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Understanding excess weight in adolescence from emotional and behavioural perspectives

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PREAMBLE / PRÉAMBULE

Preamble

The present document constitutes the synthesis of a cumulative dissertation composed of the three following articles:

Walther, M., & Hilbert, A. (2015). Emotional Openness in overweight and normal-weight adolescents. *Swiss Journal of Psychology, 74*, 29-36. doi:10.1024/1421-0185/a000145

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Préambule

Le présent document constitue la synthèse d'une thèse cumulative composée des trois articles suivants:

Walther, M., & Hilbert, A. (2015). Emotional Openness in overweight and normal-weight adolescents. *Swiss Journal of Psychology, 74*, 29-36. doi:10.1024/1421-0185/a000145

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ABSTRACT / RÉSUMÉ

Abstract

Lately, the prevalence of obesity has increased to such an extent that we now speak about a worldwide epidemic, which affects not only adults, but also children and adolescents. If adult obesity induces serious health complications, it is even more problematic in children and adolescents. In addition to a large range of immediate health issues (e.g., breathing difficulties, cardiovascular problems, diabetes, and increased risks of fractures), they also have to face long-terms consequences, as overweight children and adolescents have an increased risk of adult obesity, and therefore a greater probability of premature disability and death in adulthood (World Health Organization [WHO], 2013).

In order to control this epidemic, it is necessary to understand the causes of obesity. Even if the principal sources of the global epidemic are now well established (they mainly reside in socio-cultural modifications of our modern societies which lead individuals to consume much more than they expend), there is still much to be learned regarding the individual causes of weight gain. It is now widely acknowledged that excess weight results from the interaction of multiple factors, including those that are biological (in particular genetic), environmental, as well as behavioural and psychological (Delgrande Jordan, Kuntsche, & Gmel, 2007; WHO, 2004). In the present dissertation, we mostly focused on psychological and behavioural factors, since we investigated the implication of emotional processing, temperament dispositions, and problematic eating behaviours (PEBs) in excess weight. Research has linked those variables to obesity (e.g., Nederkoorn, Braet, Tanghe, & Jansen, 2006; Rehkopf, Laraia, Segal, Braithwaite, & Epel, 2011; Snoek, Van Strien, Janssens, & Engels, 2007), but the evidence is sparse and inconclusive, especially in adolescents.

In our first study, we examined the influence of Emotional Openness (EO), a generic model comprehensively assessing emotional processing (Reicherts, 2007; Reicherts, Genoud, & Zimmermann, 2012), on excess weight. We first compared EO in normal weight vs. overweight/obese adolescents, in order to determine if the particular EO profile found in obese adults (Braunschweig-Spatz, 2006) could be replicated in adolescents. We then tested a mediation model to determine if PEBs played a mediating role between EO and excess weight. We finally explored the psychometric characteristics of the Dimensions of Openness to Emotions questionnaire (DOE-20; Reicherts et al., 2012) in adolescents. The sample consisted of 160 youngsters (mean age: 14.36 ± 0.61 years), including 39 overweight/obese adolescents (24.5%). Although the original five-factor structure of the DOE-20 was confirmed in our sample, internal consistency was modest. Moreover, we were not able to replicate the previously found EO profile, because no significant differences were found between normal weight and overweight/obese adolescents. Finally, the mediation analysis highlighted a mediating effect of restrained eating on

the relation between three EO variables and excess weight in girls. A lower level of communication of emotions, as well as higher levels of cognitive-conceptual representation of emotions and of perception of internal bodily indicators led to a higher level of restrained eating, which, in turn, led to a higher body mass index (BMI) percentile. In contrast, no mediating effect was found in boys.

In our second study, we focused on the influence of temperament on excess weight, more precisely on temperament dispositions underlying emotional processing development, namely reactive and regulative temperament (Rothbart & Bates, 2006). With a sample composed of 130 adolescents (mean age: 14.13 ± 0.61 years), including 27 overweight/obese individuals (20.8%), we tested the same mediation model as in the first study, with temperament as independent variables instead of EO variables. The results revealed a mediating effect of restrained eating on the association between reactive temperament and BMI percentile, which differed according to gender. Restrained eating, which predicted weight gain, was more present in girls having a higher sensitivity to reward and in boys showing a higher sensitivity to punishment.

Taken together, our results suggest that restrained eating, characterised by constant food restraint interspersed with overeating episodes (Herman & Polivy, 1980), is the major PEB implicated in adolescent overweight and obesity. Besides, the identification of the mediating role of this PEB is consistent with the current definition of excess weight, which is considered as a complex disorder resulting from the interaction of multiple factors. This result supports the fact that genetic factors (i.e., temperament) play a predisposing role in the development of excess weight, and that their influence partially acts through behavioural tendencies (i.e., PEBs) (Faith & Keller, 2004). Finally, the gender differences found in the mediation analyses indicate that emotional processing plays a role in the development of excess weight only in girls, while reactive temperament is implied in excess weight in both boys and girls, but with different patterns of influence. Our results have important clinical implications, in particular that reducing restrained eating could be an important way to control weight. Reduction of restrained eating could be achieved either directly, by teaching adolescents to adopt a more flexible dietary restraint, or indirectly by working on emotional processing (e.g., improve competencies in communicating emotions), or on reactive temperament (e.g., lower sensibility to reward in girls and sensitivity to punishment in boys).

Keywords: excess weight; adolescence; emotional processing; Emotional Openness; reactive temperament; regulative temperament; problematic eating behaviours.

Résumé

La prévalence de l'obésité a considérablement augmenté ces dernières années, à tel point que l'on parle désormais d'une épidémie mondiale, qui affecte autant les enfants et les adolescents que les adultes. Si l'obésité est la cause d'importantes complications médicales chez les adultes, elle est encore plus problématique chez les enfants et les adolescents. En effet, en plus d'un certain nombre de problèmes de santé immédiats (p. ex. difficultés respiratoires, problèmes cardiovasculaires, diabète, risques accrus de fractures), ces derniers sont également confrontés à des conséquences à long terme, puisqu'ils présentent un risque accru de devenir des adultes obèses, et donc une plus grande probabilité d'invalidité ou de mort prématurée (World Health Organization [WHO], 2013).

Afin de contrôler cette épidémie, il est essentiel d'en comprendre les causes. Si les sources principales de l'épidémie mondiale sont désormais bien établies (elles résident principalement dans les mutations socio-économiques de nos sociétés modernes qui amènent les individus à consommer plus qu'ils ne dépensent), il reste encore beaucoup à apprendre sur les causes individuelles de la prise de poids. L'obésité est actuellement largement reconnue comme un trouble complexe résultant de l'interaction de nombreux facteurs, d'ordres biologiques (notamment génétiques), environnementaux, ainsi que comportementaux et psychologiques (Delgrande Jordan, Kuntsche, & Gmel, 2007; WHO, 2004). Dans cette thèse de doctorat, nous nous sommes principalement intéressés à des facteurs psychologiques et comportementaux, puisque nous avons investigué l'implication du traitement émotionnel, de certaines dispositions tempéramentales, ainsi que de certains comportements alimentaires problématiques (CAPs) sur le surpoids. Bien que plusieurs études aient mis en évidence des liens entre ces différentes variables et l'excès de poids (p. ex. Nederkoorn, Braet, Tanghe, & Jansen, 2006; Rehkopf, Laraia, Segal, Braithwaite, & Epel, 2011; Snoek, Van Strien, Janssens, & Engels, 2007), les données scientifiques sur le sujet sont encore peu nombreuses et peu concluantes, en particulier chez les adolescents.

Dans notre première étude, nous avons examiné l'influence sur le surpoids de l'Ouverture Emotionnelle (OE), un modèle générique permettant d'évaluer le traitement émotionnel dans son ensemble (Reicherts et al., 2012). Nous avons d'abord comparé l'OE d'adolescents de poids normal et d'adolescents en surpoids/obèses, afin de voir si le profil particulier mis en évidence chez des adultes obèses (Braunschweig-Spatz, 2006) pouvait être retrouvé auprès d'adolescents. Nous avons ensuite testé un modèle médiationnel afin de déterminer si les CAPs jouaient un rôle médiateur dans la relation entre l'OE et l'excès pondéral. Pour terminer, nous avons exploré les qualités psychométriques du questionnaire "Dimensions de l'Ouverture Emotionnelle" (DOE-20; Reicherts, 2007) dans notre échantillon, composé de 160 adolescents (âge moyen: 14.36 ± 0.61), dont 39 étaient en surpoids/obèses (24.5%). Bien que la structure initiale en cinq dimensions de l'instrument ait été confirmée par l'analyse factorielle confirmatoire, sa consistance interne s'est révélée modeste. De plus, nous n'avons pas été en mesure de répliquer le profil d'OE mis en

évidence chez des adultes obèses, étant donné que nous n'avons trouvé aucune différence significative entre les adolescents de poids normal et ceux étant en surpoids/obèses. Finalement, l'analyse médiationnelle a mis en évidence un effet médiateur du restrained eating dans l'association entre trois variables de l'OE et le surpoids chez les filles: Un niveau faible de communication des émotions, ainsi qu'un niveau élevé de représentation cognitivo-conceptuelle des émotions et une perception accrue des indicateurs corporels des émotions ont conduit à un degré plus important de restrained eating, induisant lui-même un plus grand excès pondéral. Par contre, aucun effet médiateur n'a été trouvé chez les adolescents de sexe masculin.

Dans notre deuxième étude, nous nous sommes intéressés à l'influence de variables du tempérament réactif et régulatif sur l'excès pondéral, variables supposées être à l'origine du développement du traitement affectif (Rothbart & Bates, 2006). Avec un échantillon de 130 adolescents (âge moyen: 14.13 ± 0.61), dont 27 individus en surpoids/obèses (20.8%), nous avons testé le même modèle médiationnel que dans la première étude, mais avec des variables du tempérament à la place de celles de l'OE. Un effet médiateur du restrained eating a été identifié dans l'association entre le tempérament réactif et le surpoids, qui différait en fonction du genre: Le restrained eating était plus présent chez les filles ayant une sensibilité accrue à la récompense, tandis qu'il était plus présent chez les garçons montrant une sensibilité accrue à la punition.

Dans l'ensemble, nos résultats indiquent que le restrained eating, caractérisé par un contrôle alimentaire constant entrecoupé d'épisodes d'hyperphagie (Herman & Polivy, 1980), constitue le principal CAP impliqué dans le surpoids chez les adolescents. L'identification du rôle médiateur de ce comportement est en accord avec la définition actuelle du surpoids, qui est considéré comme un trouble complexe résultant de l'interaction de multiples facteurs. En effet, nos résultats corroborent le fait que certains facteurs génétiques (ici, le tempérament) jouent un rôle prédisposant dans le surpoids, et que l'influence de ces facteurs génétiques passe notamment par des tendances comportementales (ici, le restrained eating) (Faith & Keller, 2004). En outre, les différences de genre mises en évidence dans nos analyses médiationnelles indiquent que le traitement émotionnel a un impact sur le surpoids uniquement chez les adolescentes, tandis que le tempérament réactif affecte le surpoids aussi bien chez les filles que chez les garçons, mais de manière différenciée. Nos résultats ont d'importantes implications cliniques, notamment le fait que réduire le restrained eating pourrait être un moyen efficace pour lutter contre le surpoids. La réduction de ce CAP pourrait se faire soit de manière directe, en apprenant aux adolescents à adopter un contrôle alimentaire plus flexible, soit de manière indirecte en travaillant sur le traitement émotionnel (p. ex. améliorer les compétences de communication des émotions) ou le tempérament réactif (p. ex. diminuer la sensibilité à la récompense chez les filles et la sensibilité à la punition chez les garçons).

Mots-clés: excès pondéral; adolescence; traitement émotionnel; Ouverture Emotionnelle; tempérament réactif; tempérament régulatif; comportements alimentaires problématiques.

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INTRODUCTION

Over the last decades, the prevalence of obesity has so dramatically increased that we now speak about a worldwide epidemic. According to the World Health Organization (WHO, 2013)[1], overweight and obesity have almost doubled since 1980, bringing their prevalence in adults to, respectively, 35% and 11% in 2008. Obesity induces serious health complications (mostly diabetes, cardiovascular diseases, musculoskeletal disorders and some types of cancer) and is considered the fifth leading risk for death in the world. Worldwide, 65% of the population live in countries where obesity kills more than underweight, so that obesity is estimated to be responsible for at least 2.8 million deaths each year (WHO, 2013).

Childhood and adolescence obesity is even more problematic, because it implies both short-term and long-term health consequences. In addition to a range of immediate health issues, including cardiovascular problems, breathing difficulties, hypertension, diabetes, and increased risks of fractures, obese children and adolescents are also more likely to become obese adults, and thus to present a greater probability of premature disability and death in adulthood, the probability of which depends on the age of the onset and on the duration of excess weight (WHO, 2014). The WHO has thus proclaimed childhood obesity as "one of the most serious public health challenges of the 21st century" (2014, Childhood overweight and obesity on the rise, para. 1), and made its prevention one of its highest priorities. These data stress the importance of the problematic and the necessity to tackle it from the earliest age.

The main causes of the global epidemic of obesity reside in socio-economic and socio-cultural transformations in modern societies. The diminution of physical activity in daily life due to technological progress and to increasing sedentary activities (e.g., computer, television), combined with ever greater and greater exposure to high-fat, energy-dense, and micronutrient-poor industrial food are mainly responsible for this epidemic (Promotion Santé Suisse, 2005). However, in order to control the worldwide epidemic, understanding the general explanatory factors is not sufficient. It is necessary to focus on the individual level to try to determine how excess weight develops in each case.

At the individual level, it is now acknowledged that excess weight is a complex disorder resulting from the interaction of multiple factors, including those that are biological, environmental, as well as behavioural or psychological (Delgrande Jordan, Kuntsche, & Gmel, 2007; WHO, 2004). Among various psychological influences on obesity, emotions seem to be of particular interest. Eating behaviours are indeed assumed to be greatly affected by emotional states, whether it is for food choices, or the quantity and frequency of meals. Although emotions influence food intake in both normal weight and overweight individuals, this impact seems to be stronger in obese people, and this may be because they encounter difficulties in emotional processing (Canetti, Bachar, & Berry,

2002). Although some research highlighted associations between emotional dysfunction and obesity, the exact mechanisms underlying these relations remain unclear. The present dissertation therefore aimed at exploring the impact of emotional processing on excess weight, with a particular emphasis on the mediating influence of problematic eating behaviours (PEBs). We decided to address this issue in an adolescent population for several reasons. First, as stated above, adolescence obesity is associated with serious medical complications and a greater risk of adult obesity. Second, adolescence has been identified as a critical period for the development of obesity (Dietz, 1994), not only because the physical development linked with puberty contributes to gaining weight, but also because adolescence usually is a period characterised by an increased independence linked with irregular meals, changes in eating habits, and more sedentary leisure activities (Must, Jacques, Dallal, Bajema, & Dietz, 1992). Finally, early adolescents (i.e., 10-15 years) generally experience increased intensity and frequency of emotionality (Larson & Lampman-Petraitis, 1989), probably due to the significant biological (i.e., puberty), psychological (e.g., identity construction; Erikson, 1968) and social changes (e.g., shift in attachment from parents to pairs) occurring at this period (Zimmermann, 2012). It is thus a critical age regarding emotional processing, since adolescents need to be able to cope with their new emotional experiences, while their competences to do so are still under construction. Emotional processing and regulation, which begin in early infancy with temperament, continue throughout adolescence to reach a mature form at the beginning of adulthood (Zeman, Cassano, Perry-Parrish, & Stegall, 2006).

The present dissertation will begin with general information pertaining to the definition and measure of excess weight, as well as to epidemiologic and etiologic data. Subsequently, the main concepts associated with our problematic, namely emotional processing, temperament, and PEBs, will be successively defined and discussed, which will then allow us to formulate our main research objectives. Next, a brief description of the methodology applied in our two studies will be presented, followed by a summary of the principal results. To conclude, results will be discussed according to their consistency with the proposed hypotheses, as well as according to their theoretical and clinical implications. Finally, limitations of the studies will be highlighted, which will permit the formulation of some recommendations for further research.

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[1] See Table of abbreviations on page 58.

THEORETICAL BACKGROUND

1. Excess weight

1.1. Definition and measure

1.1.1. Excess weight, overweight, or obesity?

When referring to a corpulent individual, the terms of excess weight, overweight and obesity are often used interchangeably by non-experts, which may lead to confusion. That is why we begin our dissertation by briefly defining and distinguishing those terms.

From a medical point of view, obesity, the most commonly used term, is defined as an abnormal or excessive fat accumulation, which may induce health issues. An important characteristic of obesity is thus its negative impact on health, leading to consider obesity both as a chronic illness and as a risk factor for other diseases, such as cardiovascular disorders, diabetes, musculoskeletal disorders or some types of cancer (WHO, 2004).

Strictly speaking, overweight refers to an excessive body weight and thus technically differs from obesity. Nevertheless, as excessive body fat and weight are usually highly correlated, except in some rare cases, overweight and obesity are often indistinctly used (Wing & Polley, 2001). In common parlance, the difference between overweight and obesity rather pertains to the degree of excess weight, overweight representing a moderate excess of body weight and fat, and obesity a larger one (Tschannen & Calmonte, 2005). We have adopted this distinction throughout this manuscript, using also the generic term of excess weight when referring to a body mass globally higher than normal, without distinction between moderate or large excess.

1.1.2. Measure of excess weight

The distinction between overweight and obesity leads us to consider another important point, namely the measure of excess weight. The most commonly used method to evaluate weight status is the body mass index (BMI; kg/m^2; Quételet, 1869), thanks to its ease of use and despite some limits reducing its precision. It is obtained by dividing the body weight (kg) by the squared height (m^2).

The WHO proposed the first international classification of adult weight status using BMI on 1986 (WHO Working Group, 1986). This classification, which is presented in Table 1, is mainly based on the association between BMI and morbidity, since it defines several threshold values from which excess weight induces health risks.

It is important to note that this classification applies only to adults. Although many countries elaborated reference growth curves based on weight/age and height/age ratios for children and adolescents, the consensus agreed on for adults could not be reached for excess weight

classification for children and adolescents, because weight and height continuously evolve at different rhythms according to populations, making it difficult to establish comparisons and norms (WHO, 2004). It is now recommended that each country develop its own weight status curves based on BMI percentile (Cole, Bellizzi, Flegal, & Dietz, 2000). This has already been done in some countries. In Europe, a child or adolescent is considered as overweight if its BMI is higher than the 90th percentile of its reference population, and as obese over the 97th percentile (Farpour-Lambert, L'Allemand, & Laimbacher, 2006). In Switzerland, the use of German norms established by Kromeyer and colleagues (2001) has been recommended, because they allow a good transition to adult norms, since at the age of 18, the 90th and the 97th percentiles tally with BMI of 25 and 30, (Farpour-Lambert et al., 2006), which respectively correspond to thresholds for overweight and obesity in adults.

Table 1: Classification of excess weight in adults according to body mass index

Classification	Body mass index	Risk of comorbidities
Underweight	< 18.5	Low
Normal weight	18.5 - 24.9	Average
Excess weight	≥ 25	
Overweight (preobese)	25.0 - 29.9	Increased
Class I obesity	30.0 - 34.9	Moderate
Class II obesity	35.0 - 39.9	Severe
Class III obesity	≥ 40.0	Very severe

Adapted from "Obesity: Preventing and managing the global epidemic", by WHO, 2004, p. 9.

As mentioned earlier, although classifications based on BMI are very helpful thanks to their ease of use, they nevertheless present some limitations. First, BMI is based on weight and not on fat proportion, while morbidity risks associated with obesity actually depend on the degree of adiposity (i.e., the quantity of fat accumulation). However, as adiposity and body weight are usually highly correlated, BMI is commonly considered as an indirect measure of adiposity. In consequence, though, BMI does not distinguish between fat mass and muscular mass, which may lead to weight status misclassifications. For example, an athletic individual with an important muscular mass may have a high BMI and thus be considered obese, while the degree of adiposity is normal and thus associated with no health risk (Office Fédéral de la Santé Publique [OFSP], 2008). Second, BMI does not take into account the body fat distribution, although it is well known that the latter influences the degree of health risk and the type of resulting disease. For example, an android fat repartition (i.e., abdominal adiposity) presents higher cardiovascular risks than a gynoid one (i.e., more uniform and peripheral repartition) (WHO, 2004). Finally, in most studies on excess weight, BMI is

calculated on the basis of self-reported weight and height, and not of actual measures. Schutz and Woringer (2002) highlighted a bias, which is higher in women, consisting of underevaluating one's weight and overvaluating one's height, which leads to an underestimation of excess weight prevalence. This bias can be avoided by taking actual measurements instead of self-reported ones.

Despite these few negative aspects, BMI is still the easiest way to assess weight status. It allows a quick and relatively sure evaluation of excess weight and of its prevalence in a population, making possible the comparison of people or populations, or the identification of subjects or groups at risks (WHO, 2004). Other methods providing further information exist, such as bodily composition (e.g., measure of waist circumference), anatomical fat repartition (e.g., magnetic resonance imaging), energy intake (e.g., dietary questionnaire), and energy expenditure (e.g., measure of physical activity through a questionnaire or motion detector). However, as they generate important financial costs and practical difficulties, without offering really significant additional information for clinical practice (Després, Lemieux, & Prud'homme, 2001; Lean, Han, & Morrison, 1995), they are rarely used. In our research, we have decided to use BMI classification, with actual measurements of weight and height to avoid the earlier mentioned bias, and chosen to refer to German norms (Kromeyer-Hauschild et al., 2001) as recommended by literature (Farpour-Lambert et al., 2006).

1.2. Epidemiologic data

1.2.1. Excess weight in the world and in Europe

The most recent statistics collected by the WHO (Global Health Observatory [GHO], 2014) date from 2008. From 1980 to 2008, worldwide excess weight nearly doubled, concerning almost half of the population. In 2008, 35% of adults (i.e., 20 years old and more) suffer from excess weight, representing 1.4 billion individuals, including 24% of overweight individuals (i.e., BMI between 25 and 29.9) and 11% of obese ones (i.e., BMI of 30 and more). Excess weight affected men and women in comparable proportions (34% for men and 35% for women), but obesity was more present in women (14%) than in men (10%). The adult prevalence of excess weight was the highest in the Americas (62%, including 36% for overweight and 26% for obesity), and the lowest in South East Asia (14%, including 11% for overweight and 3% for obesity). In 2008, Europe occupied second place in terms of excess weight prevalence (55%), 33% of adults being overweight and 22% obese. Globally, excess weight was more present in men (58.3% vs. 51.2% in women), but there were more overweight men than women (37.9% vs. 28.1%), while more obese women than men (23.1% vs. 20.4%) (GHO, 2014).

Worldwide prevalence of excess weight in children and adolescents is difficult to evaluate, because of the lack of uniformity concerning classification, causing a high degree of discordance between studies. Nevertheless, irrespective of the classification used, research globally showed high obesity

prevalence as well as increasing rates (WHO, 2004). The International Obesity Task Force (Lobstein, Baur, Uauy, 2004) estimates that 10% of the school-aged children present an excessive weight, with 7.5% being overweight and 2.5% obese. Although excess weight is largely more represented in economically developed regions, its prevalence is now significantly increasing in most parts of the world. Like with adults, Americas presents the highest prevalence of childhood excess weight (32%, including 24% of overweight and 8% of obesity), and Sub-Sahara Africa the lowest rate, with only 2% of excess weight (Lobstein, Baur, & Uauy, 2004). In the past 30 years, the prevalence of childhood excess weight has more than doubled in the USA, and even tripled in adolescents, to reach an approximate level of 30% (including 18% of overweight and 13% of obesity) in both 6-11 year old children and 12-19 year old adolescents (Ogden, Carroll, Kit, & Flegal, 2012). Again, Europe is second concerning childhood excess weight (20%), with 16% of overweight and 4% of obesity (Lobstein, Baur, & Uauy, 2004).

1.2.2. Excess weight in Switzerland

In Switzerland, as in the rest of the world, the prevalence of adult excess weight has increased during the last 20 years. Recent data indicated that 32% of Swiss adults were overweight in 2011, versus 26% in 1992. As for obesity, it increased from 6% to 13.4% during the same period (OFSP, 2012; Stamm, Fischer, Wiegand, & Lamprecht, 2012). The Swiss rate of overweight is thus comparable to that of Europe (i.e., 33%), but the obesity rate is lower in Switzerland than in Europe (i.e., 22%), as is the general level of excess weight (about 45% in Switzerland vs. 55% in Europe). Swiss men seem to be more affected than women, since 39.5% of them were overweight and 15.3% obese in 2011, while 25% of Swiss women were overweight and 11.6% obese (OFSP, 2012).

Concerning children and adolescents, the Swiss prevalence of excess weight is equivalent to that of Europe, with 15.1% of school-aged children identified as overweight and 5% as obese in 2010/2011 (in Europe: 16% and 4%, resp.). These proportions have not changed a lot in the past few years, since data of 2005/2006 indicated rates of 14.7% for overweight and 5.2% for obesity. When considering the evolution of excess weight with age, a clear increase is noticeable, with a rate of 18.5% (14.6% for overweight and 3.9% for obesity) in nursery school (i.e., about 6 years old), of 27.1% (22.3% for overweight and 4.9% for obesity) at primary school (i.e., from 7 to 12), and of 32.7% (26.2% for overweight and 6.5% for obesity) at secondary school (i.e., from 13 to 15) (OFSP, 2012; Stamm, Fischer, Wiegand, & Lamprecht, 2012).

1.3. Etiologic data

1.3.1. Physiological regulation of weight and dynamics of weight gain

Body weight depends on energy balance and is thus regulated by the quantity of consumed and expended energy. Energy balance is calculated by subtracting the energy expenditure from the

energy intake, and can be either positive when intake is superior to expenditure, or negative when expenditure is superior to intake. A positive balance contributes to an increase of energy reserves and may lead to weight gain, while a negative balance promotes a reduction of energy reserves and may induce weight loss. The energy intake refers to the whole quantity of consumed calories such as foods and drinks being metabolised by the organism (WHO, 2004). As the calorie content depends on the type of food (i.e., the quantity of lipids, carbohydrates, proteins, and fibres present in the food), it is not only the quantity of consumed food that influences the energy intake, but also the type of consumed food (Cummins et al., 1997). As for energy expenditure, it includes three main elements: the basal metabolic rate (i.e., the energy expended in order to maintain body systems, e.g., body temperature) accounts for about 60% of the total expended energy; the thermic effect of food (or postprandial thermogenesis, i.e., the energy necessary to metabolise food) accounts for approximately 10% of expenditure; the voluntary physical activity is the most variable component and the one which has the most influence on body weight control (Wing & Polley, 2001; WHO, 2004).

In each individual, energy balance differs from meal to meal, from day to day, or even from week to week, without durably modifying energy reserves and body weight. This is due to the fact that many physiological mechanisms act to preserve the balance between intake and expenditure, and thus maintain a stable body weight. Weight gain appears only when a positive energy imbalance occurs over a long period of time (Schutz, 1995). Weight gain mechanism can be divided into three phases. First, in the preobese static phase, the individual is in a long-term energy balance and the body weight remains constant. Then, the dynamic phase represents the period during which the individual gains weight, because energy intake exceeds energy expenditure. This results either from an intake greater than needed, or from a reduction of expenditure, or from a combination of both factors. If this imbalance persists, it leads to a progressive increase in weight (WHO, 2004). Nevertheless, the difference between energy intake and expenditure progressively diminishes, because of an intensification of the basal metabolic rate and of the physical expenditure imposed by excess weight (Diaz, Prentice, Goldberg, Murgatroyd, & Coward, 1992; Klein & Goran, 1993). In the third phase, named the obese static phase, a new energy balance is thus regained, but at a higher weight than during the preobese static phase. The new balance is preserved through the same physiological mechanisms, which explains why it is difficult to lose excess weight gained during the second phase. Often, if someone tries to do it by undertaking a diet, he/she enters a second cycle of weight gain, because the organism compensates the loss of energy due to a smaller caloric consumption by slowing down the basal metabolic rate or by inducing an increase in energy intake (Leibel, Rosenbaum, & Hirsch, 1995; Porikos, Hesser, & Van Itallie, 1982).

1.3.2. Excess weight, a multifactorial problematic

As stated above, excess weight is the result of an energy imbalance, due to an intake exceeding expenditure. However, "in contrast to the widely held perception among the public and parts of the scientific and medical communities, it is clear that obesity in not simply a result of overindulgence in highly palatable foods, or of a lack of physical activity" (WHO, 2004, p. 101). It is now well accepted that the factors leading to this imbalance are complex and various, and that excess weight is not the consequence of one single factor, but rather of the interaction between different factors, combined in variable proportions among individuals (Delgrande Jordan, Kuntsche, & Gmel, 2007; WHO, 2004).

The main etiologic factors of excess weight are generally classified into four groups. The first group refers to biological factors, such as age, sex, or neuroendocrine (i.e., the control of hormonal secretions by the nervous system) and genetic factors. The second group consists of behavioural factors, resulting from various socio-psychological determinants, such as emotions, attitudes, beliefs, or cognitions. The third group comprises environmental factors, related to the physical, economical, and socio-cultural contexts in which individuals live. Finally, the last group, the iatrogenic factors (i.e., excess weight induced by medicine; Bray, 1998), has a very marginal influence on excess weight. Regarding biological factors, especially genetic ones, although they have an impact on excess weight, they should not be overestimated, because genetic and biological influences usually act in interaction with contextual or behavioural elements and thus represent predisposing factors. Moreover, the present worldwide epidemic of excess weight has spread too quickly to be attributable to any genetic mutation, and rather indicates a major contribution of the behavioural and environmental factors, particularly those linked with physical activity and food intake (Delgrande Jordan, Kuntsche, & Gmel, 2007).

It is now generally acknowledged that obesity should be conceived as a behavioural rather than a metabolic disorder (Goran & Weinsier, 2000), and studies focusing on the impact of genetics suggest that genes may influence obesity partially through behavioural tendencies (Faith & Keller, 2004). Nevertheless, Faith and Keller (2004) regret that most genetic studies focused on metabolic or physiologic traits, neglecting other constitutional factors likely to have an impact on eating behaviours. The present dissertation set out to address that issue, by exploring the possible causal pathways between temperament variables, which are defined as biologically based individual differences in any kind of psychological process (Rothbart & Bates, 2006), PEBs, and excess weight. We focused on two basic temperament dispositions present early in life, namely reactive and regulative temperament, as well on a more complex psychological process, the emotional processing, which develops during infancy and adolescence on the basis of temperament. All these concepts will be further described in the subsequent chapters.

2. Emotional processing

2.1. Definitions

2.1.1. Emotion and related concepts

Some authors have pointed out the difficulty of defining emotion, because the term, borrowed from everyday language, "refers to an astonishing array of happenings, from the mild to the intense, the brief to the extended, the simple to the complex, and the private to the public" (Gross & Thompson, 2007, p. 4). Many different answers can be given to the question as to what is an emotion, because affective life is made of various similar, but qualitatively distinct phenomena (Salamin, 2009). A multitude of terms (e.g., affect, impulse, mood, feeling, etc.) therefore co-exist in literature, making communication difficult. In our dissertation, we decided to adopt Scherer's perspective (Scherer, 2003), taken up by Gross and Thompson (2007), which conceives affect as "the superordinate category for various kinds of states that involve relatively quick good-bad discriminations (and thus have in common certain attentional processes and valence appraisals)" (Gross & Thompson, 2007, p. 6). The "affect" category includes four subcategories: general stress response (i.e., to demanding situations), emotions (e.g., anger or sadness), moods (e.g., depression or euphoria), and motivational impulses (e.g., hunger, thirst, or pain).

Gross and Thompson (2007) define emotion according to what they call the "modal model": Emotion is "a person-situation transaction that compels attention, has particular meaning to an individual, and gives rise to a coordinated yet flexible multisystem response to the on-going person-situation transaction" (p. 5). This definition illustrates the three core features of emotions. First, an emotion occurs when an individual is faced with a situation that is relevant to his/her goals, and when he/she gives meaning to this situation. Second, emotion is a multicomponent phenomenon, which induces synchronised changes in the whole body and in various domains (i.e., subjective experience, behaviour, central and peripheral physiology). Third, emotion is a malleable response, which can be modulated in many ways.

But what are the differences between emotion and other phenomena categorised as affects? Stress and emotion both involve whole-body responses to stimuli, but stress refers only to negative affective responses, while emotion refers to both negative and positive ones (Lazarus, 1993, in Gross & Thompson, 2007). As for mood, it differs from emotion in that it usually lasts longer and is more diffuse than emotion; moreover, mood generally impacts cognition, while emotion impacts mostly action (Parkinson, Totterdell, Briner, & Reynolds, 1996, in Gross & Thompson, 2007). Finally, a motivational impulse, like an emotion, has a valence and influences behaviour, but emotions are much more flexible and can act on a broader range of potential targets than impulses (Ferguson, 2000, in Gross & Thompson, 2007).

In order to avoid confusion, the present dissertation will exclusively focus on emotions in the strict sense.

2.1.2. Emotional processing and emotion regulation

As seen above, an emotion is a dynamic process that requires conscious or unconscious implication of the individual, since for an emotion to emerge a meaning has to be given to a situation. The attribution of a meaning is part of a complex, multi-step process called emotional processing, which represents "the self-organisation and explication of one's own emotional experience" (Greenberg, 2006, p. 6) and enables people to use their emotions, to work on them, and to give sense to them (Salamin, 2009). Different models of emotional processing have been proposed, as for example the "situation - attention - appraisal - response" sequence associated with the modal model of emotion proposed by Gross and Thompson (2007). The sequence starts with a psychologically relevant situation - often external, but also sometimes internal, based on mental representations. The situation is then evaluated according to its familiarity, valence and value relevance, which gives rise to an emotion (Ellsworth & Scherer, 2003, in Gross and Thompson, 2007). Another interesting model, comprising more steps, is Baker's (2001), in which "an emotional experience begins with the cognitive appraisal of an external input. The next steps are gaining awareness of the emotion and the accompanying sensations, and then linking them to the triggering event, which allows the labelling of the emotion. The process includes the expression of the emotion and finally the control of the emotional experience and its expression" (Walther & Hilbert, 2015, p. 29).

Emotion regulation, a similar concept which sometimes is confused with emotional processing, represents different ways of acting on emotions in order to regulate them, that is, either to initiate, avoid, inhibit, maintain, or modulate the occurrence, the form, the intensity, or the duration of an emotion (Eisenberg & Spinrad, 2004). Emotion regulation is thus an integral part of emotional processing, and may occur at each step of the process, acting either on the initial input, on the emotional experience itself, or on its communication (Baker, 2001).

Of course, the concepts of processing and regulation do not apply only to emotions, but to affects in general. Affect processing may refer to the processing of stress responses, emotions, moods, and impulses. As for affect regulation, it includes stress coping, emotion and mood regulation, and defence mechanisms (Gross & Thompson, 2007).

2.2. Emotional Openness

2.2.1. Description of the model

To examine emotional processing in our studies, we resorted to the concept of Emotional Openness (EO; Reicherts, Genoud, & Zimmermann, 2011, 2012). This multidimensional model conceptualises emotional processing as represented by the subject himself/herself and considers emotions as complex phenomena, implying three levels or registers of processing. The bodily register comprises neurophysiologic and physical phenomena, whether they are autonomic and motor. The cognitive-experiential level consists of cognitive representation of emotions, integrating somatic and

situational information to create emotion-specific cognitions, and of monitoring functions. Finally, the social register includes emotional expression processes, allowing interpersonal transmission or regulation of emotions. Based on these three levels, the EO model proposes five dimensions intended to characterise the main components of emotional processing (Reicherts, 2007):

- The Cognitive-Conceptual Representation of Emotions dimension (REPCOG) refers to the representations of emotions based on self-perceptions of mental and bodily states as well as situation-related components. More precisely, this dimension involves abilities to distinguish emotional states from other somatic sensations, to differentiate various emotions, to understand the situation that induced the emotions, and eventually to verbally name emotions.
- The Communication of Emotions dimension (COMEMO) focuses on the interactional level and on the social functions of emotions. This dimension includes "the processes of expressing emotions, mostly intentionally by the face, the voice, by gestures, posture or body movements, in order to make other people understand the affective state or emotion the person is experiencing, or to modify or mask it" (Reicherts, 2007, p. 6). It also includes intentional verbalisation of emotions in order to warn others, to seek help to regulate negative emotions, or to deal with positive emotions.
- The Perception of Internal and External Bodily Indicators of Emotions dimensions (PERINT and PEREXT) represent the awareness of the somatic phenomena characterising or accompanying emotions, mostly due to psycho-vegetative and somato-motor activation. Internal bodily indicators include, for example, cardio-vascular or respiratory activation (e.g., linked with anger or anxiety) or decrease (e.g., linked with sadness), temperature changes (e.g., linked with anger), or gastro-intestinal responses (e.g., nausea, diarrhoea). External bodily indicators, which are visible to others, comprise, among others, muscular activities (e.g., tension, trembling or jerking), facial or vocal expressions, and gesture or posture. The respective predominance of PERINT or PEREXT dimensions can characterise internalising vs. externalising patterns of emotional reactions (Cacioppo et al., 1992).
- The Regulation of Emotions dimension (REGEMO) refers to abilities to monitor (i.e., decrease or increase), postpone, stabilise or attenuate emotional states. Emotion regulation can act on the three levels (i.e., bodily, cognitive and social), and is linked with all the other dimensions of the model, because it relies on conceptual representations as well as on awareness of bodily indicators of emotions, and because it also includes activities of communication and expression aimed at modulating the emotion by sharing it with others, which may lead to interpersonal emotion regulation.

The subjective representations of these dimensions can be conceived as states linked with intra-individual or situational differences, or as traits describing stable tendencies underlying inter-individual differences, which can be summarised in an EO profile (Reicherts, 2007). Figure 1 (next page) illustrates the links between EO dimensions and which of the three registers they belong to.

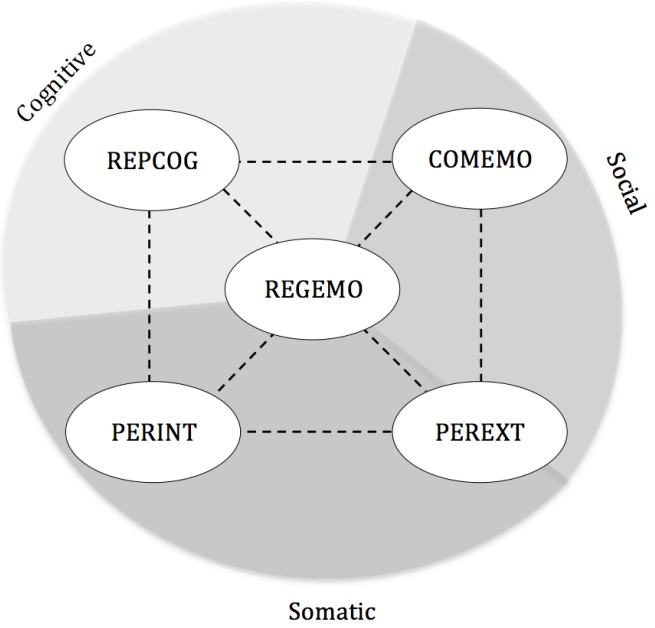

Figure 1: Domains of affective phenomena and the dimensions of Emotional Openness. Adapted from "Dimensions of Openness to Emotions (DOE) – Manual" by M. Reicherts, 2007, p. 9.

2.2.2. Emotional Openness and psychopathology

When considering associations between EO and psychopathology, it is important to keep in mind that lower or higher scores on a particular dimension are not favourable or unfavourable per se; rather, it is the global profiles that can be problematic. For example, a high score on PERINT is problematic only if REPCOG or REGEMO are simultaneously very low, because an increased perception of internal bodily indicators may cause problem only if one is not able to recognise or regulate the emotion that is behind these somatic phenomena (Reicherts, 2007).

Some studies revealed particular EO profiles linked with some mental disorders or problems, such as dependence and personality disorders (Reicherts, Casellini, & Genoud, 2007), somatoform disorders (Salamin, 2009), gambling behaviours (Genini, 2003) or burnout (Genoud & Reicherts, 2008). Research also highlighted associations between EO profiles and eating disorders or PEBs. A study showed that individuals exhibiting a higher PERINT and lower REPCOG and COMEMO were more likely to develop eating disorders (Reicherts et al., 2000 in Reicherts, 2007). Similar results were found in a preliminary clinical study with inpatients suffering from bulimia nervosa, who showed, compared to the reference sample, reduced REPCOG and COMEMO, and an increased PERINT (Carrard, 2000). Another clinical study investigating EO profiles of inpatients presenting anorexia nervosa provided comparable results (Guerry, 2004). At the beginning of the treatment, they exhibited restricted REPCOG, COMEMO and REGEMO, and elevated PERINT compared to the reference group. The treatment provided clinically significant improvement. Finally, a study exploring EO in obese adults highlighted a specific EO profile, including lower scores on REPCOG, COMEMO and REGEMO dimensions, and higher scores on PERINT and PEREXT dimensions, indicating that obese people encounter difficulties in recognising their emotions, in communicating

and in regulating them and that they present an increased perception of both internal and external bodily indicators of their emotions (Braunschweig-Spatz, 2006).

One main objective of the present dissertation was to determine if the same EO profile could be found in overweight and obese adolescents. Further details concerning the aims of our work will be given later. Let us now focus on temperament, which is considered a basis for subsequent development of emotional processing.

3. Temperament

3.1. Definition

Temperament refers to "biologically rooted individual differences in behaviour tendencies that are present early in life and relatively stable across various kinds of situations and over the course of time" (Bates, 1987, p. 1101). As temperament dispositions are assumed to form the basis for the subsequent maturation of personality (Rothbart & Bates, 2006), it is an important notion in the field of child and adolescent development. There are many different conceptions of temperament, and here we will consider Rothbart's model (Rothbart & Bates, 2006), which is probably the best known and the most widely used model in research on personality development. It defines temperament as "constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity and attention" (p. 109). Reactivity and self-regulation are the two broad terms originally used by Rothbart and Derryberry (1981) to distinguish the two main dimensions of temperament. The term "constitutionally" indicates that temperament, although biologically based and thus partly determined by heredity, is also influenced by maturation and experience (Rothbart & Sheese, 2007). Regarding the respective parts of biological and experiential influences on temperament, it was first assumed that individual differences observed early in life were more likely to reflect biology, its influence diminishing as the child grows up, being supplanted by the impact of socialisation. However, current research suggests that both biological and environmental factors play a role throughout development, and temperament is now mostly considered as a "multiply determined outcome of both biological and experiential processes" (Rothbart & Sheese, 2007, p. 332). The next sections define the reactive and regulative dimensions of temperament in more depth.

3.1.1. Reactive temperament

The reactive component of temperament consists of emotional, motor and attentional reactivity and thus refers to automatic processes, such as "excitability, responsivity or arousability of the behavioural and physiological systems of an organism" (Muris & Meesters, 2008, p. 7). Different models of reactive temperament exist, and here we will take into account Gray's Reinforcement

Sensitivity Theory (Gray, 1990), which is recognised as "one of the most influential biologically based models of personality" (Cooper, Gomez, & Aucote, 2007, p. 296). It describes two basic brain systems controlling behavioural responses to punishing and reinforcing stimuli. The behavioural inhibition system (BIS) is responsible for sensitivity to signals of punishment, while the behavioural activation system (BAS) mediates sensitivity to signals of reward (Gray, 1990). Individual differences in these two systems are theorised to underlie the personality traits of anxiety and impulsivity (Bijttebier, Beck, Claes, & Vandereycken, 2009): "Activity in the BIS is responsible for feelings of anxiety and incites the individual to stop whatever action is going on and to scan the environment for further cues", whereas activity in the BAS induces impulsive behaviour, inciting the individual to "pursue any action that might result in reward, with little attention for the possibility of negative consequences" (Muris & Ollendick, 2005, p.274).

3.1.2. Regulative temperament

The regulative part of temperament consists of self-regulatory processes, allowing individuals to modulate their reactivity, and thus refers to more conscious and voluntary processes. To describe these voluntary control processes, Rothbart and Bates (1998) developed the concept of effortful control (EC), defined as "the ability to inhibit a dominant response to perform a subdominant response" (p. 137). EC represents a higher-order factor including lower-order dimensions. In adulthood and adolescence, EC involves three specific abilities: attention regulation represents the ability to deliberately manage attention; inhibitory control refers to the ability to inhibit an inappropriate behaviour; and activation control pertains to the ability to activate a behaviour, especially when there is a natural tendency to avoid it (Evans & Rothbart, 2007). In childhood, EC is also divided into three lower-order dimensions, which slightly differ from those described in adults and adolescents (Rothbart, Ahadi, Hershey, & Fisher, 2001): attentional focusing represents the "tendency to maintain attentional focus upon task-related channels"; perceptual sensitivity refers to the "amount of detection of slight, low intensity stimuli from the external environment"; and low-intensity pleasure pertains to the "amount of pleasure or enjoyment related to situations involving low stimulus intensity, rate, complexity, novelty, and incongruity" (Rothbart, 2006, sec. The Questionnaire).

3.2. Temperament and emotional processing

Although a consensus on the taxonomy between the different temperament models has not been reached, most authors agree that individual differences in emotionality (or emotional reactivity) and in emotion regulation represent the two core components of temperament (Rothbart & Sheese, 2007). For example, Rothbart and Sheese (2007) explain that when they discuss temperament reactivity, they "refer to individual differences in the temporal and intensive patterns of emotional

response and ultimately to individual differences in the organisation and functioning of emotion-processing networks" (p. 333). As for EC, or regulative temperament, they assert that it allows the suppression of the reactive systems of defence and approach, thus reducing the influence of emotions on people's behaviour: "Using effortful control, we can more flexibly approach situations we fear and inhibit actions we desire" (p. 337).

Rothbart and colleagues admit that when they first divided temperament into reactive and regulative components, they did not realise the extent to which reactive emotions were also self-regulated (Rothbart & Derryberry, 1981). Now, they recognise that both reactive and self-regulative aspects are implied in the emergence of an emotion, which they consider to be the result of the information processing giving affective significance to personal events - what we call "emotional processing" (Rothbart & Sheese, 2007). In other words, we can state that they consider both reactive and regulative temperament dispositions to be implied in emotional processing, whereas emotion regulation, for them, relies only on regulative temperament: "Emotion regulation includes attentional strategies employed through effortful control" (p. 333).

3.2.1. Temperament and adaptive emotion regulation

EC allows diminishing activation of reactive systems (both BIS and BAS), either by modifying overt or internal inputs triggering those systems, or by altering the outputs produced by them. Diverse strategies for reducing reactivity can be found from early infancy onwards; they seem to be stable across life, and underlie emotion regulation strategies found later in adolescents and adults (Shoda, Mischel, & Peake, 1990). The control of attentional orienting, that is the capacity to focus and to shift attention, constitutes one example of strategies based on the modification of inputs. Caregivers use young infants' attention to regulate their emotional state, distracting them by bringing their attention to other stimuli, which allows the reduction of their distress. As the child grows up, the attentional orientation gets more and more self-regulated, finally becoming a real emotion regulation strategy. Children's greater attentional orienting abilities have been associated with lower parent-reported negative affect in laboratory (Johnson, Posner, & Rothbart, 1991). Similarly, adolescents and adults evaluating themselves as having good skills at focusing and shifting attention report less negative emotions (Evans & Rothbart, 2007). However, controlling attentional orienting may not always be sufficient, because even if we are not looking at a distressing stimulus, we still know it is there, and internal representations can be as effective as real stimuli in triggering or maintaining emotional reactivity. Reinterpretation, that is, shifting attention to other mental representations, therefore is another important emotion regulation strategy, better known under the name of suppression (Gross, 2002, in Rothbart & Sheese, 2007). Moreover, feedback loops between the reactive systems and their outputs (e.g., reactions produced by the autonomic nervous system) can maintain emotional activation, but EC can directly modulate consciously controlled aspects of physiological arousal, such as respiration

rate or muscle tension; this is an example of regulation strategy based on the modification of output.

These various emotion regulation strategies, as well as others not described here, seem to underlie, by means of EC, the development of socialised thoughts and behaviours. Rothbart and colleagues (Rothbart, Ahadi, & Hersehy, 1994) discovered that young children with greater levels of EC exhibited more empathy and guilt or shame, as well as less aggressiveness. It is hypothesised that EC allows children to put themselves in the place of others. EC is also associated with prosocial behaviour in adolescents and adults. Individuals having higher levels of EC are better able to regulate negative emotions that promote antisocial behaviours, such as anger or anxiety (Kochanska, Murray, & Harlan, 2000). But if a high level of EC promotes adaptive emotion regulation, a low level, conversely, is associated with maladaptive emotion regulation, and may possibly lead to some psychopathological disorders. This is the subject of the next section.

3.2.2. Temperament and psychopathology

An important body of research highlighted associations between temperament and psychopathology in children and adolescents as well as in adults, mostly concerning the two broad dimensions of internalising and externalising disorders. Internalising disorders include symptoms pertaining to inner emotions and to over-controlled reaction, such as anxiety, depression, somatoform disorders, or social withdrawal, while externalising disorders involve symptoms related to under-controlled and outward behaviours, such as aggressiveness, impulsivity, oppositional behaviours, attentional difficulties, or hyperactivity (Thackery, 2012; Wilmshurst, 2005). In adolescents, lower level of EC was generally positively linked with both internalising and externalising problems (Hofer, Eisenberg, & Reiser, 2010; Muris, Meesters, & Blijlevens, 2007; Muris & Ollendick, 2005). However, EC is not the only temperament disposition involved in psychopathology, reactive temperament also plays an important role. It has indeed been demonstrated that levels of reactive temperament that are either too high or too low may lead to psychological dysfunctions, and that, therefore, mental balance requires moderate levels of both behavioural inhibition and activation. For example, anxiety, an aversive emotional state linked with the BIS, is commonly associated with various forms of psychopathology (Fox, Henderson, Marshall, Nichols, & Ghera, 2005), but is also an evolutionarily conserved mechanism promoting adaptive behaviours (Ohman & Mineka, 2001). Therefore, individuals with low levels of BIS are as likely to develop emotional dysfunctions as those with high levels (Rothbart & Sheese, 2007). Research thus generally found that internalising problems are associated with a higher tendency to behavioural inhibition, and externalising problems with a higher tendency to behavioural activation (Colder & O'Connor, 2004).

More specifically, temperament was also associated with substance use disorder in adolescent boys and girls. Several studies conducted on alcohol, tobacco or cannabis use suggested that high

sensitivity to reward (BAS) influence both the onset and maintenance of substance use, while low sensitivity to punishment (BIS), combined with low EC, play a role in the persistence of consumption (Pardo, Aguilar, Molinuevo, & Torrubia, 2007; van Leeuwen, Creemers, Verhulst, Ormel, & Huizink, 2010; Willem, Bijttebier, & Claes, 2010).

Finally, temperament dispositions were also found to be associated with excess weight. As the same neurological pathways are responsible for the reinforcing effect of addictive drugs and palatable food, some authors supported the idea of a "food addiction" (Blumenthal & Gold, 2010; Wang et al., 2001). Sensitivity to reward, a psychobiological trait similar to BAS and representing "the ability to derive pleasure or reward from natural reinforcers like food, and from pharmacologic rewards like addictive drugs" (Davis, Strachan, & Berkson, 2004, p. 131), has been associated with overeating and obesity in adults, but with some inconsistencies, studies alternately identifying an excess of sensitivity to reward (Davis, Strachan, & Berkson, 2004; Davis, Patte, levitan, Reid, Tweed, & Curtis, 2006) or a lack of sensitivity to reward (Pagoto, Spring, Cook, McChargue, & Schneider, 2006; Wang, Volkow, Thanos, & Fowler, 2004) as risk factors for obesity. Research also highlighted reduced EC in obese adults (Cserjési, Luminet, Poncelet, & Lénárd, 2009; Gunstad et al., 2007; Gunstad, Lhotsky, Wendell, Ferrucci, & Zonderman, 2010) and children (Cserjési, Molnár, Luminet, & Lénárd, 2007; Kamijo et al., 2012). Besides, obese children were also found to present higher behavioural activation levels and lower inhibitory control than normal weight children (Nederkoorn et al., 2006). In order to better understand the associations between temperament and excess weight, this dissertation aimed at investigating the potential implication of PEBs in this association. The next section presents what we mean by PEBs, as well as their relations with emotional processing.

4. Problematic eating behaviours

4.1. Definition

Problematic eating behaviours (PEBs) generally refer to eating patterns which are not governed by the natural regulatory mechanisms of food intake (i.e., adequate responses to physiological signals of hunger and satiety), or in which the self-regulation capacities are diminished or lost (Herman & Polivy, 2004). These behaviours are similar to those found in eating disorders, but in an attenuated and non-pathological form, and may sometimes lead to serious clinical disorders, such as obesity, anorexia nervosa, or bulimia nervosa (Mazur, Dzielska, & Małkowska-Szkutnik, 2011). In this dissertation, we concentrated on two types of PEBs, disinhibited eating and eating in the absence of hunger (EAH), which are described below.

4.1.1. Disinhibited eating

Disinhibited eating represents a tendency to engage in periodic overeating episodes, usually in response to cues other than hunger (Stunkard & Messick, 1985), and generally comprises three subtypes of behaviours (van Strien, Frijters, Bergers, & Defares, 1986). First, emotional eating refers to the act of overeating in response to negative emotions. Second, external eating represents the tendency to rely on external cues (i.e., food related stimuli, like smell or sight of food) instead of internal ones to regulate food intake. Third, restrained eating is characterised by constant food restriction interspersed with overeating episodes.

In adults, the general concept of disinhibited eating has clearly been associated with excess weight and weight gain (McGuire, Wing, Klem, Lang, & Hill, 1999; Williamson, Lawson, Brooks, & Wozniak, 1995), as well as with binge eating (Howard & Porzelius, 1999). Nevertheless, associations between excess weight and PEBs pertaining to disinhibited eating are not as well established, especially in adolescents. Indeed, while some studies documented no association between emotional eating and excess weight at all (Wardle et al., 1992), others discovered associations differentiated according to gender, with sometimes a positive relation between emotions and obesity in girls, but no association in boys (Braet et al., 2008), and other times a negative relation in boys, but no association in girls (Snoek et al., 2007). As for external eating, some publications found no association at all (van Strien, Herman, & Verheijden, 2009), others a negative association (Snoek, van Strien, Janssens, & Engels, 2007), and others a positive one, but only in boys (Braet et al., 2008). Finally, only restrained eating shows well-established associations with excess weight in both adults and adolescents (Snoek et al., 2007; Wardle et al., 1992).

4.1.2. Eating in the absence of hunger

Eating in the absence of hunger (EAH) is a form of alimentary disinhibition in which individuals eat without being physiologically hungry, usually in response to the presence of palatable foods (Faith et al., 2006; Shomaker et al., 2010). Fisher and Birch (1999), who first proposed this concept, discovered that dietary restriction imposed on young girls by their mothers predisposed them to consumption of snack food in a non-hunger state, in the same way as self-imposed dietary restraint predisposed restrained eaters to periodically overeat. Three prompting factors of EAH were identified, which allowed the definition of three EAH behaviours: negative affect eating is induced by negative emotions (i.e., sadness, anger, or anxiety); external eating is promoted by sensory properties of food (i.e., sight or smell of food) or social determinants (i.e., other people eating); and fatigue/boredom eating refers to eating in response to fatigue or boredom, considered as negative emotions of lower intensity (Tanofsky-Kraff et al., 2008).

EAH has mostly been studied in children and adolescents, and was found to be associated with excess weight in both of them (Faith et al., 2006; Shomaker et al., 2010). Some research highlighted gender differences in children, EAH sometimes being linked with obesity only in boys (Faith et al.,

2006; Moens & Braet, 2007), but this distinction was not replicated in adolescents (Shomaker et al., 2010). To our knowledge, only one research focused on the three distinct EAH behaviours, demonstrating that obese children and adolescents showed higher levels of negative affect eating than normal weight ones, regardless of their gender. The same result was found for fatigue/boredom, but only as a tendency. Regarding associations between EAH and excess weight in adults, evidence is still lacking.

4.2. Problematic eating behaviours and emotional processing

The three PEBs included in disinhibited eating are derived from theories accounting for obesity (van Strien et al., 1986). First, Psychosomatic Theory (Kaplan & Kaplan, 1957) attributes weight gain to emotional eating. Emotional eaters are believed to overeat in order to reduce discomfort due to negative emotions, because they are presumably not able to distinguish between physiological cues of hunger and bodily feelings produced by emotions, probably because of faulty learning experiences (Bruch, 1964; van Strien & Ouwens, 2007). The act of overeating may thus represent a way to cope with emotions, because it momentarily neutralises dysphoria (Polivy, Herman, & McFarlane, 1994). Second, Externality Theory (Schachter, Goldman, & Gordon, 1968) postulates that these difficulties in recognising and understanding somatic sensations lead people to rely on external cues to regulate food intake, and thus to engage in external eating. Finally, Restraint Theory (Schachter et al., 1968) suggests explaining excess weight by restrained eating (Herman & Polivy, 1980). This theory proposes that dietary restraint may result in a state of chronic hunger leading people to succumb to disinhibitors, typically emotional distress, alcohol, or diet-threatening preloads (Herman & Polivy, 2004). According to Van Strien et al. (1986), restrained eating is due to the incessant fight against hunger, which results in a loss of contact with internal sensations of hunger.

These three theories clearly postulate the influence of maladaptive emotional processing in the development of PEBs, and by extension, of excess weight. Emotional dysfunctions have been assumed to play a role in obesity for a long time. For example, several studies indicated a greater level of alexithymia, representing a general deficit in emotional processing (Sifneos, 1973), in obese adults compared to normal weight ones (Clerici, Albonetti, Papa, Penati, & Invernizzi, 1992; Slochower, 1976). More recently, research documented associations between difficulties in emotion regulation and obesity in women (Zijlstra et al., 2011), as well as in adolescents girls (Rehkopf et al., 2011). Besides, maladaptive emotion regulation was also found to be linked with binge eating in adolescents of both genders and with loss of control eating in children (Czaja, Rief, & Hilbert, 2009), two eating behaviours likely to lead to excess weight.

As can be seen, the literature exploring the influence of emotional dysfunction on obesity focused mainly on emotion regulation, neglecting the other components of emotional processing. Further research is therefore needed in order to better understand the exact mechanisms underlying the associations between emotional processing and weight gain, and the present dissertation set out to contribute to that issue.

5. Research objectives and organisation of work

In the light of the theoretical elements exposed until now, the overall objective of our dissertation was to investigate the links of temperament dispositions and emotional processing with excess weight, considering also the potential influences of PEBs. We decided to focus on an adolescent population because, as mentioned in the introduction, adolescence is a critical period for the onset of obesity (Dietz, 1994; Must et al., 1992) as well as for the development of emotional processing (Larson & Lampman-Petraitis, 1989; Zeman et al., 2006).

This dissertation is composed of two distinct studies. The first one focused on emotional processing, more precisely on EO, and the second one on reactive and regulative temperament.

The first study aimed at determining if the same EO profile as the one found in obese adults could be highlighted in adolescents. This profile included lower abilities in recognising, regulating, and communicating emotions, as well as a higher awareness of internal and external bodily indicators of emotions (Braunschweig-Spatz, 2006). However, as no specific EO instrument existed for adolescents, we began by examining the factorial structure and the psychometric properties of the Dimensions of Openness to Emotions (DOE-20; Reicherts, 2007), an instrument assessing EO in adults. This instrument had been administrated to only one adolescent sample before we did it (Zimmermann, 2012), and thus, our dissertation also represented the opportunity to replicate results of that study, in particular those pertaining to EO differences according to gender. Zimmermann's study documented higher abilities in recognising and regulating emotions in boys, and higher awareness of bodily indicators in girls (2012). These were the main objectives of our first publication, entitled "Emotional Openness in overweight and normal-weight adolescents" (Walther & Hilbert, 2015). Then, in our second publication, "Emotional Openness, problematic eating behaviours, and overweight in adolescents" (Walther & Hilbert, submitted), also part of the first study, we decided to look at PEBs, because their theoretical foundations are conceptually similar to some EO dimensions: The difficulties in distinguishing physiological cues of hunger and bodily indicators of emotions believed to produce PEBs may be reflected by a lower level of cognitive-conceptual representation of emotion, as well as by higher levels of awareness of bodily indicators of emotions. Indeed, confusion between cues of hunger and feelings produced by emotions may lead people to overestimate the presence of bodily indicators of emotions. Moreover,

in PEBs, overeating presumably represents a way to regulate emotions, because it temporarily neutralises dysphoria (Polivy et al., 1994). We can thus suppose that people encountering PEBs lack more effective strategies, and therefore possess lower abilities in regulating emotion, as well as in communicating them, since communicating emotions also allows their regulation (Reicherts, Genoud & Zimmermann, 2012). We thus tested a meditational model, which hypothesised that PEBs play a mediating role in the associations between EO dimensions and excess weight. We also examined the prevalence of PEBs in adolescents, with a particular emphasis on differences according to gender and BMI status. Even if it is well established that emotional and restrained eating are generally more present in adolescent girls and external eating more present in adolescent boys (Brugman et al., 1997; Sánchez-Carracedo, Saldaña, & Domènech, 1996; Snoek et al., 2007; Wardle et al., 1992), the literature presents some divergences concerning BMI status differences in the prevalence of external and emotional eating (see pp. 18-19 for details).

In our second study, reported in the third publication, entitled "Temperament dispositions, problematic eating behaviours, and overweight in adolescents" (Walther & Hilbert, in revision) we switched our focus from emotional processing to reactive and regulative temperament dispositions. The modest results of the mediation analysis conducted in the first study led us to think that emotional processing might not yet have reached its definitive form in our adolescent participants, since emotional processing continuously develops from early childhood until the beginning of adulthood (Zeman et al., 2006). We therefore estimated that it might be more relevant to focus on temperament dispositions underlying emotional processing development, namely reactive and regulative temperament. In the light of the previously exposed literature revealing relations between temperament and psychopathology, we can postulate that PEBs, which are supposed to contribute to excess weight, are associated with a lower degree of EC, since reduced regulative temperament was evidenced in both internalising and externalising disorders in adolescents (Hofer, Eisenberg, & Reiser, 2010; Muris, Meesters, & Blijlevens, 2007; Muris & Ollendick, 2005), as well as in excess weight in adults (Cserjési et al., 2009; Gunstad et al., 2007, 2010) and children (Cserjési et al., 2007; Kamijo et al., 2012). As for reactive temperament, if we take into account the concept of "food addiction" (Blumenthal & Gold, 2010; Wang et al., 2001) as well as studies conducted on links between substance use disorders and temperament (indicating that both a high BAS and a low BIS contributed to the persistence of substance use disorders; Pardo et al., 2007; van Leeuwen et al., 2010; Willem et al., 2010), we may suppose that a higher sensitivity to reward (BAS) combined with a lower sensitivity to punishment (BIS) are associated with PEBs, and consequently with excess weight.

Now that the objectives have been thoroughly described, the next chapter will present a summary of the methodology used in the two studies, followed by a chapter synthesising the main results, which will be discussed in the last section.

METHOD

1. First study

1.1. Hypotheses

- **$H_{1.1}$:** Compared to normal weight adolescents, overweight or obese adolescents will present a particular EO profile, including lower levels of REPCOG, COMEMO, and REGEMO, and higher levels of PERINT and PEREXT;

- **$H_{1.2}$:** Girls will have higher scores on PERINT and PEREXT, and boys higher scores on REPCOG and REGEMO;

- **$H_{1.3}$:** Boys will have higher levels of external eating, but lower levels of emotional and restrained eating than girls; PEBs will be more present in overweight and obese adolescents than in normal weight ones;

- **$H_{1.4}$:** PEBs will mediate the associations between EO dimensions and BMI percentile; more precisely, REPCOG, REGEMO, and COMEMO will negatively predict PEBs, while PERINT and PEREXT will positively predict PEBs; PEBs will, in turn, positively predict BMI percentile.

1.2. Sample and procedure

The sample of the first study consisted of adolescents attending the second grade of secondary schools in Fribourg, a French-speaking part of Switzerland, recruited through the school medical service. During the medical examination, youngsters were systematically weighed and measured by the school nurse. For those who consented to take part in the study, weight and height were directly noted by the nurse on the questionnaires that they were given to complete at home. In compensation for study participation, adolescents could win an iPod and cinema tickets. As the school doctor considered that participants had sufficient capacity for discernment, parents' consent was not necessary. The study was approved by the Ethics Committee of the Department of Psychology of the University of Fribourg (Switzerland).

Table 2 (see next page) presents the main socio-demographic data of this sample and of the sample of the second study.

Table 2: Main socio-demographic characteristics of the samples of study 1 and study 2

	Study 1 (*N* = 160)	**Study 2** (*N* = 130)
Mean age (± *SD*)	14.36 (± 0.61)	14.13 (± 0.46)
Sex (%)		
Girls	93 (58%)	74 (56.9%)
Boys	67 (42%)	56 (43.1)
Schooling (%)		
Lowest stream	22 (13.8%)	20 (15.4%)
Middle stream	60 (37.5%)	37 (28.5%)
Highest stream	78 (48.8%)	62 (47.7%)
Nationality (%)		
Swiss	109 (68.1%)	123 (94.6%)
Other	51 (31.9%)	7 (5.4%)
Native language (%)		
French	115 (71.9%)	123 (94.6%)
Other	43 (26.9%)	7 (5.4%)
BMI status (%)		
Underweight	10 (6.3%)	6 (4.6%)
Normal weight	110 (69.2%)	97 (74.6%)
Excess weight, including:	39 (24.5%):	27 (20.8%):
Overweight	22 (14.1%)	20 (15.4%)
Obese	17 (10.4%)	7 (5.4%)

1.3. Instruments

First, after collecting some socio-demographic data, the original French version of the Dimensions of Openness to Emotions questionnaire (DOE-20; Reicherts, 2007), containing 20 items, was used to assess emotional processing. Then, affective experiences of our sample were explored via a shortened form (10 items) of the Positive and Negative Affect Schedule questionnaire (PANAS; Mackinnon et al., 1999).

Concerning PEBs, the French version of the Dutch Eating Behaviour Questionnaire (DEBQ; Lluch et al., 1996) was administrated to evaluate disinhibited eating, and, in order to assess EAH, the Eating in the Absence of Hunger Questionnaire for Children and Adolescents (EAH-C; Tanofsky-Kraff et al., 2008) was translated into French and controlled through a back translation procedure by a licenced translator (Hilbert et al., unpublished manuscript).

Table 3 (see next two pages) summarises the structure and the psychometric characteristics of each instrument used in this study as well as in the second study.

Table 3: Structure and psychometric properties of the instruments used in study 1 and study 2

		Instrument	Structure	Age	Psychometric properties
STUDY 1 AND STUDY 2	Problematic eating behaviours	**Dutch Eating Behaviour Questionnaire** (DEBQ), French version: Lluch et al. (1996) Original version: van Strien, Frijters, Bergers, and Defares (1986)	33 items evaluated on a 5-point Likert scale, from never (0) to very often (4); 3 subscales: restrained eating (RE), emotional eating (EmE), external eating (ExE)	Adult form, suitable for children and adolescents	French version: 3 factor-structure confirmed; high internal consistency in normal weight and obese adults (.82 ≤ α ≤ .96) (Lluch et al., 1996)
		Eating in the Absence of Hunger Questionnaire for Children and Adolescents (EAH-C), French translation: Hilbert et al. (unpublished manuscript) Original version: Tanofsky-Kraff et al. (2008)	14 items assessed on a five-point Likert scale, from never (0) to always (4); 3 subscales: negative affect eating (NAE), external eating (EE), fatigue/boredom eating (FBE)	6-19 years	English version: 3 factor structure confirmed; good internal consistency (.80 ≤ α ≤ .88) (Tanofsky-Kraff et al., 2008)
STUDY 1	Emotional processing and affectivity	**Dimensions de l'Ouverture Emotionnelle** [Dimensions of Openness to Emotions], 20-item trait version (DOE-20): Reicherts (2007)	20 items rated on a five-point Likert scale, from not at all (0) to extremely (4); 5 subscales: cognitive-conceptual representation of emotions (REPCOG), perception of internal and external bodily indicators (PERINT, PEREXT), communication of emotions (COMEMO), regulation of emotions (REGEMO)	Adult form, suitable for adolescents	French version: factorial validity confirmed in two adult and one adolescent sample; internal consistency acceptable for all subscales (.74 ≤ α ≤ .83), except for REGEMO (α = .67) in adult samples (Reicherts, 2007)
		Positive and Negative Affect Schedule (PANAS), short form: Mackinnon et al. (1999) Translation based on the French version: Caci and Baylé (2007)	10 items evaluated on a 5-point Likert scale, from not at all (0) to extremely (4); 2 subscales: positive affectivity (PA), negative affectivity (NA)	Adult form, suitable for adolescents	English short form: two-factor structure validated; good internal consistency (PA: α = .78; NA: α = .87) (Mackinnon et al., 1999)

STUDY 2	**Reactive and regulative temperament**	**Behavioural Inhibition and Activation Scales** (BIS/BAS Scales), French version: Caci, Deschaux, and Baylé (2007) Original version: Carver and White (1994)	24 items assessed on a four-point Likert scale, from totally wrong (0) to totally true (3); 1 subscale for behavioural inhibition system (BIS); 3 subscales for behavioural activation system (BAS): reward responsiveness (BAS-RR), drive (BAS-D), fun seeking (BAS-FS)	Adult form, suitable for adolescents	French version: two-order structure confirmed (with higher-order factors for BIS and BAS); good internal consistency for all subscales ($.67 \leq \alpha \leq .74$), except for drive ($\alpha = .58$) (Caci, Deschaux, and Baylé (2007)
		Early Adolescent Temperament Questionnaire - Revised Short Form (EATQ-R Short Form), French translation: Walther (unpublished manuscript) Original version: Ellis and Rothbart (2001)	Only the Effortful Control Factor: 16 items rated on a five-point Likert scale, from almost always untrue (0) to almost always true (4); 3 subscales: activation control (EC-AC), attention (EC-A), inhibitory control (EC-IC)	9-15 years	English version: factorial validity confirmed; satisfactory internal consistency ($.60 \leq \alpha \leq .82$) (Ellis and Rothbart (2001)

1.4. Statistical analyses

In the first publication (Walther & Hilbert, 2015) psychometric properties of the DOE-20 were studied. The five-dimensional structure was explored by means of a confirmatory factor analysis (CFA) conducted with AMOS 16, and internal consistency was examined using inter-item correlations, item-total correlations and subscale intercorrelations, carried out with SPSS 19 (as were the rest of the analyses). Then, in order to detect potential differences in EO by BMI status and gender, a 2 X 2 multivariate analysis of variance (MANOVA) was conducted, with BMI status (normal weight vs. overweight/obesity) and gender as factors and the five EO dimensions as dependent variables. Post-hoc ANOVAs were run for significant variables.

The second publication (Walther & Hilbert, submitted) first explored the prevalence of PEBs. The mean response rate on each point of the Likert scale was calculated for each PEB, and the "seldom" response was used as cut-off to determine the presence of PEBs. Differences by gender and weight status were explored using a 2 X 2 MANOVA with gender and weight status (normal weight vs. overweight/obesity) as independent variables and PEBs as dependent variables.

Then, in order to test the mediating influence of PEBs on the relation between EO and excess weight, a mediation analysis was conducted using the bootstrapping method (Shrout & Bolger, 2002). Figure 2 (see next page) illustrates the tested model (example for REGEMO as independent variable). We used an SPSS macro (Preacher and Hayes, 2004; 2008) which allows the evaluation of indirect effects in the case of multiple independent variables by testing the effect of each independent variable, controlling for the others (considered as covariates). This macro was run separately for boys and girls, and one time for each EO dimension, being the independent variable, with the four others EO dimensions considered as covariates; BMI percentile was the dependent variable, and PEBs the mediators. Some PEBs, which were conceptually similar and thus highly correlated, were grouped together in order to get three more distinct mediating variables: the Emotional Eating Scale of the DEBQ and the Negative Affect Eating and Fatigue/Boredom Eating Scales of the EAH-C were clustered to form a variable representing the tendency to eat in response to negative emotions (called "emotional overeating/EAH"); the External Eating Scales from the DEBQ and from the EAH-C were grouped together in order to form a variable focusing on the tendency to eat in response to sensory properties of food (called "external overeating/EAH"); finally, the Restrained Eating Scale of the DEBQ stayed as a single variable representing the tendency toward food restraint.

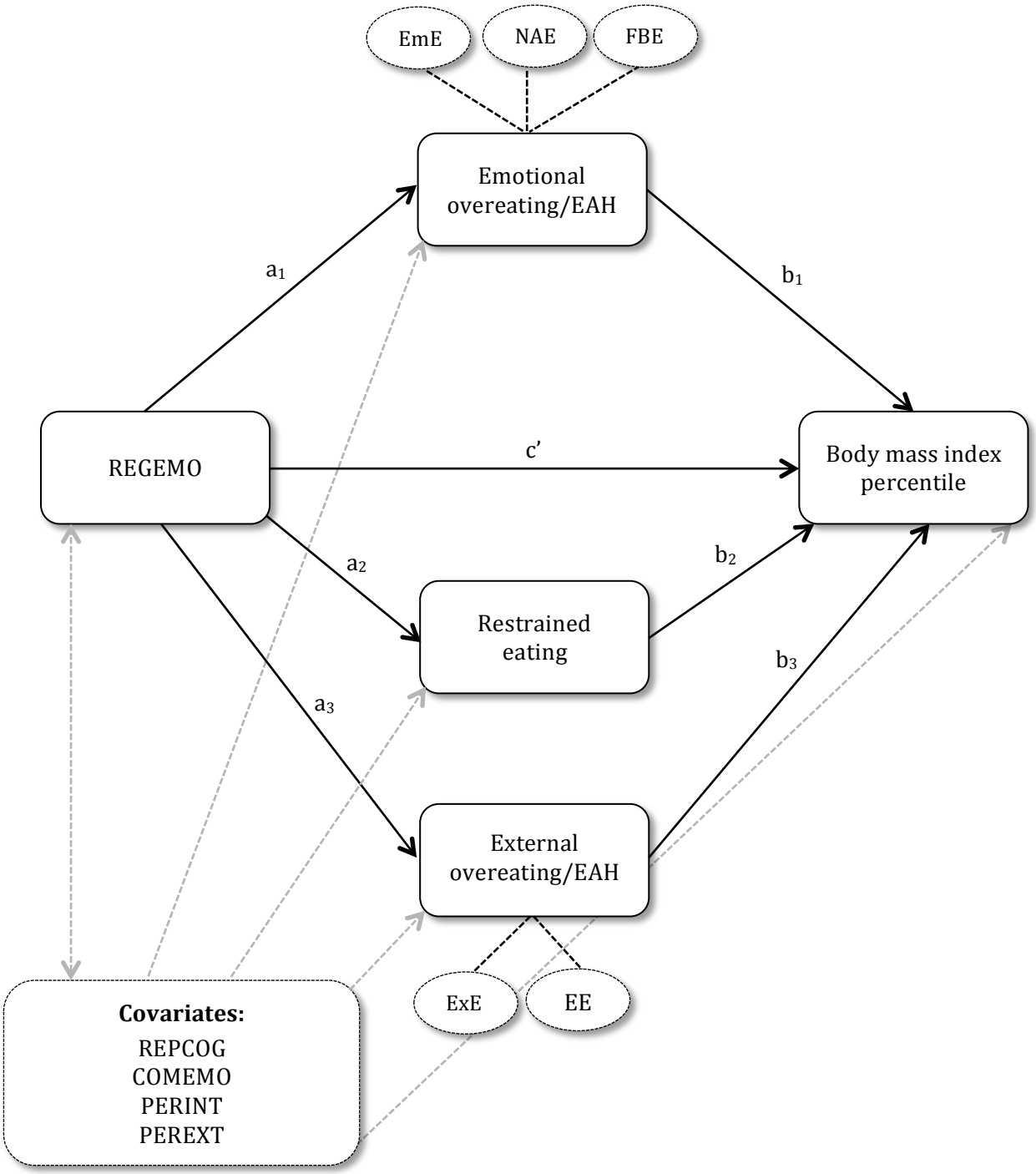

Figure 2: The hypothetical path diagram illustrating the mediating effect of problematic eating behaviours in the association between Emotional Openness and body mass index percentile: example for the regulation of emotion as independent variable (on the basis of Preacher & Hayes, 2008).

REGEMO = regulation of emotions; REPCOG = cognitive-conceptual representation of emotions; COMEMO = communication of emotions; PERINT = perception of internal bodily indicators of emotions; PEREXT = perception of external bodily indicators of emotions; EmE = emotional eating; NAE = negative affect eating; FBE = fatigue/boredom eating; ExE = external eating (from the Dutch Eating Behaviour Questionnaire); EE = external eating (from the Eating in the Absence of Hunger Questionnaire for Children and Adolescents); EAH = Eating in the Absence of Hunger.

2. Second study

2.1. Hypotheses

- **$H_{2.1}$:** PEBs will mediate the associations between temperament dispositions and BMI percentile; more precisely, BIS and EC will negatively predict PEBs, while BAS will positively predict PEBs; PEBs will, in turn, positively predict BMI percentile.

- **$H_{2.2}$:** PEBs will be negatively correlated with BIS and EC, and positively with BAS. BMI percentile will be negatively correlated with BIS and EC, and positively with BAS; PEBs will be positively correlated with BMI percentile.

2.2. Sample and procedure

The sample of the second study consisted of 130 adolescents attending the second grade of secondary schools, recruited through the school medical service of the canton of Jura, another French speaking area of Switzerland. The procedure was exactly the same as for the first study (see p. 22). Table 2 (p. 23) presents the main socio-demographic characteristics of the sample.

2.3. Instruments

First, reactive temperament was measured through the French version of the Behavioural Inhibition System and Behavioural Approach System Scales questionnaire (BIS/BAS; Caci et al., 2007). To assess regulative temperament, the Effortful Control factor of the Early Adolescent Temperament Questionnaire - Revised Short Form (EATQ-R; Ellis & Rothbart, 2001) was translated into French and controlled through a back translation procedure (Walther, unpublished manuscript).

As in study one, disinhibited eating was evaluated using the French version of the Dutch Eating Behaviour Questionnaire (DEBQ; Lluch et al., 1996), and EAH was assessed via a French translation - checked through a back translation procedure (Hilbert et al., unpublished manuscript) of the Eating in the Absence of Hunger Questionnaire for Children and Adolescents (EAH-C; Tanofsky-Kraff et al., 2008). See Table 3 (pp. 24-25) for detailed information.

2.4. Statistical analyses

First, in order to test the potential mediating effect of PEBs on the association between temperament dispositions and BMI status, a mediation analysis was conducted by means of the bootstrapping method (Shrout & Bolger, 2002), following the same procedure as in the first study (see p. 26). The only difference relates to the independent variables and to the covariates, which

were the temperament dispositions in that second study, instead of the EO variables in the first one. BMI percentile stayed as the dependent variable, and PEBs as the mediators.

Then, bivariate correlations were conducted to study associations between temperament variables (BIS, BAS, EC and the second-order variables of BAS and EC), BMI percentile, and PEBs (from the DEBQ and the EAH-C).

RESULTS

1. First study

1.1. Factorial validity and psychometric properties of the DOE-20

Globally, the adequacy of the five-factor structure of the DOE-20 was confirmed in our adolescent sample, since several indices on the CFA demonstrated an adequate fit of the data to the model. The Comparative Fit Index (CFI = .84) was superior to threshold value of .80 and the Root Mean Square Error of Approximation (RMSEA = .06) was in the interval between .05 and .08, indicating a reasonable fit. As for the chi square, although it was significant ($\chi^2_{(1, N = 157)} = 246.77$; $p < .001$), the chi square/degrees of freedom ratio ($\chi^2/df = 1.54$) was under the threshold value of 2.

Internal consistency marginally reached the cut-off value of .70 for COMEMO (α = .68), REPCOG (α = .69) and PEREXT (α = .69), but fell under the acceptable value for PERINT (α = .56) and REGEMO (α = .59). The inter-item correlation matrix showed moderate mean intercorrelations per subscale (PERINT: $M_r = .24$ [$.19 < r < .30$]; REGEMO: $M_r = .27$ [$.13 < r < .57$]; COMEMO: $M_r = .35$ [$.26 < r < .47$]; PEREXT: $M_r = .36$ [$.26 < r < .48$]; REPCOG: $M_r = .37$ [$.29 < r < .44$]). These results, along with the modest α scores, indicate a moderately satisfactory homogeneity of dimensions. The item-total correlation matrix was satisfactory, since all correlations were superior to .30 for each scale, indicating that each item correlated well enough with the dimension it belongs to. Correlations were higher for COMEMO, PEREXT and REPCOG than for PERINT and REGEMO (PERINT: $.31 < r < .38$; REGEMO: $.31 < r < .44$; COMEMO: $.40 < r < .53$; PEREXT: $.40 < r < .60$; REPCOG: $.42 < r < .51$). Finally, intercorrelations between subscales were comprised between low and moderate ($M_r = .20$; $.04 < r < .35$; absolute values), suggesting that the five EO dimensions were not completely independent. Associations between dimensions were assumed in the tested model, in order to take this result into account.

1.2. Differences in Emotional Openness by gender and body mass index status ($H_{1.1}$ – $H_{1.2}$)

Results of the MANOVA revealed a significant main effect of gender ($F_{(5, 139)} = 5.62$, $p < .001$), but no significant main effect of BMI status ($F_{(5, 139)} = 1.40$, $p = .227$), nor any significant interaction effect ($F_{(5, 139)} = .45$, $p = .811$). Effect size was large for gender ($\eta^2 = .17$), and low for BMI status ($\eta^2 = .05$) and for the interaction effect ($\eta^2 = .02$). Subsequent ANOVAs for gender produced significant effects for REPCOG ($F_{(1, 143)} = 9.98$, $p = .002$) and REGEMO ($F_{(1, 143)} = 14.99$, $p < .001$), which were both higher in boys than in girls (see Table 4 on the next page). Effect sizes were moderate for REPCOG ($\eta^2 = .06$) and REGEMO ($\eta^2 = .09$), but small for COMEMO ($\eta^2 = .02$), PERINT ($\eta^2 = .01$) and PEREXT ($\eta^2 = .01$).

Table 4: Means differences in Emotional Openness by gender and body mass Index status

Emotional Openness variables	Total sample	Gender			BMI status		
		Boys	Girls	*p* value	NW	OW	*p* value
	M (*SD*)	*M* (*SD*)	*M* (*SD*)		*M* (*SD*)	*M* (*SD*)	
REPCOG	2.19 (.81)	2.49 (.75)	1.98 (.79)	.001	2.18 (.78)	2.24 (.89)	.713
REGEMO	1.96 (.84)	2.08 (.90)	1.88 (.78)	.105	2.05 (.83)	1.72 (.84)	.043
COMEMO	2.44 (.81)	2.73 (.64)	2.23 (.86)	.002	2.45 (.78)	2.42 (.90)	.697
PERINT	1.65 (.83)	1.59 (.75)	1.69 (.89)	.413	1.66 (.87)	1.62 (.74)	.810
PEREXT	1.73 (.88)	1.83 (.79)	1.65 (.93)	.425	1.81 (.88)	1.5 (.85)	.052

Note. p value refers to results of the MANOVA; REPCOG = cognitive-conceptual representation of emotions; REGEMO = regulation of emotions; COMEMO = communication of emotions; PERINT = perception of internal bodily indicators of emotions; PEREXT = perception of external bodily indicators of emotions; BMI = body mass index; NW = normal weight; OW = overweight/obese.

1.3. Prevalence of problematic eating behaviours ($H_{1.3}$)

The "seldom" response was used as a cut-off to determine the presence of PEBs. Regarding the prevalence of PEBs pertaining to disinhibited eating (evaluated through the DEBQ), 30% of the overall sample reported encountering emotional eating at least seldom, external eating was reported as at least seldom experienced by 63% of the sample, and restrained eating by 39%. Concerning PEBs linked to EAH (assessed through the EAH-C), negative affect eating was reported to be encountered at least seldom by 13% of the sample, external eating by 41%, and finally, 14% of the sample declared experiencing fatigue/boredom eating at least seldom (see Table 5).

Table 5: Prevalence of problematic eating behaviours: Mean response rates (as a percentage) on each point of the Likert scale and cumulated response rates for rarely and seldom

		Never	Rarely	Seldom	Often	Very often	At least seldom (cut-off value)
Disinhibited eating	Emotional eating	43	24	16	8	6	30
	External eating	16	21	28	21	14	63
	Restrained eating	37	21	20	12	7	39
Eating in the absence of hunger	Negative affect eating	67	20	9	3	1	13
	External eating	30	29	26	13	2	41
	Fatigue/boredom eating	66	19	8	5	1	14

The MANOVA conducted to explore gender and BMI status differences in the prevalence of PEBs showed a significant main effect of BMI status ($F_{(6, 140)} = 9.17$, $p < .001$), but no significant main effect of gender ($F_{(6, 140)} = 1.36$, $p = .236$), nor a significant interaction effect ($F_{(6,140)} = .67$, $p = .674$). Effect sizes were large for BMI status ($\eta^2 = .28$), moderate for gender ($\eta^2 = .06$) and small for the interaction effect ($\eta^2 = .03$).

Subsequent ANOVAs for BMI status yielded significant effects on restrained eating ($F_{(1, 145)} = 31.18$, $p < .001$), external eating from the DEBQ ($F_{(1, 145)} = 12.15$, $p = .001$), and fatigue/boredom eating ($F_{(1, 145)} = 5.03$, $p = .026$), as well as a marginally significant effect on negative affect eating ($F_{(1, 145)} = 3.14$, $p = .078$). Effect sizes were large for restrained eating ($\eta^2 = .17$), medium for external eating ($\eta^2 = .08$), and small for fatigue/boredom ($\eta^2 = .03$) and negative affect ($\eta^2 = .02$) eating. Restrained, negative affect and fatigue/boredom eating were more present in overweight adolescents, while external eating was more present in normal weight ones (see Table 6).

Post-hoc ANOVAs were also conducted for gender despite the non-significant multivariate effect, as effect size was moderate. Significant differences were found on emotional eating ($F_{(1, 145)} = 5.26$, $p = .023$) and negative affect eating ($F_{(1,145)} = 4.35$, $p = .039$), which were higher in girls than in boys, with small effects sizes for both variables ($\eta^2 = .04$ and $\eta^2 = .03$, resp.) (see Table 6).

Table 6: Mean scores of problematic eating behaviours y gender and body mass index status

		Total sample (N = 160)	**Gender**			**BMI status**		
			Girls *M* (*SD*)	**Boys** *M* (SD)	*p* value	**NW** *M* (*SD*)	**OW** *M* (*SD*)	*p* value
Disinhibited eating	EmE	1.04 (.83)	1.22 (.85)	0.83 (.78)	.023	1.05 (0.79)	1.06 (.98)	. 808
	ExE	1.96 (.68)	1.94 (.67)	1.89 (.69)	.484	2.03 (.64)	1.61 (.69)	.001
	RE	1.25 (.91)	1.41 (1.41)	1.21 (.98)	.300	1.11 (.84)	1.93 (.78)	.001
Eating in the absence of hunger	NAE	.52 (.75)	.66 (.83)	.38 (.64)	.039	.47 (.67)	.71 (.96)	.078
	EE	1.29 (.78)	1.26 (.77)	1.29 (.83)	.785	1.29 (.81)	1.23 (.72)	.590
	FBE	.57 (.71)	.60 (.69)	.52 (.73)	.461	.52 (.60)	.82 (.89)	.026

Note. EmE = emotional eating; ExE = external eating from the Dutch Eating Behaviour Questionnaire; RE = restrained eating; NAE = negative affect eating; EE = external eating from Eating in the Absence of Hunger Questionnaire for Children and Adolescents; FEB = fatigue/boredom eating; *M* = mean; *SD* = standard deviation; NW = normal weight; OW overweight/obese.

p value refers to results of the MANOVA.

1.4. Mediating effect of problematic eating behaviours on the association between Emotional Openness and body mass index percentile ($H_{1.4}$)

In girls, restrained eating significantly mediated the association between three EO variables and BMI percentile, namely COMEMO (ab_1 = -.0539, 95% CI [-.0961, -.0200]), REPCOG (ab_2 = .0473, 95% CI [.0129, .0917]), and PERINT (ab_3 = .0394, 95% CI [.0064, .0808]). COMEMO negatively predicted restrained eating (a_1 = -.34), while REPCOG (a_2 = .29) and PERINT (a_3 = .25) positively predicted restrained eating. Restrained eating (b = .16), in turn, positively predicted BMI percentile. Bootstrap results highlighted no significant indirect effect in boys.

Figure 3 present the final mediation model between EO dimensions, restrained eating and BMI percentile in adolescent girls.

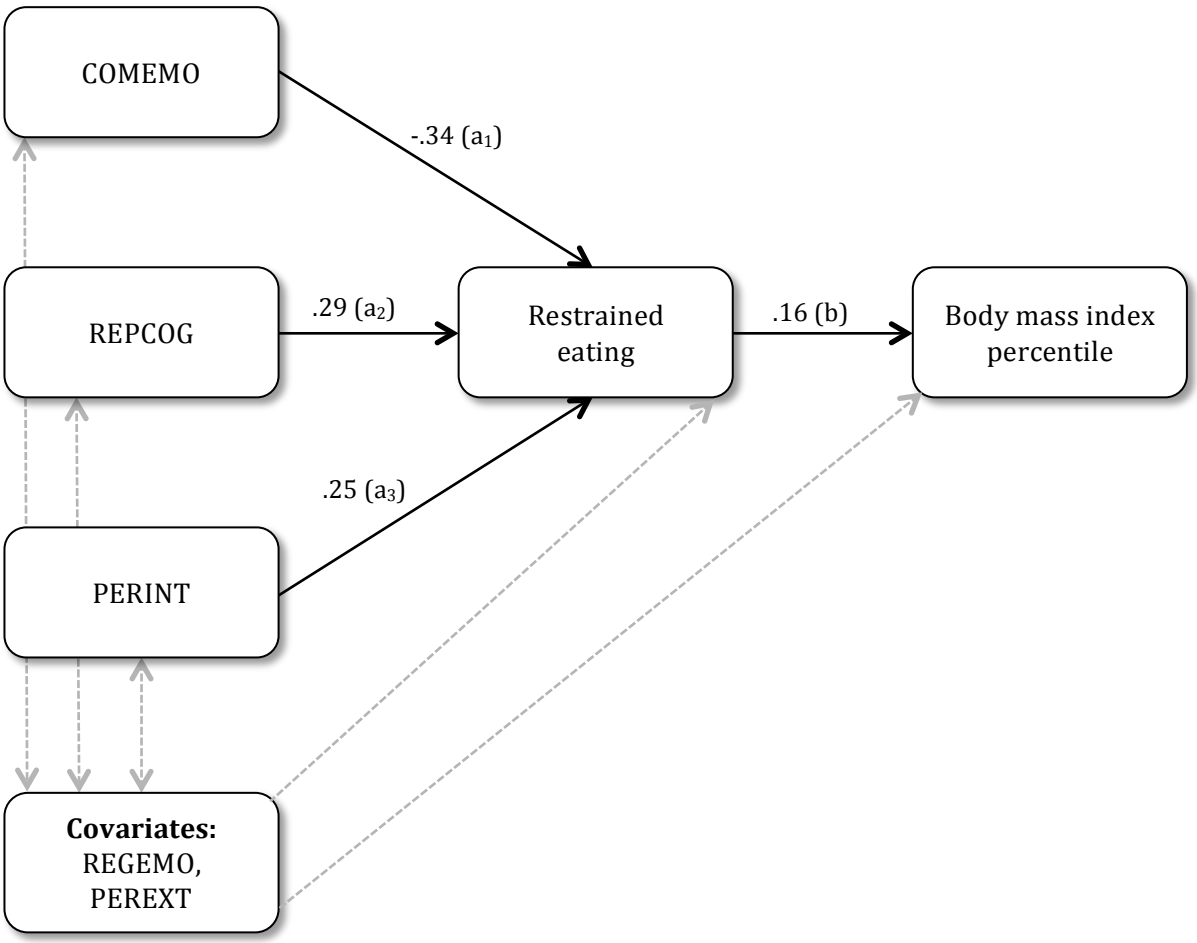

Figure 3: The path diagram illustrating the effect of cognitive-conceptual representation, communication and perception of bodily indicators of emotions on body mass index percentile mediated by restrained eating in adolescent girls.

COMEMO = communication of emotions; REPCOG = cognitive-conceptual representation of emotions; PERINT = perception of internal bodily indicators of emotions; REGEMO = regulation of emotions; PEREXT = perception of external bodily indicators of emotions.

2. Second study

2.1. Mediating effect of problematic eating behaviours on the association between temperament dispositions and body mass index percentile ($H_{2.1}$)

Restrained eating was identified as a mediating variable between temperament dispositions and BMI percentile in both girls and boys, but not for the same variables.

In girls (see Figure 4), restrained eating significantly mediated the relations between the three subscales of BAS and BMI percentile (BAS-RR: ab_1 = 0.914, 95% CI [0.272, 3.164]; BAS-D: ab_2 = 0.715, 95% CI [0.249, 2.137]; BAS-FS: ab_3 = 0.716, 95% CI [0.261, 2.197]). BAS-RR, BAS-D and BAS-FS positively predicted restrained eating (RR: a_1 = 4.569; D: a_2 = 3.401; FS: a_3 = 3.506), which, in turn, positively predicted BMI percentile (b = .29).

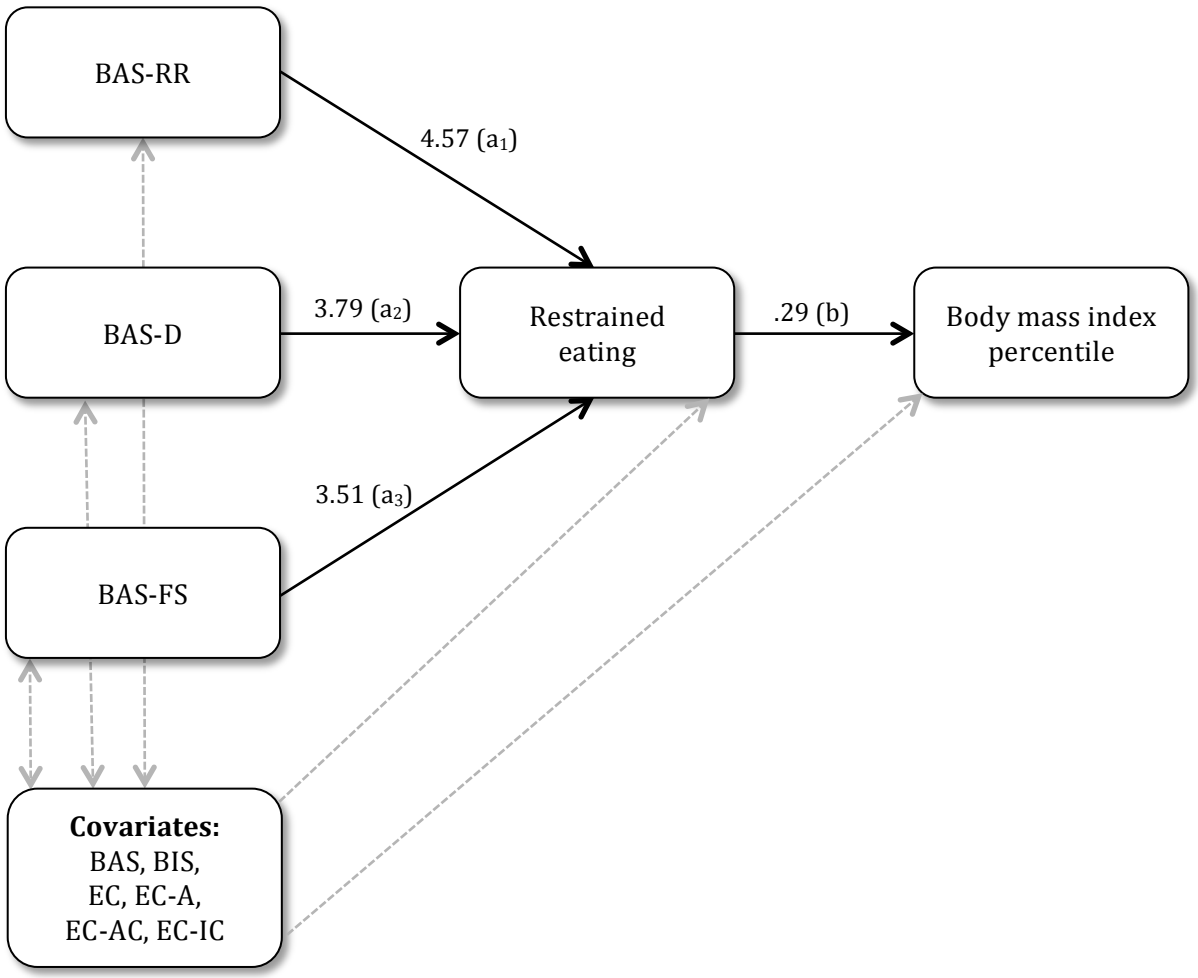

Figure 4: The path diagram illustrating the effect of behaviour activation system subdimensions on body mass index percentile mediated by restrained eating in adolescent girls.

BAS-RR = reward responsiveness; BAS-D = drive; BAS-FS = fun seeking; BAS = behavioural activation system; BIS = behavioural inhibition system; EC = effortful control; EC-A = attention; EC-AC = activation control; EC-IC = inhibitory control.

In boys (see Figure 5), restrained eating significantly mediated the associations between BIS and BMI percentile (ab = 0.083, 95% CI [0.001, 0.196]). BIS positively predicted restrained eating (a = .477), which, in turn, positively predicted BMI percentile (b = .151).

However, no mediating effect of PEBs was found on the associations between EC variables and BMI percentile.

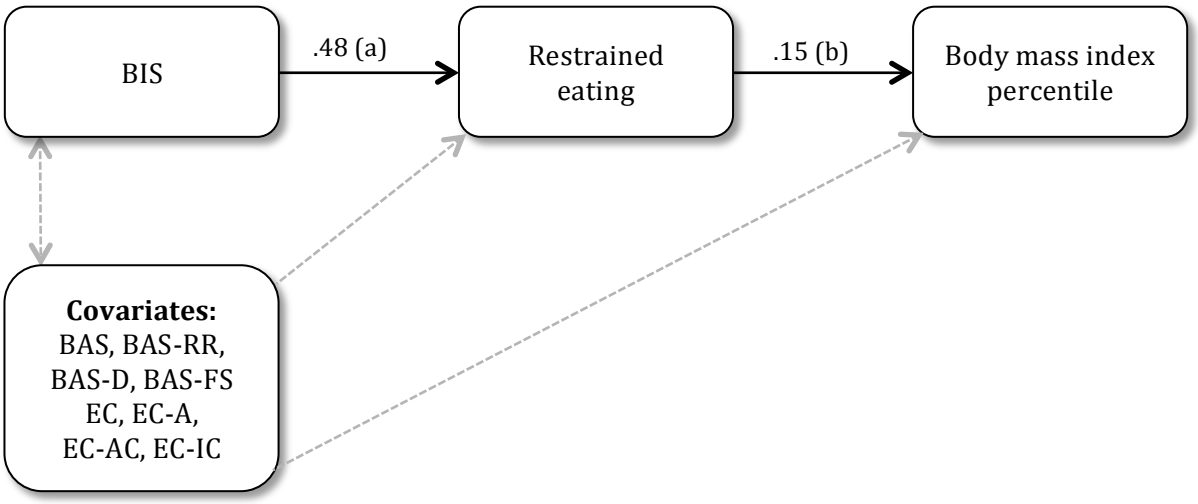

Figure 5: The path diagram illustrating the effect of behaviour inhibition system on body mass index percentile mediated by restrained eating in adolescent boys.

BIS = behavioural inhibition system; BAS = behavioural activation system; BAS-RR = reward responsiveness; BAS-D = drive; BAS-FS = fun seeking; EC = effortful control; EC-A = attention; EC-AC = activation control; EC-IC = inhibitory control.

2.2. Associations between temperament dispositions, problematic eating behaviours, and body mass index percentile ($H_{2.2}$)

Several correlations were found between temperament and PEBs, highlighting interesting patterns of associations. In girls, emotional eating, fatigue/boredom eating and external eating (from the DEBQ and the EAH-C) were positively correlated with BAS and negatively with EC. In boys, external eating was positively associated with BIS and BAS, while negatively with EC. BMI percentile was positively linked with restrained eating in both girls and boys, and negatively with external eating (of the DEBQ) in girls. Finally, there were no significant bivariate associations between temperament and BMI percentile.

The detailed bivariate correlations between temperament dispositions, PEBS, and BMI percentile are presented in Table 7 for girls, and in Table 8 for boys (see next two pages).

Table 7: Bivariate correlations between problematic eating behaviours, reactive and regulative temperament, and body mass index percentile in girls

		Disinhibited eating			EAH			Reactive temperament					Regulative temperament				BMI
		RE	EmE	ExE	EE	NAE	FEB	BIS	BAS	RR	D	FS	EC	A	AC	IC	
Disinhibited eating	RE			-.29*													.66**
	EmE			.36*	.28*	.63**	.57**		.23*		.26*		-.36**	-.42**	-.30**		
	ExE				.54**		.29*		.24*	.25*	.31**		-.34**	-.33**	-.25*	-.29*	-.26*
EAH	EE					.46**	.56**									-.27*	
	NAE						.68**										
	FBE										.26*		-.33**	-.30**		-.34**	
Reactive temperament	BIS																
	BAS									.65**	.84**	.76**	-.47**	-.35**	-.46**	-.39**	
	RR										.34**	.26*					
	D											.46**	-.46**	-.33**	-.42**	-.41**	
	FS												-.38**	-.26*	-.44**	-.26*	
Regulative temperament	EC													.90**	.85**	.81**	
	A														.67**	.63**	
	AC															.47**	
	IC																
BMI																	

Note. EAH = eating in the absence of hunger; RE = restrained eating; EmE = emotional eating; ExE = external eating (from the Dutch Eating Behaviour Questionnaire); EE = external eating (from the Eating in the Absence of Hunger Questionnaire for Children and Adolescents); NAE = negative affect eating; FBE = fatigue/boredom eating; BIS = behavioural inhibition system; BAS = behavioural activation system; RR = reward responsiveness; D = drive; FS = fun seeking; EC = effortful control; A = attention; AC = activation control; IC = inhibitory control; BMI = body mass index percentile.

Only significant correlations are reported: * = $p < .01$; ** = $p < .001$.

Table 8: Bivariate correlations between problematic eating behaviours, reactive and regulative temperament, and body mass index percentile in boys

		Disinhibited eating			EAH			Reactive temperament					Regulative temperament				BMI
		RE	EmE	ExE	EE	NAE	FEB	BIS	BAS	RR	D	FS	EC	A	AC	IC	
Disinhibited eating	RE					.27*										-.29*	.41**
	EmE			.37**	.36**	.68**	.64**										
	ExE				.47**			.30*	.37**		.41**	.28*					
EAH	EE						.35**				.32*						
	NAE						.70**										
	FBE																
Reactive temperament	BIS								.34*	.32*							
	BAS									.70**	.81**	.87**					
	RR										.27*	.43**					
	D											.64**	-.35**		-.34**	-.29*	
	FS																
Regulative temperament	EC													.81**	.82**	.68**	
	A														.50**	.36*	
	AC															.33*	
	IC																
BMI																	

Note. EAH = Eating in the absence of hunger; RE = restrained eating; EmE = emotional eating; ExE = external eating (from the Dutch Eating Behaviour Questionnaire); EE = external eating (from the Eating in the Absence of Hunger Questionnaire for Children and Adolescents); FBE = fatigue/boredom eating; BIS = behavioural inhibition system; BAS = behavioural activation system; RR = reward responsiveness; D = drive; BAS-FS = fun seeking; EC = effortful control; A = attention; AC = activation control; IC = inhibitory control; BMI = body mass index percentile.

Only significant correlations are reported: * = $p < .01$; ** = $p < .001$.

DISCUSSION

1. Synthesis of results and validation of hypotheses

First, the validity of the five-factor structure of the DOE-20, already established in two adult (Reicherts, 2007) and one adolescent (Zimmermann, 2012) samples, was confirmed in our own sample. However, internal consistency was only moderately satisfactory, which is consistent with Zimmermann's results (2012), which also found less satisfactory internal consistency in adolescents than in adults.

The hypothesis of a particular EO profile in overweight or obese adolescents ($H_{1.1}$) could not be confirmed by our analyses, as we found no significant EO differences according to BMI status.

The next hypothesis, exploring gender differences on EO ($H_{1.2}$), was partially verified, since differences were highlighted for two dimensions. In our sample, boys reported higher abilities in recognising and regulating their emotions than girls (REPCOG and REGEMO), which is consistent with Zimmermann (2012). We were not able, though, to reproduce differences previously found concerning the perception of internal and external bodily indicators of emotions (PERINT and PEREXT), which were higher in girls in Zimmermann (2012), but did not differ according to gender in our sample.

Regarding the prevalence of PEBs, those linked to disinhibited eating (i.e., assessed through the DEBQ) are quite common in youngsters, as they were reported as at least seldom experienced by 30% to 63% of our sample. In contrast, behaviours pertaining to EAH (i.e., evaluated through the EAH-C) are less common, since they were reported as at least encountered by 13%, 14%, and 41% of the sample. Behaviours related to externality were the most frequent, particularly external eating of the DEBQ, and those related to emotions the least frequent, especially those pertaining to EAH (i.e., negative affect and fatigue/boredom eating). Finally, restraint lay in-between. Results partially supported our hypothesis concerning differences according to gender and BMI status ($H_{1.3}$). Globally, girls experienced behaviours pertaining to emotionality more often than boys. Moreover, behaviours linked with emotionality and restraint were more present in overweight adolescents, while those linked with externality were more represented in normal weight adolescents, results in line with previous research (Lluch et al., 2000; Sánchez-Carracedo et al., 1996; Snoek et al., 2007; Tanofsky-Kraff et al., 2008).

Next, the first mediation analysis permitted to partially confirm the hypothesis postulating a mediating influence of PEBs on the association between EO dimensions and BMI percentile ($H_{1.4}$). Restrained eating was identified as a mediator for three EO dimensions, but only in girls. Lower levels of communication of emotions (COMEMO) led to a greater tendency to restrained eating, while higher levels of representation of emotions (REPCOG) and a greater awareness of internal

bodily indicators of emotions (PERINT) contributed to more restrained eating. Restrained eating, in turn, predicted a larger BMI percentile. In boys, however, no mediating effect was found.

Let us now turn to reactive and regulative temperament. Our next to last hypothesis regarding the mediating influence of PEBs on the associations between temperament and BMI percentile ($H_{2.1}$) was also partially confirmed, since a mediating effect of restrained eating was discovered, which differed according to gender. Restrained eating positively mediated the association between sensitivity to reward (BAS) and BMI percentile in adolescent girls, and also positively mediated the association between sensitivity to punishment (BIS) and BMI percentile in adolescent boys. In detail, girls showing more sensitivity to reward had a greater tendency to restrained eating, while boys with more sensitivity to punishment were more prone to this PEB. Restrained eating, in turn, contributed to a greater body weight in both adolescent boys and girls.

Finally, some patterns of bivariate associations between temperament, PEBs and BMI percentile were highlighted, partially corroborating our last hypothesis ($H_{2.2}$). Globally, in girls, behaviours pertaining to emotionality and externality were positively associated with BAS and negatively with EC. In boys, external eating was positively linked with BIS and BAS, and negatively with EC. As for BMI percentile, it was positively associated with restrained eating in both girls and boys, and negatively with external eating from the DEBQ in girls.

2. Theoretical interpretations and implications

2.1. Emotional Openness in normal weight and overweight adolescents

The first important aim of our dissertation was to determine if the specific EO profile highlighted in obese adults, including lower abilities in recognising, regulating, and communicating emotions, as well as a higher perception of internal and external bodily indicators of emotions (Braunschweig-Spatz, 2006), could be replicated in our overweight and obese adolescent sample. This objective was not fulfilled, as we found no significant EO differences according to BMI status. Besides, there was still no difference when socio-demographic data, positive affect, and negative affect were controlled.

Nevertheless, our sample was composed of both overweight and obese participants, whereas Braunschweig-Spatz's one comprised only obese individuals (2006). This important methodological difference may explain our disappointing results, and that is why we replicated our analysis by comparing only obese adolescents to normal weight ones. In that case, even if there still was no significant EO difference, the effect size of BMI status was moderate, suggesting a potential influence of this variable, which could not be detected because of limited power. Our sample indeed included only 17 obese subjects, a small number which probably reduced the power for analyses.

Therefore, the fact that we did not find any EO differences according to BMI status does not mean that affect processing does not influence excess weight at all. Our results rather suggest that emotional processing may influence obesity, but not overweight. It could also be that the DOE-20 questionnaire is not well adapted to assess EO in adolescents. This idea is corroborated by the limited internal consistency found in our sample as well as in another adolescent sample (Zimmermann, 2012). Finally, as already mentioned, emotional processing has not reached its definitive form at adolescence, since it keeps on developing from early childhood to the beginning of adulthood (Zeman et al., 2006). It may thus be that our participants did not show a stable EO profile, which may explain why we could not replicate the EO profile found in obese adults. In order to address that issue, we then decided to focus on temperament dispositions, which are present very early in life and underlie the development of emotional processing (Rothbart & Bates, 2006).

2.2. The mediating role of problematic eating behaviours in the associations of emotional processing and temperament with excess weight in adolescents

Another important objective of the present dissertation was to investigate the associations linking emotional processing and temperament dispositions to excess weight, with consideration of the mediating effects of PEBs in adolescents. Overall, we can conclude that emotional processing, assessed through EO, as well as reactive temperament dispositions, evaluated through BIS/BAS tendencies, do influence excess weight in adolescents, although this influence is not direct, but mediated by a single PEB, namely restrained eating.

The identification of the mediating role of restrained eating is consistent with the current definition of excess weight, which is now considered as a complex disorder resulting from the interaction of multiple factors, including biological, environmental, behavioural, and psychological ones (Delgrande Jordan, Kuntsche, & Gmel, 2007; WHO, 2004). More specifically, it has been evidenced that genetic factors play a predisposing role in the development of excess weight, and that the influence of genetics partially acts through behavioural tendencies (Faith & Keller, 2004). The results of our second mediation analysis clearly support this point of view, since they indicate that temperament, biologically based individual differences in any kind of psychological process (Rothbart & Bates, 2006), influences excess weight through the mediating role of restrained eating, a problematic eating behavioural tendency. Our results also represent a partial answer to the concern raised by Faith and Keller (2004), who regret that most genetic studies focused on metabolic or physiologic traits, neglecting other constitutional factors likely to have an impact on eating behaviours. Results of the first mediation analysis concerning EO go in the same direction, since reactive and regulative temperament dispositions are considered as bases for the subsequent development of emotional processing (Rothbart & Bates, 2006; Rothbart & Sheese, 2007). Besides, our results are consistent with previous research highlighting difficulties in emotional processing

in obese people (Canetti et al., 2002), particularly in females, including both adolescents girls (Rehkopf et al., 2011) and women (Zijlstra et al., 2011).

Let us now consider results of the mediation analyses in more depth. In the first mediation analysis, restrained eating mediated the association between three EO dimensions and excess weight in girls. Lower competences in communicating emotions (COMEMO) led to a greater tendency to restrained eating, while higher abilities in recognising emotions (REPCOG) and a stronger perception of somatic indicators of emotions (PERINT) contributed to greater restrained eating, which, in turn, led to greater body weight. No mediating effect was found in boys. In the second mediation analysis, restrained eating mediated the association between sensitivity to reward (BAS) and excess weight in girls, and the association between sensitivity to punishment (BIS) and excess weight in boys. Adolescent girls having a higher sensitivity to reward had a greater tendency to experience restrained eating, while adolescent boys with a higher sensitivity to punishment encountered this PEB more often. Again, restrained eating was associated with a higher degree of excess weight.

The positive impact of restrained eating on BMI percentile found in girls in the first mediation analysis and in both boys and girls in the second one support previous research, since this PEB, characterised by constant food restraint interspersed with overeating episodes (Herman & Polivy, 1980; van Strien et al., 1986), was sometimes found to be associated with obesity only in adolescents girls (Wardle et al., 1992), while other times in adolescents of both genders (Snoek et al., 2007; Stice, Presnell, Shaw, & Rohde, 2005).

Regarding the first mediation analysis, the negative effect of communication of emotions on restrained eating found in girls is consistent with our hypothesis as well as with Restraint Theory (Schachter et al., 1968), which postulates that the constant food restriction implicated in restrained eating may result in a state of chronic hunger leading people to periodically succumb to disinhibitors, and to experience episodes of overeating. Restrained eaters typically increase their food intake when exposed to negative emotions (Herman & Polivy, 1980), the act of overeating representing a way to regulate emotions, because it temporarily neutralises dysphoria (Polivy et al., 1994). As sharing emotions serves, among others, the purpose of emotion regulation (Reicherts, Genoud & Zimmermann, 2012), people having low competencies in communicating emotions may try to regulate them by eating, which contributes to overeating episodes typically found in restrained eating. While the positive effect of the perception of bodily indicators of emotions on BMI percentile is in line with our hypotheses, this is not the case for the positive impact of representation of emotions on BMI percentile, which was expected to be negative. However, both results can be connected with restrained eating, which is due, according to van Strien et al. (1986), to the incessant fight against hunger, resulting in a loss of contact with internal sensations of hunger. It seems important here to remind readers that the EO model pertains to emotional processing as represented by the subject, and not as actual measure of it (Reicherts, 2007; Reicherts et al., 2012). In this context, high self-evaluated awareness of somatic indicators of

emotions and high self-assessed abilities in recognising emotions may actually reflect an excessive focus on emotions, which may conduct individuals to interpret most somatic sensations as due to emotions, even those due to hunger. This strong focus on emotions may increase the loss of contact with internal cues of hunger, therefore contributing to overeating episodes typically found in restrained eaters.

Regarding now the second mediation analysis, the fact that sensitivity to both reward and punishment positively influences restrained eating may seem counterintuitive, but can actually be explained by the dual nature of restrained eating: sensitivity to reward affecting the overeating component of this PEB, while sensitivity to punishment acting on its restraint component. An important point to raise is that the mediation analysis revealed no effect of effortful control (EC) on PEBs. This result, inconsistent with our hypothesis, indicates, on one hand, that regulative temperament seems to have no impact on PEBs, and, on the other hand, that restrained eating is influenced only by emotional reactivity (i.e., reactive temperament), but not by conscious emotion regulation (i.e., regulative temperament). This somewhat surprising result deserves replication and further examination. The absence of association between EC and restrained eating may also be clarified with consideration of clinical data. Research demonstrated that eating disorders belong to a spectrum varying in degrees of impulsiveness, restrictive anorexia nervosa being at the least impulsive pole, and bulimia nervosa at the most impulsive one (Claes, Vandereycken, & Vertommen, 2005; Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006). Anorexia nervosa binge-eating/purging type, a disorder including constant food restriction with overeating or purging episodes (American Psychiatric Association, 2000), lies in the middle of the spectrum. We could therefore suppose that restrained eating, a behaviour similar to that found in binge eating/purging anorexia nervosa, but in an attenuated form, might also be in the middle of this spectrum, restrained eaters presenting thus an average level of impulsiveness. A low level of impulsiveness is characterised by strong BIS and EC associated with a weak BAS, while a high level of impulsiveness implies weak BIS and EC, and a high BAS. A medium level of impulsiveness is thus characterised by moderate levels of these three temperament dispositions. Therefore, if restrained eaters present a moderate level of impulsiveness, then they should also present a moderate level of EC, which explains why this temperament variable does not influence restrained eating. This interpretation, which would deserve further examination, is consistent with the results pertaining to reactive temperament, suggesting that a high BIS linked with the restraint component of restrained eating and a high BAS linked with its overeating component may balance each other, so that restrained eaters globally have a medium level of impulsiveness.

2.3. The influence of gender on the mediating effect of restrained eating

A striking result of our studies was the gender differences found in the two mediation analyses, suggesting that emotional processing plays a role in the development of excess weight only in girls, while reactive temperament is implied in excess weight in both boys and girls, but with different patterns of influence.

Those gender differences may be explained by the girls' higher tendency to be influenced by emotions in their eating behaviours. The first mediation analysis indeed revealed that restrained eating was induced, in adolescent girls, by an excessive focus on emotions, associated with difficulties in communicating emotions and, by extension, in regulating them. The second mediation analysis suggested that a higher sensitivity to reward contributed to the overeating component of restrained eating in adolescent girls. It is well known that negative emotions constitute the main disinhibiting factors contributing to overeating episodes in this PEB (Herman & Polivy, 2004). Thus, if results of the two mediation analyses are integrated, we could imagine that the girls' strong focus on emotions associated with their difficulties in regulating them and with their tendency to act impulsively to get a reward without taking account of the potential negative outcomes, may lead them to experience overeating episodes. In adolescent boys, nevertheless, no EO variable influenced restrained eating. This PEB seems to be induced, in the latter, by their higher sensitivity to punishment, so that they may restrict their food intake because of the anticipation of negative outcomes of eating, that is, for fear of becoming obese. It thus appears that girls are particularly sensitive to the disinhibiting influence of negative emotions, while other factors may influence overeating episodes in boys. Conversely, if the restraint component of restrained eating appears to be influenced by the behavioural inhibition tendency in boys, we can imagine that other variables than temperament may induce restraint in girls. These hypotheses are corroborated by our prevalence data, demonstrating that restrained eating is present in the same proportions in boys and girls, while emotional eating is more represented in adolescent girls, data already found in previous research (Lluch et al., 2000; Sánchez-Carracedo et al., 1996; Snoek et al., 2007; Tanofsky-Kraff et al., 2008). Our results may also suggest that girls are generally more prone to lose control than boys, which is consistent with clinical facts reporting higher prevalence of binge eating (Croll, Neumark-Sztainer, Story, & Ireland, 2002; Decaluwé, Braet, & Fairburn, 2003; Field et al., 1999; Schneider, 2003) and loss of control over eating (Elliott et al., 2010; Goldschmidt et al., 2008) in females than in males, including children and adolescents.

2.4. Problematic eating behaviours in adolescent boys and girls

The last important aim of the present dissertation was to investigate the prevalence of PEBs in adolescents, with a particular emphasis on differences according to gender and BMI status. We can conclude from our results that PEBs related to disinhibited eating are pretty common in adolescents, since they were reported as at least seldom encountered by 30% to 63% of our sample. Conversely, behaviours pertaining to EAH are less common, as they were reported as at least encountered by 13%, 14%, and 41% of the sample. Behaviours pertaining to externality (i.e., external eating from the DEBQ and the EAH-C) were the most frequent, and those linked with emotions (i.e., emotional, negative affect and fatigue/boredom eating) the least frequent, restrained eating being in-between. Such patterns have already been highlighted in previous research (Snoek et al., 2007). Results also revealed gender differences, namely higher levels of emotional and negative affect eating in girls than in boys, which partially supports earlier findings (Lluch et al., 2000; Sánchez-Carracedo et al., 1996; Snoek et al., 2007; Tanofsky-Kraff et al., 2008). In our sample, PEBs also differed according to weight status. Compared to normal weight adolescents, those overweight experienced behaviours pertaining to emotions and restraint more often, while they experienced behaviour linked to externality less often, data consistent with previous literature (Lluch et al., 2000; Sánchez-Carracedo et al., 1996; Snoek et al., 2007; Tanofsky-Kraff et al., 2008). It seems logical that behaviours linked with emotions and restraint are more represented in overweight adolescents, as they are assumed to be implicated in excess weight. However, the higher prevalence of PEBs pertaining to externality in normal weight adolescents may seem counterintuitive, but it is actually consistent with earlier studies highlighting a negative association between external eating and overweight in adolescents (Lluch, Herbeth, Méjean, & Siest, 2000; Snoek et al., 2007; Wardle et al., 1992). This result may be explained by the fact that food intake in preadolescents is mostly controlled by parents. It seems obvious that an overweight child's parents will try to reduce as much as possible his/her exposure to external food cues (e.g., unhealthy snacks), limiting thus his/her tendency to external eating (Snoek et al., 2007). Finally, bivariate correlations indicated that restrained eating was the only PEB significantly associated with BMI percentile in adolescents of both genders. This is consistent with the results of our two mediation analyses, as well as with previous literature (Snoek et al., 2007; Stice et al., 2005; Wardle et al., 1992). Taken together, these results suggest that restrained eating represents the major PEB implicated in excess weight in adolescents, being an important behavioural factor promoting excess weight, and probably also a behavioural consequence of excess weight. We could imagine that restrained eaters are facing a vicious circle, where their tendency to food restraint leads them to overeating episodes contributing to weight gain, and where weight gain, in turn, increases their tendency to food restraint. This hypothesis of course deserves further verification.

3. Clinical implications

One of the major contributions of the present dissertation is the demonstration that emotional processing and reactive temperament influence excess weight in adolescents through the mediating effect of restrained eating, findings which have important clinical implications.

First, as restrained eating has been identified as the major problematic eating behaviour implicated in excess weight in adolescents, reducing this PEB may thus represent an important way to control weight. Reduction of restrained eating could be achieved either directly or indirectly by working on emotional processing or on reactive temperament. One avenue to act directly on this PEB may be to teach adolescent restrained eaters to adopt a more flexible dietary restraint. Two type of restrained eating have been identified (Westenhoefer, 1991). Rigid restraint is associated with more frequent and more severe binge episodes, as well as with a higher BMI, while flexible restraint is linked with less frequent and less severe overeating episodes, as well as with a lower BMI and with a greater success in a one-year weight reduction program (Westenhoefer, Stunkard, & Pudel, 1999). This suggests that adopting a less rigid dietary restraint could help adolescent boys and girls to control their weight by limiting overeating episodes, and break the earlier mentioned vicious circle.

If we want to reduce restrained eating indirectly, the methods will necessarily differ depending on whether we are faced with adolescent boys or girls, since the factors promoting this PEB differ according to gender. With girls, it may be beneficial to work on EO, and especially to try to develop the communication and the regulation of emotions, as well as to reduce their excessive focus on emotions by teaching them to better distinguish between somatic sensations linked with emotions and those due to hunger. Intervention modules aiming at improving EO abilities have recently been developed. They can be implemented in various psychotherapeutic approaches, and have already proved to be effective for different mental disorders (Reicherts, Pauls, Rossier, & Haymoz, 2012). For girls, it may also be interesting to try to lower impulsivity, particularly the tendency to behavioural activation, in order to limit the overeating episodes. A method aimed at reducing delay discounting (i.e., the inability to delay gratification) called “Episodic future thinking” revealed significant efficacy in reducing food intake during an overeating episode in obese adults (Daniel, Stanton, & Epstein, 2013). Further research is warranted on the efficacy of such methods in overweight or obese adolescents. Finally our results suggest that, with boys who are restrained eaters, it would be more appropriate to work on sensitivity to punishment, in order to reduce their anticipation of negative outcomes of eating, which would probably help them limit their dietary restraint or adopt more flexible dietary control.

4. Weaknesses of the studies and new research perspectives

Although our studies yielded some interesting results, they nevertheless present some limitations. The first identified weakness is the use of the body mass index (BMI) to classify our participants as normal weight, overweight, or obese. As stated in the introduction, this index presents some limitations, including the fact that it is based on weight, and thus does not take into account body fat proportion and repartition, while morbidity risks associated with excess weight depend on the degree and on the repartition of adiposity. Consequently, the BMI does not permit distinguishing between fat mass and muscular mass, which may lead to weight status misclassifications (WHO, 2004). Despite these limitations and thanks to its ease of use, the BMI stays the most commonly used method to evaluate weight status. In addition, in our studies, the BMI was calculated based on actual measurements of weight and height, instead of self-reported ones, as is often the case, which reduced the risk of the usual bias consisting of underevaluating one's own weight and overvaluating one's own height (Schutz & Woringer, 2002).

The relatively small size of our two samples (first study: N = 160; second study: N = 130) probably has limited the power for analyses. This may explain, at least partly, why we were not able to highlight a particular EO profile in our overweight or obese adolescents, or why only restrained eating was identified as a mediating variable in our two mediation analyses. It therefore may be beneficial to reproduce our studies with greater samples, and particularly to increase the number of individuals having an excessive weight, in order to create separate groups for overweight and obese participants. In most of our analyses, we made no distinction between overweight or obese subjects, because this would have led to groups being too small to conduct valid analyses. Nevertheless, it seems important to consider overweight and obese individuals separately, as they appear to present different psychological and behavioural characteristics. For example, Davis and Fox (2008) discovered a non-linear association between sensitivity to reward and BMI status, overweight subjects being more sensitive to reward than normal weight ones, but obese ones less sensitive to reward than overweight ones. It could therefore be beneficial to reproduce our studies by comparing three distinct groups composed of normal weight, overweight, and obese adolescents.

Another limitation of our work is the use of self-reported instruments to assess temperament, emotional processing, and PEBs. Self-report questionnaires suffer from several issues limiting their validity, including, among others, the risk of a lack of honesty of respondents, a potential lack of introspective ability of respondents, or a risk of misinterpretation of the questions (Hoskin, 2012). More particularly, self-evaluation of emotional processing may be limited in youngsters because emotional insight, as emotional processing in general, is still under development during adolescence (Zimmermann, 2012). As for PEBs, the DEBQ has recently received criticisms regarding its lack of discriminative and predictive validity (Evers, de Ridder, & Adriaanse, 2009;

Jansen et al., 2011). It may thus be interesting to replicate our studies with actual measures instead of self-reported ones. We could imagine a laboratory evaluation of food intake (e.g., Goldschmidt, Tanofsky-Kraff, & Wilfley, 2011) to examine PEBs, or a behavioural assessment of temperament through computer-based neurocognitive testing, for example through the Door Opening Task to evaluate BIS and BAS (Daugherty & Quay, 1991), and through the Go/Stop Task to assess EC (Logan, Schachar, & Tannock, 1997).

The last identified weakness of our dissertation is the moderately satisfactory internal consistency of the DOE-20 in our sample. This lack of consistency may be due either to the small number of items per dimension (n = 4), or to possible comprehension problems. Indeed, for an important part of participants in our first study, French was not their native language, and we noticed that their α values were even worse than for those whose native language was French. It may be possible that the formulation of the questions was too complex for adolescents. This hypothesis is supported by the results of another study investigating psychometric properties in an adolescent sample (Zimmermann, 2012), which also found moderate internal consistency. It therefore could be interesting to develop a DOE version specifically adapted to an adolescent population.

5. Concluding words

At the end of this dissertation, we do not claim to have elucidated the whole issue of obesity, nor to have found a miracle solution to control its epidemic. We nevertheless reckon to have made some significant contributions to the understanding of the mechanisms implied in adolescence excess weight. We have discovered that reactive temperament and emotional processing influence overweight in adolescents through the mediating effect of restrained eating. These results corroborate the current view of excess weight, which is now considered as resulting from the interaction of multiple factors (Delgrande Jordan, Kuntsche, & Gmel, 2007; WHO, 2004), and more specifically from the interaction of genetic and behavioural factors, genetic predispositions acting on excess weight through behavioural tendencies (Faith & Keller, 2004). We also have demonstrated that restrained eating was the most important problematic eating behaviour implicated in adolescent excess weight. Finally, our dissertation highlighted gender differences in the factors contributing to restrained eating, girls being more influenced by emotions in their eating behaviours than boys.

We hope that the proposed clinical implications will be of help to people working with overweight or obese adolescents, and that the further research recommendations will provide readers with valuable avenues to pursue investigations on the emotional and behavioural influences on excess weight.

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TABLE OF ABBREVIATIONS

Abbreviation	Meaning
• BAS:	Behavioural activation system
• BAS-D:	Drive (subscale of BAS)
• BAS-FS:	Fun seeking (subscale of BAS)
• BAS-RR:	Reward responsiveness (subscale of BAS)
• BIS:	Behavioural inhibition system
• BIS/BAS Scales:	Behavioural Inhibition and Activation Scales
• BMI:	Body mass index
• CAP(s):	Comportement(s) alimentaire(s) problématique(s)
• COMEMO:	Communication of emotions
• DEBQ:	Dutch Eating Behaviour Questionnaire
• DOE-20:	Dimensions of Openness to Emotions Dimensions de l'Ouverture Emotionnelle
• EAH:	Eating in the absence of hunger
• EAH-C:	Eating in the Absence of Hunger Questionnaire for Children and Adolescents
• EATQ-R:	Early Adolescent Temperament Questionnaire - Revised Short Form
• EC:	Effortful control
• EO:	Emotional Openness
• PANAS:	Positive and Negative Affect Schedule
• PEB(s):	Problematic eating behaviour(s)
• OE:	Ouverture Emotionnelle
• OFSP:	Office Fédéral de la Santé Public [Federal Office of Public Health]
• PERINT:	Perception of internal bodily indicators of emotions
• PEREXT:	Perception of external bodily indicators of emotions
• REGEMO:	Regulation of emotions
• REPCOG:	Cognitive-conceptual representation of emotions
• WHO:	World Health Organization

Note. Conventional statistical and scientific abbreviations are not included in this list.