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Emotional eating is related with temperament but not with stress biomarkers in preschool children

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ABSTRACT

Emotional eating (EE) corresponds to a change in eating behavior in response to distress and results in an increase of food intake (overeating (EOE)) or in food avoidance (undereating (EUE)). EE has been related to temperament (i.e. negative emotionality) and dysregulated stress biomarkers in school-aged children; parenting has been understood to influence this relationship in older children. The aim of the study was to investigate to which extent stress biomarkers and negative emotionality are related to EE and to understand the role of parenting in this relationship. The sample consisted of 271 children aged 2–6 years of the Swiss cohort study SPLASHY. We assessed the child's EE, negative emotionality and parenting by parent based reports. Salivary samples were collected over two days to analyze cortisol and salivary alpha-amylase levels. From the whole sample of children, 1.1% showed EOE and 32.9% EUE. Negative emotionality was related to EOE and EUE (0.13 (CI 0.06, 021), $p < 0.001$; 0.25 (CI 0.14, 0.35), $p < 0.001$). There was no relationship between stress biomarkers and EE and parenting had any moderating role (all $p > 0.05$). Similar to a Danish study, parents reported more often EUE than EOE of their child. Both are related to the temperament. Even though the course of EE has not yet been well documented, we conclude that a certain subgroup of children with difficult temperament could be at-risk for eat and weight regulation problems in later childhood.

1. Introduction

Emotional eating is defined as dysfunctional coping with stressful events and can result in either increased food intake or in food avoidance. It corresponds to a change in eating behavior in response to negative emotional stimuli and distress (Wardle, Guthrie, Sanderson, & Rapoport, 2001). There is evidence that about 3.2–63% of children or adolescents show signs of emotional *over*eating (EOE). This broad range of prevalences can be explained by methodological differences within the different studies. For example, an American study interviewed children and adolescents from 5 up to 13 years on emotional eating. They reported that 63%

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of the participants affirmed the question 'Do you ever eat because you feel bad, sad, bored, or any other mood?' (Shapiro et al., 2007). Another US study found prevalences of 27% for emotional disinhibition (which is corresponding with increases in appetite in different emotional states) in 197 girls aged 4–6 years (Carper, Orlet Fisher, & Birch, 2000). Carper and colleagues used a child-based, age-adapted assessment (i.e. age-adapted version of the Dutch Eating Behavior Questionnaire DEBQ) (Carper et al., 2000) whereas another age-adapted version of the same questionnaire revealed prevalences of 28.8–30.4% in a European school-aged sample of children and adolescents with severe obesity who are seeking treatment (Halberstadt et al., 2016). In contrast to these child based assessments, parent-based assessment revealed clearly lower prevalences. Within the Danish population based study of 1327 children aged 5–7 years (Micali et al., 2011) only 3.2% showed emotional overeating when using a well-validated questionnaire (i.e. Child Eating Behavior Questionnaire CEBQ (Wardle et al., 2001)). To our knowledge, there is no other parent assessed prevalence data and no data of any other European country and further no data on younger children at preschool age.

The fact that data in young children is missing is even more important as EOE is characterized by a loss of control over eating, the tendency to eat in absence of hunger and the risk of continuous weight gain (Goossens, Braet, Van Vlierberghe, & Mels, 2009; Koenders & van Strien, 2011; Moens & Braet, 2007; van Strien, Herman, & Verheijden, 2012). Emotional overeaters at the age of early adulthood are known to increase the amount of food consumption under stress conditions (van Strien et al., 2012) and to eat more high-caloric and sweet food such as chips, cake or ice-cream under emotional distress within adolescence (Nguyen-Michel, Unger, & Spruijt-Metz, 2007; van Strien, Roelofs, & de Weerth, 2013). EOE in adolescence has further been shown to be associated with symptoms of loss of control of eating (LOC) and binge eating disorder (BED) in adolescents (Stice, Presnell, & Spangler, 2002).

In contrast to overeating as a stress response, approximately 30% of adults report a reduction of food intake (Epel, Lapidus, McEwen, & Brownell, 2001). This reduced food intake under emotional conditions is defined as emotional *under*eating (EUE) and is part of the food avoidant behavior that is described together with an elevated sensitivity to internal cues of satiety (Wardle, Guthrie, Sanderson, & Rapoport, 2001). The Danish population based study of Micali et al. (2011) which had been described above further assessed EUE by the well-validated Child Eating Behavior Questionnaire CEBQ (Wardle, Guthrie, Sanderson, & Rapoport, 2001; Carnell & Wardle, 2007). Parents were asked to provide information on EUE and EOE, but the questionnaire CEBQ does not provide any cut-off values and therefore in this Danish study, EUE and EOE were both defined as present if parents scored the child's EOE or EUE as "present at least sometimes". About 26% of the 1327 parents reported that their child aged 5–7 years shows EUE (Micali et al., 2011). Due to the fact that EUE would rather be expected to be associated with increased weight conditions, astonishingly EUE has been observed in children with very high and very low BMI (Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009) and has also been related to feeding problems and low growth during the first year assessed in children aged 5–7 years (Micali, Rask, Olsen, & Skovgaard, 2016). Nevertheless, probably due to the idea that EUE represents a more natural response to stress as animal studies have revealed that stress conditions provoke food avoidance (Sominsky & Spencer, 2014), previous research has so far not focused on EUE. Up to now, data on the course of EUE are lacking and it remains open whether EOE and EUE are triggered by similar conditions.

Eating behavior is influenced by chronic stress conditions through biological pathways. Chronic stress provokes a change in physiological stress biomarkers and can result as altered or reduced hypothalamic-pituitary-adrenal (HPA) regulation with typically increased or low morning cortisol levels and steeper or flattened diurnal rhythms (also known as cortisol slopes) (Gunnar & Vazquez, 2001). This adjustment of the stress biomarkers is a result of chronic stress exposure and has been understood as an adaptation of the HPA axis under a prolonged and repeated HPA activation also known as hypocortisolism (Heim, Ehlert, & Hellhammer, 2000). The HPA axis and the autonomic nervous system (ANS) are the two main components of the biological stress response, involving the secretion of glucocorticoids (e.g., cortisol), the activation of the sympathetic branch of the ANS and the release of salivary alpha-amylase. Cortisol and alpha-amylase both underlie a strong autonomous circadian diurnal pattern with opposed patterns. Cortisol shows a typical peak in the early morning, around 30 min after waking up, a steadily decrease throughout the day and reaches its nadir in the first hours after the sleep onset. Salivary alpha-amylase shows a decrease over the first 30 min after waking up and a consistent increase throughout the day.

In animal studies, HPA activation has been found to influence eating behavior (Ulrich-Lai, Fulton, Wilson, Petrovich, & Rinaman, 2015) through the release of corticotropin-releasing hormone and urocortin who suppress grehlin secretion (i.e. known to stimulate appetite) and act on different receptors in the hypothalamus which together reduce food intake (Sominsky & Spencer, 2014). In humans, the release of cortisol increases the appetite and shifts nutritional behavior towards the choice of high-fat and sweet food in most cases (Epel et al., 2001; Tomiyama, Dallman, & Epel, 2011), which in return results in a short-term reduction of stress perception via a dampening of the stress biomarkers (Dallman et al., 2003). Chronic stress exposure and dysregulated stress biomarkers might result in EOE unrelated to hunger- or satiety responses but triggered by emotional cues. Previous investigations in children at school age supported this idea. EOE was related to high levels of stress experiences (i.e. daily hassles and negative life events during the last 6 months) in children aged 5–12 years when EOE was assessed by an age-adapted version of the DEBQ (Michels, Sioen, Braet, et al., 2012), and a greater energy intake in absence of hunger has been associated with dysregulated biological stress biomarkers in children aged 5–9 years (Francis, Granger, & Susman, 2013), but EOE was not assessed in this latter study ($n = 43$). Whether the same patterns can be found in children at preschool age which is a sensitive period for the development of biological stress biomarkers and self-regulation strategies within childhood remains open. Furthermore, research on the relationship of diurnal stress patterns and emotional eating in children at preschool age is scarce and the only study which investigated this association reported significant findings for lower morning cortisol levels with EOE in children at preschool age (Lumeng et al., 2014). However, the existence of a similar relationship with EUE has not been investigated yet, nor has any study focused on the role of both main components of biological stress biomarkers (including cortisol and salivary alpha-amylase levels) which are both known to be related to body weight in children (Gunnar & Quevedo, 2007; Miller et al., 2013). In addition, appropriate self-assessment of emotional eating for children at preschool age might be difficult due to limited introspection and limited self-awareness capacity at that age (Stegge & Terwogt, 2007).

According to psychological theories, the child's ability to adjust to new or stressful conditions is influenced by family factors and the child's temperament. Temperament has been conceptualized as a psychobiological construct, describing the child's approaching and avoidance behavior as well as its reactivity to strains and demands (Boyce, Barr, & Zeltzer, 1992). In detail, high levels of negative emotionality as a correlate of temperament describe high sensitivity to environmental experiences and to stress. Children with high negative emotionality are characterized by a stable tendency to react to normative stressors with high levels of perceived distress and intense reactions such as crying, whining, fighting or anger expression (Pluess & Belsky, 2010). Negative emotionality assessed by EAS Temperament Survey for children (Buss & Plomin, 1984) was positively related with EOE and EUE in a general population based sample of children aged 3–8 years in a previous study (Haycraft, Farrow, Meyer, Powell, & Blissett, 2011) and difficult temperament (e.g. characterized as low self-regulation and negative reactivity) depicted by a selection of items that are related to the Strengths and Difficulties Questionnaire SDQ (Goodman, 2001) which is generally known to measure emotional and behavioral problems increased the impact of emotional eating on the risk for overweight conditions in a sample of children aged 6–12 years from the general population (Tate, Trofholz, Rudasill, Neumark-Sztainer, & Berge, 2016). Further children at the age of 9.5 years who are irritable and difficult to soothe have been generally more likely to tantrum over food which was related to overweight problems (Agras, Hammer, McNicholas, & Kraemer, 2004).

Previous work on preschoolers has further linked child's temperament rated by parents or teachers to increased cortisol reactivity during a challenging task (Blair et al., 2008; Talge, Donzella, & Gunnar, 2008) and to increased salivary alpha-amylase reactivity during a frustration task (Spinrad et al., 2009). Further previous studies showed a relation of diurnal patterns of HPA and temperament (negative emotionality) in young children (Dettling, Gunnar, & Donzella, 1999, 2000).

Besides temperament, family environment including feeding practices are known to have an impact on eating behavior. Most studies have focused on feeding practices and indicated that parental feeding is closely related to the child's eating behavior already at the age of 2–5 yrs (Blissett, Haycraft, & Farrow, 2010; Gregory, Paxton, & Brozovic, 2010; Haycraft & Blissett, 2012). In addition to the feeding style of the parents, general parenting style is likely to influence the development of self-regulation abilities over food and thus to further influence eating behavior in children (Morris, Silk, Steinberg, Myers, & Robinson, 2007). So far, EUE has been related to permissive parenting including inconsistent parenting and poor monitoring in a small population-based sample of children at the age of 3–8 yrs (Blissett, Meyer, & Haycraft, 2011) and to inconsistent parenting in a larger population-based sample of children at the age of 8–11 yrs (Schuetzmann, Richter-Appelt, Schulte-Markwort, & Schimmelmann, 2008). Parenting distress due to demands as a parent, but also due to the child's temperament and behavior have been linked to an increased biological stress reactivity and prolonged recovery periods after stress exposure in children at preschool age (Hastings et al., 2011).

Emotional eating might represent the behavioral consequence of the child's continuous reactivity to correlates of allostatic load already at an early age. High HPA responses (with higher cortisol levels in the morning and larger cortisol awakening responses (CAR)), for example, have been related to more sweet food intake and steeper slopes to more frequent sweet, fat and snack behavior in children aged 5–10 years (Michels et al., 2013); and greater sAA awakening responses (sAA AR) but flatter sAA slope with high levels of negative affect the day before in adolescents (Doane & Van Lenten, 2014). Clear evidence on the relation of these stress biomarkers and emotional eating is especially meaningful as the preschool age is considered to be a critical period for the development of emotion regulation strategies and emotional eating behavior. To sum up, previous studies have investigated EOE and found a relationship with HPA responses at school and preschool age, but there is no empirical support for EUE. Up to now, HPA axis was in the main focus of the few existing studies and evidence for the relationship of emotional eating. The second main component of biological stress response, the autonomic nervous system, was not investigated in children so far.

From a psychological point of view it can be assumed, that the child's temperamental disposition which influences daily interaction with emotional challenges and distress is related to altered eating under emotional arousal. Especially during early to middle childhood, family factors such as parental distress, closely related to parenting style impact on the child's behavior. As a consequence, parental factors are assumed to accelerate the associations between biological stress level and temperament and the eating style (emotional eating) of the child (Paschall, Gonzalez, Mortensen, Barnett, & Mastergeorge, 2015). We therefore hypothesize that parenting behavior moderates the relationship between stress biomarkers and between temperament with emotional eating. According to our assumptions, high levels of stress biomarkers manifested by large awakening responses and steep slopes and high negative emotionality as a dispositional factor contribute both to high levels of emotional over- and undereating and parenting behavior has a moderating role in this relationship.

2. Methods

2.1. Study sample and design

The Swiss Preschooler's Health Study (SPLASHY) is a multi-site prospective cohort study including 476 children during early childhood within two sociocultural areas of Switzerland (German and French speaking part). The study (registered as ISRCTN41045021) has been previously described (see Messerli-Bürgy et al., 2016). Children were recruited from 84 child care centers within five cantons of Switzerland (Aargau, Bern, Fribourg, Vaud, Zurich) which together made up 50% of the Swiss population in 2013. Recruitment started between November 2013 and October 2014 when children were 2–6 yrs old. The detailed study design and the overall objectives have been previously described (Messerli-Bürgy et al., 2016). The study was approved by all local ethical committees (No 338/13 for the Ethical Committee of the Canton of Vaud as the main ethical committee) and is in accordance with the Declaration of Helsinki. Parents provided written informed consent. The current analysis focuses on the baseline cross-sectional data of 440 participants providing valid questionnaire data and 271 providing valid saliva samples.

2.2. Assessment

2.2.1. Child-based assessments

Assessment of diurnal cortisol and salivary alpha amylase patterns. Measures of diurnal cortisol patterns were taken by parents on two different days (one weekday and one weekend day) including 5 samplings of saliva on each day by using Salivettes (Sarstedt, Nürnbrecht, Germany). Parents were told to avoid chewing gums, any eating or drinking, teeth brushing and physical activity that provokes breathlessness within 1 h before sampling.

Measurement of basal salivary cortisol and alpha-amylase concentrations (during one weekday with child care and one weekend day; 5 times/day): upon awakening in the morning around 7.30–8.00 (within 10 min of awakening), 30 min after awakening, before lunchtime (11.30–12.00), before snack (16.00) and at bedtime (20.00). Parents entered the time periods of assessment in a diary. Saliva was collected using Salivette (Sarstedt) collection devices, which are cotton rolls that children keep in their mouth for 1 min. All samples were stored at −20 °C in the freezer of each center until badge analysis. Salivary cortisol was analyzed by using a commercial chemiluminescence immunoassay (LIA) (IBL Hamburg, Germany) with a high sensitivity of 0.16 ng/m.

Alpha-amylase was analyzed using an automatic analyzer Cobas Mira (assay kits from Roche), as previously described (Nater et al., 2010). Inter- and Intra-CV was below 11.5% and 7.7% for cortisol. Inter- and intra-assay variabilities of alpha-amylase was 7.0% and 7.2%.

2.2.2. Parent-based assessment

Emotional eating was assessed by the Child Eating Behavior Questionnaire CEBQ of Wardle et al. (2001) which includes eight subscales. The CEBQ was proven to have a good validity and high internal reliability in the original validation sample (reports of parents of 2-9-year-olds) (Wardle, Guthrie, Sanderson, & Rapoport, 2001; Carnell & Wardle, 2007). Parents were asked to report on the eating behavior of their children by responding to each item using a 5 point-Likert scale with a range of never (1) up to always (5). The questionnaire includes two scales of emotional eating: calculated by 3 items on EOE (e.g. My child eats more when worried) and by 4 items on EUE (e.g. My child eats less when upset) which correspond either to an increase or a decrease of food intake in response to distress. Cronbach's alphas ranging from 0.72 to 0.75 for both emotional eating subscales had been previously reported (Wardle, Guthrie, Sanderson, & Rapoport, 2001) and are identical with the reliability in our sample with 0.72 for EOE and 0.75 for EUE. The questionnaire does not provide any cut off value, but in accordance with Micali et al. (2011), frequencies of EOE and EUE were determined by an algorithm. The algorithm determined the presence of EOE and EUE if all items of each of these subscales scored as "present at least sometimes" (value 3).

Negative emotionality was assessed by the EAS Temperament Survey for children (Buss & Plomin, 1984), German version: (Angleitner, Harrow, Hempel, & Spinath, 1991). The questionnaire is a parental rating scale including 20 items that are related to four potential temperaments of the child: negative emotionality, shyness, sociability and activity. The parents respond on a five-point Likert scale with a range of uncharacteristic (1) up to characteristic (5) for the child. For this study the temperament characteristic 'negative emotionality' (calculated by 5 items) was chosen which describes the tendency to become aroused easily and intensely and is understood as a general trait of perceived distress in young children. An example of items are „cries easily", „tends to be somewhat emotional", „often fusses and cries", „gets upset easily", or „reacts intensely when upset". The Cronbach's alpha within this sample was 0.74 for this subscale which is comparable with the literature $\alpha = 0.72$ (Spinath, Angleitner, Borkenau, Riemann, & Wolf, 2002).

Parenting behavior including parental stress and parenting style was assessed using the Alabama Parenting Questionnaire (APQ) for parents (Frick, Christian, & Wootton, 1999), German version DEAPQ-EL-HS (Reichle & Franiek, 2009) and the Parenting Stress Scale (PSS) (Berry & Jones, 1995; Berry & Warren, 1995), German version of Kölch and Schmid (2008). The APQ consists of 42 items to assess parenting style. Out of the six domains, the two parenting domains „inconsistent parenting" (e.g. The punishment you give your child depends on your mood) (calculated by 6 items) and „poor monitoring" (You get so busy that you forget where your child is and what he/she is doing) (calculated by 6 items) were selected in this investigation. The domain „inconsistent parenting" achieved a reliability level of $\alpha = 0.71$ which is comparable with the literature ($\alpha = 0.72$) (Reichle & Franiek, 2009), but Cronbach's alpha of the domain „poor monitoring" was 0.51 which is insufficient compared to the reported $\alpha = 0.75$ (Reichle & Franiek, 2009) and therefore was not considered for the analyses.

The Parenting Stress Scale (PSS) is a questionnaire with 18 items and assesses the level of stress that parents perceive within their parenting role. An example of an item is „Having child(ren) has meant having too few choices and too little control over my life". A total score is calculated. Cronbach's Alpha achieved $\alpha = 0.80$ in our sample which is highly comparable with the literature ($\alpha = 0.79$; (Stadelmann, Perren, Kölch, Groeben, & Schmid, 2010)).

2.2.3. Potential confounding variables

Age, gender, socioeconomic status (SES) and body mass index of the child were included as confounding variables. SES was assessed by coding the current occupational status of both parents using the International Socio-Economic Index (ISEI) value (Ganzeboom, 2010) and calculating the highest parental ISEI of both parents.

To assess body mass index of the child (BMI), height was measured to the nearest 0.1 cm with a stadiometer and weight to the nearest 0.1 kg (Seca, Basel, Switzerland) using standardized procedures (barefoot and in light clothing). BMI was calculated by weight/height squared (kg/m^2).

2.3. Statistical analysis

2.3.1. Data reduction for cortisol assessment

We collected and analyzed saliva of 363 of the participating 476 children. Of these 250 provided saliva samples for all 10 measurements whereas 113 did not provide enough saliva for all 10 samples. Out of a total number of analyzed samples ($n = 3630$), 23 samples with values of cortisol and sAA with three standard deviations above the mean were removed as these samples might have been contaminated by altered pH-values or blood (Kunz-Ebrecht, Mohamed-Ali, Feldman, Kirschbaum, & Steptoe, 2003). Parents of children with missing saliva were more often migrants ($\chi^2 = 12.87$; $p = 0.001$), showed lower levels of parenting stress ($F_{1,438} = 7.85$, $p = 0.01$) and their children showed lower levels of emotionality ($F_{1,438} = 4.39$; $p = 0.04$), but there was no difference in age, gender, SES, BMI, eating behavior or parenting style. A total of 3607 samples of sAA and cortisol measures were finally considered for analyses.

Adherence to the timing of sampling was strictly requested for daily profiles as it is known that alterations in timing can invalidate cortisol results (Stalder et al., 2016). According to the new standards for morning sampling collected with a delay of more than 5 min from the requested time point are invalid and have to be excluded (Stalder et al., 2016). In accordance with Michels (Michels, Sioen, De Vriendt, et al., 2012), evening samples were excluded if the sampling time differed by more than 1 h from the requested time. Due to non-time compliers, a total of 92 children had to be excluded from further analyses.

Saliva results were available and valid for 271 children, but in most cases not for both sampling days and not for all sampling time points. Statistical comparisons of daily profiles of both days revealed no difference between the two sampling days. Therefore, data of both days were collapsed by calculating a mean value for each sampling time point. Due to missing values, calculations of awakening response and slope were finally limited to 207 children for cortisol slope, 213 children for sAA awakening response and 219 children for sAA slope.

2.3.2. Slope calculations

Cortisol and sAA results of the different time points were log-transformed. The CAR corresponds to the change in cortisol and sAA-AR to the change in salivary alpha amylase within the first 30 min following awakening (Steptoe, 2007) and was assessed by the difference of the first sample at waking and the second sample at 30 min after awakening. Diurnal cortisol and sAA patterns (cortisol slope and sAA slope) were calculated based on regression concentration of the first sample and two additional samples over the day (out of lunch time, snack time or bedtime sampling) for each child according to Saridjan et al. (2014). The peak value at

30 min after awakening was excluded for slope calculations due to the idea that the peak value and the slope are modulated by different neurobiological systems (Clow, Thorn, Evans, & Hucklebridge, 2004).

2.3.3. Statistical analyses

Statistical analyses were conducted using SPSS (IBM, SPSS; Version 23.0, Chicago, IL, USA). Descriptive statistics are presented using Mean ± SD for all continuous variables. Outcome variables were checked for normal distribution. Parenting style and parenting stress were sqrt-transformed and values of salivary cortisol and salivary alpha-amylase were all log-transformed prior to statistical analyses.

To assess the association between the stress biomarkers, child's negative emotionality and eating behavior, we used a multilevel model with a random intercept for childcare center and with the respective stress biomarkers or child's negative emotionality as predictor, and EOE or EUE as outcome. Second, to test the moderating role of parenting behavior we included this variable together with its interaction with the respective predictor in the model. All combinations of predictors and outcomes were tested in separate models. All analyses were adjusted for children's age, gender, BMI and familial socioeconomic status, and in addition analyses involving cortisol awakening response were adjusted for wake up time as suggested by Stalder et al. (2016).

3. Results

According to the cut-off values created by Micali et al. (2011), we found prevalences of 1.1% for EOE and 32.9% for EUE. Descriptives of the sample are presented in Table 1. In comparison with the literature based on population based samples mean values of psychological scores were similar in this study sample for emotional eating (Ashcroft, Semmler, Carnell, van Jaarsveld, & Wardle, 2008; Haycraft et al., 2011), for temperament (Haycraft et al., 2011) and for parenting stress (Berry & Jones, 1995; Berry & Warren, 1995; Stadelmann et al., 2010), but lower for inconsistent parenting (Essau, Sasagawa, & Frick, 2006). Mean values of biological stress levels showed comparable cortisol and alpha-amylase values with results of another population based study of preschool and school children in Belgium (Michels et al., 2013), but showed lower levels than in a smaller German sample of toddlers and young children (Baumler, Kirschbaum, Kliegel, Alexander, & Stalder, 2013). Morning secretion levels of cortisol and alpha-amylase are expected to be opposite to each other showing a peak at 30 min post-awakening for cortisol levels and a nadir at that time for sAA. In our sample, 40.1% of the children did not show any cortisol peak at 30 min post-awakening and in 49,3% of children any nadir of sAA at that time.

Intercorrelations of the predictors, the moderators and the outcome variables are shown in Table 2. EOE was significantly related with EUE, negative emotionality, parenting stress and parenting style, whereas EUE showed similar relationships except for parenting stress. Stress biomarkers were not related with emotional eating. Only CAR was associated with negative emotionality.

3.1. The relationship between negative emotionality and stress biomarkers with emotional eating in preschool children

Negative emotionality was positively related with EOE and EUE even after controlling for covariates (age, sex, BMI and SES) in preschool children in our study.

Furthermore, high BMI was associated with EOE, but not with EUE, showing that specifically higher body weight is related to an increased food intake under emotional conditions. SES was a significant covariate in predicting EOE ($p = 0.04$). Low SES increased the interaction of EOE and negative emotionality and therefore pronounced the negative impact of temperament on emotional eating. There was no other impact of age, gender, SES or BMI.

After controlling for age, sex, BMI and socioeconomic status, there was no significant association between stress biomarkers of both axes and EOE or EUE (see Table 3). Neither cortisol, nor sAA daily profiles nor awakening responses showed a significant relationship with emotional eating.

3.2. The impact of parenting stress and parenting style

Moderation analyses were calculated to assess the role of parenting stress and inconsistent parenting style on the relationship of temperament with emotional eating and further of stress biomarkers with emotional eating. Neither parenting stress, nor parenting style did moderate any of these relationships when analyses were controlled for age, gender, BMI and SES ($p > 0.05$ for all analyses). Only BMI played a significant role in predicting EOE by negative emotionality or stress biomarkers when including parenting stress (Coeff = 0.08 (CI 95% 0.04, 0.12), $p < 0.001$) or parenting style (Coeff = 0.09 (CI 95% 0.05, 0.12), $p < 0.001$), as moderator. Therefore temperament and stress biomarkers were predictors of EOE in children with high body weight.

4. Discussion

This study aimed to investigate emotional eating in young children. We were interested to know whether EOE and EUE can

Table 1
Descriptives of eating behavior, negative emotionality, parenting behavior and stress biomarkers.

	N	M	SD
Covariates			
Gender (m/f)	476	251/225	
Age	476	3.89	0.69
Socioeconomic status	437	61.85	15.9
BMI	463	16.02	1.35
Eating behavior			
Emotional overeating	439	1.52	0.56
Emotional undereating	440	2.91	0.83
Negative emotionality and parenting behavior			
Negative emotionality	440	2.79	0.71
Parenting stress	440	37.13	7.29
Inconsistent parenting	440	2.48	0.55
Stress biomarkers			
HPA (salivary cortisol)			
Immediately after awakening (nmol/l)	225	12.88	1.82
30min after awakening (nmol/l)	247	14.79	1.82
Before lunch (nmol/l)	270	5.75	1.78
Before afternoon snack (nmol/l)	267	4.89	2.04
At bedtime (nmol/l)	260	1.54	2.18
CAR (log-transformed)	207	0.06	0.33
Diurnal cortisol slope (log-transformed)	212	−0.08	0.04
ANS (salivary alpha-amylase (sAA))			
Immediately after awakening (U/ml)	231	16.21	3.39
30min after awakening (U/ml)	247	16.21	3.31
Before lunch (U/ml)	265	26.3	3.09
Before afternoon snack (U/ml)	257	28.18	3.23
At bedtime (U/ml)	255	27.54	2.95
sAA-AR (log-transformed)	213	−0.03	0.49
Diurnal sAA slope (log-transformed)	219	0.02	0.06

Note. Emotional overeating (range 5–20); emotional undereating (range: 5–20); negative emotionality (range: 5–25), parenting stress (range: 5–90); inconsistent parenting (range: 5–30).

both be found in children at preschool age and to which extent the child's temperament and stress biomarkers are related to emotional eating. In our sample, parents reported EOE in only 1.1% of the children, which is a considerably lower rate than discussed in the child-based assessments where prevalences of 25–63% have been reported (Carper et al., 2000; Shapiro et al., 2007). In contrast, the Danish cohort study used a parent-based assessment and reported 3.2% of EOE and 25% of EUE in children aged 5–7 years (Micali et al., 2016). Even though our estimates on EOE and EUE relied on the same definition and same questionnaire (CEBQ) as in the Danish study EOE prevalences were lower, but EUE prevalences even higher with one third (32.9%) of the children showing signs of EUE. The slightly overall higher age of the Danish cohort might partly explain divergent prevalence rates in the samples. As such, EUE is known to decrease steadily with age in normative populations (Nicholls & Bryant-Waugh, 2008) and lower rates of EOE in our sample could be due to limited food access in 2–6 years old children. Further, in contrast to the Danish cohort study covering the whole country, our sample was recruited within child care centers over 5 cantons covering more than 50% of the Swiss population and representing more migrants (only Swiss parents (39.2%)) than discussed in the Danish study. However, both studies included healthy children with similar SES distributions.

The child's temperament was related with EOE and EUE in preschool children by controlling for age, gender, socioeconomic status levels, BMI and recruitment conditions (different child care centers in different socio-cultural areas of Switzerland), which is partly in line with the results of Haycraft et al. (2011). They previously investigated a mixed sample of preschool and school-aged children in United Kingdom and found emotional temperament to be related with food avoidant behavior (i.e. closely related with EUE), but not with food approaching behavior (i.e. related with EOE). We conclude that independent of the child's gender, the stable high reactivity to normative stressors with expression of negative emotionality relates with more external regulation of eating behavior in terms of emotional eating. Eating behavior regulation apart from internal hunger and satiety cues might represent a risk condition for disturbed eating patterns at long term. Already at this age, higher BMI of the child was related to more EOE, but not to EUE. In addition, we found indicates that even in this healthy population of young children, the relation of negative emotionality and emotional eating was especially pronounced in low SES families. This is of importance, as these families are known to be at risk for the development of overeating and overweight (Bush et al., 2016). In sum, negative emotionality as an index of increased negative reactivity to normative events in a child's daily life seems to relate similarly to EOE and EUE in our study. We assume that at this age, this relationship represents a rather general vulnerability for stress-related eating behavior while the course and relation to weight problems during later childhood remains open.

In contrast to the literature and our hypotheses, we did not find any relationship of emotional eating and stress biomarkers (Ouwens, van Strien, van Leeuwe, & van der Staak, 2009). Mean changes of cortisol levels between awakening and peak were clearly in between the higher values of a German group (Baumler et al., 2013) who investigated toddlers and children at a similar age, and the lower values of the Belgian group (Michels et al., 2013). In more than 40% of the children we did not find any peak of cortisol or any nadir of alpha-amylase within the morning secretion levels. This has not been discussed in the Belgian study but has been reported in infants, toddlers and in a mixed group of toddlers and preschoolers before (Baumler et al., 2013; Bright, Frick, Out, & Granger, 2014; Stalder et al., 2013). We cannot rule out that daytime napping, restricted sleep or time lags between suggested and protocoled saliva sampling might have influenced the data, even though parents provided information on sleeping duration the night before awakening assessments and duration was within the expected range of young children. Besides these possible methodological constraints, the discrepant findings in our study can be explained as follows: Firstly, awakening responses and diurnal slope might not be sensitive enough to capture subtle dysregulations of stress biomarkers in healthy children. Reactivity measures under an acute stress exposure as found in other studies for pathological aspects of eating behavior might be more suitable (Monteleone, Scognamiglio, Canestrelli et al., 2011; Monteleone, Scognamiglio, Monteleone et al., 2011). Secondly, we think that changes of specific behaviors due to dysregulations of stress biomarkers might demand certain time periods to impact on behavior that were not captured by our cross-sectional design and might only present on the long term. Thirdly, limited food access of a preschool age child reduces the chances of observations and representative parental estimations of the child's emotional over- and undereating. Finally, in contrast to the existing data on 3–4 yrs old children of Lumeng et al. (2014), where a relation between stress biomarkers at preschool arrival and emotional eating assessed by the CEBQ via parents has been shown in a selected low SES population, we investigated children from different SES groups and are the first to sample saliva at awakening time and further reassessed cortisol and alpha-amylase throughout the day including bedtime levels. Further analyses of migrant status as a potential confounder did not show any significance. Whereas awakening saliva cortisol represents an index of longer term stress response, saliva measures of cortisol at pre- or school arrival might capture more acute reactivity to a normative but still important daily challenge. Future studies should thus investigate, whether relations between correlates of stress biomarkers and emotional eating are restricted to correlates of more acute stress and less to indicates of responses to chronic, constant stressors.

We expected that parenting stress or parenting style moderate the relationship of stress biomarkers or negative emotionality and emotional eating as this could represent the spill-over of stress

Table 2
Correlation matrix of emotional eating, stress biomarkers, emotionality and parenting behavior.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Emotional overeating (1)	R		0.23**	−0.08	−0.02	−0.04	−0.06	0.18**	0.15**	0.23**
Emotional undereating (2)	R			0.07	0.01	−0.05	−0.02	0.20**	0.05	0.19**
CAR (3)	R				0.36**	−0.04	0.04	−0.21**	0.09	−0.01
Diurnal cortisol slope (4)	R					0.01	−0.04	−0.1	−0.01	0.04
sAA-AR(5)	R						0.60**	0.01	−0.01	−0.10
Diurnal sAA slope (6)	R							0.01	0.04	−0.03
Emotionality (7)	R								0.38**	0.27**
Parenting stress (8)	R									0.30**
Inconsistent parenting (9)	R									

**$p < 0.01$.

Table 3
Parameter estimates from linear mixed models for eating behavior.

	Emotional overeating		Emotional undereating	
	Coeff. (95%)	P-value	Coeff. (95%)	P-value
STRESS BIOMARKERS				
HPA				
CAR	−0.03 (−0.12, 0.05)	0.44	0.05 (−0.05, 0.16)	0.34
Diurnal cortisol slope	0.04 (−0.57, 0.66)	0.89	0.09 (−0.67, 0.86)	0.81
ANS				
sAA-AR	−0.02 (−0.09, 0.02)	0.23	−0.02 (−0.11, 0.05)	0.48
Diurnal sAA slope	−0.15 (−0.49, 0.18)	0.37	−0.09 (−0.51, 0.32)	0.66
TEMPERAMENT				
Emotionality	0.05 (0.02, 0.08)	0.001	0.07 (0.04, 0.10)	0.001

Note: Adjusted for age, sex, BMI and socioeconomic status.

conditions of parents and parental modeling in terms of feeding style on their children as discussed in other studies (Collins, Duncanson, & Burrows, 2014; Gunnar, Hostinar, Sanchez, Tottenham, & Sullivan, 2015; Topham et al., 2011), but our cross-sectional data did not reveal evidence for that. It has to be investigated, whether the impact of parenting and self-reported stress of the parents on emotional eating reveals during middle to late childhood, when the child develops more age adapted access to food and when self-regulation of food intake is established. It is but noteworthy, that in our study, again, the BMI of the child moderated the relation between biological and psychological factors and emotional eating. In other words, children with a high BMI showed more EOE and their temperament and stress biomarkers were predictors of EOE.

5. Conclusions

In our sample of healthy children aged 2–6 years we detected a high prevalence of EUE and a comparably low prevalence of EOE. EUE might represent a still normative reaction to stress at this age. Emotional eating was related to the child's negative emotionality and there was no evidence that stress biomarkers and different facets of parenting are related to emotional eating behavior. Children from low SES groups and children with a higher BMI might be at risk for dysfunctional eating and weight regulation already at this early age. Longitudinal studies are necessary to clarify to which extent these associations may stay stable over time or may potentially change under different parenting conditions at middle childhood.

Authors' contributions

The main responsibility for the study design and project management was with the principal investigators JJP, SM, SK and OGJ. All authors contributed to the development of the study design and to the data collection. NMB drafted the manuscript. All authors read and commented on drafts and approved the final manuscript. The Swiss National Research Foundation and the Jacobs Foundation neither interfered with the design of the study nor provided direct support (e.g., subject recruitment).

Competing interests

The authors declare that they have no competing interests.

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