention in addition to an SWLP on PA and BMI of obese adolescents. The second purpose was to explore some underlying processes involved in these effects, using SDT (Deci & Ryan, 2002) as an explanatory framework. For this, 54 obese adolescents were randomized into an SWLP or an SWLP + MI condition and then followed over a 6-month period.

Effects of MI on PA and BMI

SWLP consisted mainly in (1) providing information intended to increase the value/importance of PA and participants’ confidence about their capacities to do it, as well as in (2) developing skills to integrate PA into their lifestyle. Such intervention generally assumes that individuals are ready to make changes. However, many obese teenagers could be ambivalent or resistant to adopting PA in their lifestyle. By contrast, MI is specifically designed to minimize resistance and resolve ambivalence to change. We presumed that in an SWLP, MI could increase participants’ motivation toward PA and thus complement the acquisition of behavioral change skills. In other words, an additive effect was presumed because SWLP and MI work through different mechanisms. The results indicate that the addition of MI sessions to an SWLP improved both PA practice and BMI reduction in obese adolescents. Adolescents in the SWLP + MI group reported an increase in self-reported PA by a mean of 33 minutes per day, and of energy expenditure by a mean of 283 kilocalories per day. As compared, participants in the SWLP group remained stable on those variables. These changes in PA for the SWLP + MI group, resulted in a difference between the groups at 6 months suggesting that the addition of 6 MI sessions to the 2 SWLP sessions had a positive impact on PA practice of obese adolescents. The effect sizes in the present study for self-reported PA length ($d = .57$) and energy expenditure ($d = .38$) are consistent with those reported among obese adults for 5 MI sessions (spread over the two additional months) after
20 SWLP sessions spread over the initial four month period ($d = .55$) (Carels et al. 2007), and larger than those reported for 4 MI sessions combined with 16 SWLP sessions over four months ($d = -.11$ to -.04) (Befort et al., 2008). Of note, the results for self-reported PA change were confirmed by objective data recorded on a subsample of participants for each group. Past research highlighted the necessity of combining objective and self-reported methods to enhance accuracy of PA measurement (Cliff et al., 2010). From this point, equivalent results stemming from both methods of measurement on the differences of PA change between groups give strong additional credit to the results of this study.

Concerning BMI, although the two groups did not differ at 6 months, the changes observed were in the expected direction. Adolescents in the SWLP + MI group reported a decrease in BMI by a mean of 1.61 kg/m$^2$. The effect size reported on BMI ($d = .59$) is consistent with global mean effect sizes in prior research using MI in addition to an SWLP among obese adult populations ($d = .40$) (Armstrong et al., 2011). The absence of difference between the groups for BMI at 6 months may partially be explained by the small sample size.

Taken as a whole, these results highlight that MI appears to be a promising approach throughout an SWLP to improve obesity management among obese adolescents. This study is the first to empirically corroborate the positive impact of MI on pediatric obesity in complement to an SWLP. More interventions are warranted to identify the optimal dose and timing of the two parts of the interventions to promote the greatest change in PA among such populations.

**Effect of MI on motivational variables**

In order to identify some of the mechanisms involved in the results described above, the present study explored the impact of MI on motivational variables extracted from SDT (Deci & Ryan, 2002), namely motivational regulations, perceived competence toward PA and perceived autonomy support from medical staff. Results revealed that adolescents in the
SWLP + MI group reported an increase in integrated and identified regulations as well as a decrease in amotivation over the program. By diminishing amotivation, MI sessions had a positive impact on the “quantity” of motivation (Vansteenkiste & Sheldon, 2006). Moreover by helping participants to understand why it is personally important and meaningful to participate in PA (i.e., identified regulation) and to value and internalize these personal reasons (i.e., integrated regulation) – two types of autonomous regulation which are particularly important for maintaining sustainable PA behavior among obese adolescents (Gourlan et al., in press) – MI also had an impact on the “quality” of motivation (Vansteenkiste & Sheldon, 2006). In addition, participants in the SWLP + MI group reported higher levels of perceived autonomy support from medical staff. These results confirm that MI is an autonomy supportive counseling method likely to help individual to assimilate in their self, regulation of behavior which are difficult to implement (i.e., PA) but useful for their functioning or well-being (Markland et al., 2005). More precisely, the MI core principles (i.e., expressing empathy, developing discrepancy, rolling with resistance, supporting self-efficacy) could be major elements of an autonomy supportive climate and processes that promote internalization of behavior (Vansteenkiste & Sheldon, 2006). As it appears necessary to further determine the active components of SDT based interventions (Ng et al., 2012), additional research is needed to more clearly identify which among MI principles operate on perception of autonomy support and the process of internalization (Patrick & Williams, 2012).

A similar positive change over time for intrinsic motivation and perceived competence was also observed for both groups. This result suggests that MI sessions had no additional effect – above and beyond SWLP – on these variables. Two main reasons may explain these results. Firstly, the impact of the SWLP on perceived competence and intrinsic motivation may have created a “ceiling effect”. For example, the SWLP had an impact on perceived competence to a certain level (e.g., M = 89.32 and 85.44 for the MI and the SWLP groups,
respectively, at the end of the intervention on a 100 point scale), that may have prevented additional improvement with the MI intervention. A second explanation is that the MI sessions were not sufficient to affect intrinsic motivation and perceived competence. On this point, past research has reported the absence of effect of MI on perceived competence (e.g., Befort et al., 2008). Future studies should thus address this issue.

Taken as a whole, these results confirmed that while SWLP increases perceived competence (Annesi & Whitaker, 2010), MI sessions as an adjunct might reduce amotivation and promote autonomy support and autonomous regulation toward a behavior (Markland et al., 2005; Vansteenkiste & Sheldon, 2006). In other words, these two types of intervention seem to work through different mechanisms (Burke, 2011). While SWLP can provide the necessary skills to complete the target behavior, MI can boost the quantity and quality of motivation for change. Consequently, MI is effective to complete an SWLP by specifically addressing resistance and ambivalence issues about change. While the addition of MI during SWLP generated positive changes in this study, it is important to note that there are several ways of combining or integrating MI and SWLP. While many studies have focused on using MI as a “pretreatment” to build motivation for change prior other treatment (like cognitive-behavioral treatment), this study and others have shown that MI can be valuable during a treatment, because motivational issues can remain a concern throughout the course of such program (Arkowitz, Westra, Miller, & Rollnick, 2008). Finally, as suggested by some authors (e.g., Flynn, 2011) MI can also serve as an integrative framework in which other interventions can be incorporated. Juxtaposing two techniques can indeed raise several issues if interaction styles are different or if the techniques used are incompatible. For example, “contingent reward” a behavior change technique that is regularly used in the treatment of obesity (e.g., Dombrowski et al., 2012) is rather incompatible with the principles of both MI and SDT (Vansteenkiste, Williams, & Resnicow, 2012). The high autonomy support score observed in
the SWLP + MI group (i.e., 6.47 on a 7-point scale) shows that this limit was not an issue in
this study. However, a true integration of MI with other programs implies that healthcare
providers incorporate its fundamental skills throughout their interventions, and use it
whenever motivational issues arise.

Limitations and Perspectives

One limitation of the study concerns the relatively small sample size. Replication with
a larger sample is warranted. Another limitation is that the intervention was not time-matched
to the control group but rather was provided as an addition to a standard care program that all
patients received. It is thus unclear whether the observed benefits in participants who received
the SWLP plus MI treatment were due to MI or simply additional therapeutic contact
generated by the MI sessions. This limitation is common in many studies that test the effects
of MI as a supplement to standard programs (e.g., Carels et al., 2007; Hardcastle et al., 2008).
However, it is unlikely that benefit due to additional counselor time provides a full
explanation for the observed difference. The positive evolutions of identified, integrated
regulations, amotivation and perceived autonomy support observed among MI participants
suggest that the higher PA level observed in this group is – at least in part – due to the
characteristics of MI. To better calculate the additive effects of MI, future research should use
dismantling designs, such as comparing MI + SWLP, and another type of session (e.g., health
education; Befort et al., 2008) + SWLP, to SWLP alone, and ideally should control for length
of treatment and number of sessions (i.e., using a time-matched control group). A related
point of interest would be to investigate if MI is more effective at the beginning or throughout
the SWLP, as well as an examination of potential mediators and moderators of outcomes.
Finally, the synergistic effect of MI on SWLP (or other programs) could be studied in RCT in
which groups of obese participants are assigned either to SWLP delivered by a healthcare
provider not trained in MI (i.e., rated low in MITI code) compared to a healthcare provider
who is rated high in MITI code. Future research should also integrate a post intervention follow-up period (e.g., 6 months post intervention) in order to evaluate the maintenance of MI effects over time.

As a conclusion, keeping these limitations in mind, results of the present study indicate that MI is an effective intervention that improves PA among obese adolescents compared to a standard weight loss program alone. While an SWLP can provide the necessary skills to adopt behavior change MI can develop motivation for change (Burke, 2011), notably by supporting participants’ autonomy perception and promoting autonomous reasons for adopting health behaviors. The relatively low cost-effectiveness associated with MI makes it an attractive method of intervention for the management and prevention of pediatric obesity.

In the present investigation, six MI sessions of approximately twenty minutes during six months were sufficient to increase PA and decrease BMI.
Acknowledgements

This research has benefited from the help of the French National Institute of Prevention and Health Education (INPES). The authors would also like to thank Doctor Claudine Perrin for her advice and assistance during the trial.
Appendix 1. SWLP intervention: behavior change techniques and materials used and a summary of each session.

Note. SWLP content is mapped to the behavior change techniques proposed by Michie et al (2011). PA= Physical activity. "a" = Only PA content is presented in this document, similar behavior change techniques were used for eating behavior.
<table>
<thead>
<tr>
<th>Session</th>
<th>Behavior change technique</th>
<th>Summary</th>
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| Session 1: Evaluating behavior and providing information | • Goal setting (behavior)  
• Providing information on consequences of behavior in general  
• Prompt self-monitoring of behavior” | The main aim of the first session was to help adolescents to develop intentions to change (eating behavior, physical activity). This session notably consisted in setting behavioral goals. Based on current recommendations (Blair, LaMonte, & Nichaman, 2004) adolescents were instructed to engage in moderate PA for at least 30 minutes per day, five or more days per week. In addition, adolescents were provided with some general information about PA. More precisely, adolescents were first presented the different “ways” of doing PA (Donnelly et al., 2009), namely sport activities (e.g., local sport club), leisure time PA (e.g., doing PA with friends in a playground) and lifestyle PA (e.g., walking to go to school). In addition, the different “families” of activities for sport and leisure time PA were presented, namely, team (e.g., football), artistic (e.g., dance), combat (e.g., judo) and individual activities (e.g., running). Then, the relationships between PA and health outcomes (e.g., obesity, cardiovascular disease risk) were presented based on epidemiological reports (e.g., Stensel, Gorely, & Biddle, 2008). Lastly, the adolescents were given a booklet and asked to self-monitor and record their PA over a “typical” week (i.e., excluding holidays). |
| Session 2: Providing feedback and giving instructions to perform behaviors | • Providing feedback on behavior  
• Providing information on consequences of behavior to the individual (tailored to obese adolescent)  
• Provide information about where and when to perform the behavior. | The aim of the second session was to help adolescents to adopt behavior change. Completed self-monitoring records for PA were discussed and adolescents were given feedback about the differences between their actual behavior and the recommendations. In order to raise adolescents’ awareness about the importance of adopting behavior change, benefits of PA were presented. In short, benefits of PA on physical health (e.g., weight loss, health risks reduction), psychological health (e.g., stress, anxiety), and social aspects (e.g., making friends) were presented. Lastly, adolescents were told about where and when to carry out the behaviors. They were instructed to join a local (or school) sport club and to adopt a more highly active lifestyle (e.g., walking to go to school, going to a park to walk with the dog). |
Appendix 2. MI intervention: Summary of the different phases, examples of subjects dealt with, open ended questions and techniques used during MI sessions.

Note. PA= Physical activity, * = When perceived as necessary during intervention.
Phase 1, making participant’s acquaintance and building awareness

General concerns: “What would you like to discuss first? What worries you in school or in your life? What are your plans for the future?”

PA and weight related concerns: “What do you think about your weight? What can you tell me about your past and current PA practice?”

Pro and cons of actual situation: “What do you think about current situation? How do you feel about this situation? According to you, what are the pros and cons of the current situation? According to you, what are the pros and cons to possibly becoming more active?”

Phase 2, Alternatives and problem solving

Readiness to change: “On a scale of 1 (i.e., not ready at all) to 10 (i.e., totally ready) how ready are you to become more active?”

PA importance: “In your opinion, what could PA bring you? Why is PA becoming more important for you?”

Future projection: “Suppose that you succeed in becoming more active, how do you perceive yourself in the next few weeks, months or even years? If you decide to change, what things would you like to see change in your life?”

Elaboration: “If you decide to become more active tomorrow, tell me ALL the things that you will be able to do. You can, tell me the kind of activities, how often you will do them, who you will do them with...don’t hesitate to tell me everything that you can come up with!”

Phase 3, Goal setting and agenda setting

Behavior choice: “Among all the behaviors that we have talked about previously, which one(s) will you finally try implement first? Why such a choice? What do you find attractive in this (or these) option(s)?”

Plan construction: “Let’s create an action plan! Tell me about what activity(ies) you would like to try, when, for how long, where, (maybe) with whom?”

Potential barriers: “In your opinion, what are the potential barriers to your plan? What strategies could help you to overcome these barriers?”

Plan commitment: “This is what you really want to try first, right?!?”

Support self-efficacy

Confidence to change: “On a scale of 1 (i.e., absolutely not confident) to 10 (i.e., absolutely confident) how confident are you in succeeding in becoming more active? What would help you to pass from __ to __?”

Past success: “When did you successfully carry out a project that was particularly important for you? It could be anything. For example at school, with your family or friends.”

Personal resources: “According to you, what are the strengths that you have and that could help you to adopt this new habit with success?”

Phase 4, Behavior modification consequences and perspectives

Behavior change feedback: “What can you tell me about your behavior change initiative? What are your feelings toward your new behavior(s)? What are the benefits and costs that you take from it? If necessary, what are the changes you could try make in order to help you be more at your ease with the new habit(s) you have adopted?”

Behavior maintenance and perspectives: “What is the next step for you with this behavior? What is the next step for you vis-a-vis your initial aim to be more physically active?”

Roll with resistance

Double reflection: “Ok, on one hand you said that it’s important for you to change but on the other hand you also said that it’s not an issue at the moment”

Change focus: “If it’s not an issue for you at the moment, tell me more about...”

Emphasizing adolescent’s control: “It’s important that you know that I’m not here to force you to become more active. It’s up to you to decide to change or not”
References


Footnotes

1 Tables including results from all the MLM analyses are available from the first author on request.

2 Objective and self-reported PA appeared significantly correlated both at baseline and 6 months for PA length (r = .41 and r = .53, p < .01, respectively) and energy expenditure (r = .36 and r = .47, p < .05, respectively).
Table 1.

Reliability analysis (Cronbach’s coefficient alpha), Means (M) and Standard Deviations (SD) for psychosocial variables, BMI, self-reported and objective PA at each measurement point

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Notes: SWLP group= Standard Weight Loss Program group (n = 28). SWLP + MI group= Standard Weight Loss Program plus Motivational Interviewing group (n = 26).

PA= Physical activity. M=Mean. SD= Standard Deviation. PA length is in hours per day. Energy expenditure is in kilocalories per day.
Figure 1. CONSORT flowchart of participants.

Note. SWLP= Standard weight loss program, MI= Motivational interviewing.
Figure 2. Trajectories of participants in the MI and SWLP groups for self-reported PA energy expenditure, PA length, BMI, amotivation, identified regulation and integrated regulation.

Note. PA= Physical activity, BMI= Body mass index, H/d= Hours per day, Kcal/d= Kilocalories per day, Kg/m²= Kilograms per square meter