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Regulating bodily states and emotions: the influence of child and caregiver factors on emotional eating in 18-month-old toddlers

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ABSTRACT

Parental feeding practices, child temperament, and poor emotion regulation abilities are central factors associated with Emotional Eating (EE) during childhood (3–10 years). Yet, it is poorly understood how children develop EE behaviours in early life. This experimental study investigated the influences of parental and child factors on early expression of EE behaviours in 18-month-old toddlers (N = 71). Toddlers attended the lab twice. After eating lunch to satiation, we manipulated internal emotional states and examined how toddlers regulated their responses to a mildly stressful (experimental) task compared to a control task, using the Laboratory Temperament Assessment Battery "attractive toy behind a barrier" task. Immediately after, an Eating in the Absence of Hunger (EAH) protocol was administered. Toddlers' behaviours during each task were coded, along with measuring the energy consumption of snack food items. We found that experimental condition alone did not predict EE. However, toddlers exhibiting higher behavioural reactivity to changes in emotional state showed higher EE and consumed more energy. Higher parental use of food to regulate emotions predicted fewer calories EAH. Child eating traits were not found to be predictive of EE in the absence of hunger. We conclude that EE is a behaviour performed by some toddlers, yet an emotional perturbation alone is not enough to elicit EE at this developmental stage. Having a temperament that results in high behavioural reactivity to the situation and poor emotional regulation abilities may facilitate EE's occurrence. Future research should further investigate how both individual and situational factors interact to inform the development of EE in early life.

1. Introduction

Infancy and toddlerhood are characterised by developing skills relating to self-awareness and body-environment interactions. Among these abilities is interoceptive processing, which refers to the ability sense, integrate, and interpret information about the state of the inner body, both at the conscious and unconscious levels (Berntson & Khalsa, 2021; Khalsa et al., 2018). Across infancy and toddlerhood, children begin to learn that internal sensations like discomfort in the abdomen may indicate hunger and that environmental inputs, such as consuming food, can alter these sensations (Fotopoulou & Tsakiris, 2017; Atzil & Barrett, 2017; Atzil et al., 2018; Filippetti, 2021). Interoception is therefore crucial for appraising and assigning meaning to internal bodily states, which allows children to regulate their needs by communicating them to a caregiver or taking action (e.g., feeding or stopping eating).

Emotional eating (EE) is an example of how children may associate interactions between external environmental cues, with changes to internal signals. EE refers to eating in response to subjective emotional states, rather than to physiological hunger (Chawner & Filippetti, 2024; Devonport et al., 2019; Fuente González et al., 2022). As a result, discomforting internal signals associated with emotional states may be relieved, or regulated, by consuming food.

From 3 to 4 years onwards, EE has been observed and described as an eating trait (Blissett et al., 2010; Herle et al., 2017). Yet, developmental and experimental research in younger samples including toddlerhood is scarce. A recent model proposed by Chawner and Filippetti (2024) suggests how EE may develop from infancy through childhood. According to this model, certain individual and environmental factors such as child temperament, genetics, and parenting practices— can increase a child's probability for EE. However, for these factors to influence EE at any given moment, the context must be conducive (e.g. food must be available and an emotion must be experienced). Consequently, children learn to engage in EE in certain contexts, based on the internal feedback they receive from their attempts to regulate emotions and their feelings of satiation, which result from interactions between internal signals and the external environment.

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In the literature, three important processes and factors relating to the development of EE have dominated the research focus: emotion regulation, child temperament, and parental feeding practices. Poor emotion regulation abilities have been associated with increases in EE (Harrist et al., 2013). The hypothesis linking emotion regulation to EE posits that when individuals experience a negative emotional state, they strive to return back to a more neutral or positive emotional state (Guerrini-Usubini et al., 2023) – akin to an emotional set-point (Berridge, 2004). If adaptive regulation strategies (e.g. playing, seeking caregiver comforting) are unavailable or ineffective, EE may be used as a way to regulate emotions (Favieri et al., 2021).

Temperamental traits such as negative affect, often measured by questionnaire, have been consistently associated with increased EE in childhood (Messerli-Bürgy et al., 2018), yet few studies have replicated these associations in younger children (Ju et al., 2024). For example, high reactive temperament—characterised by negative affect and impulsivity—in children aged 4 to 6 is associated with increased food consumption in response to stress (Ohrt et al., 2020). Longitudinal studies indicate that high negative affect at age 4 can predict EE at ages 6, 8, and 10 (Steinsbekk et al., 2018). Additionally, lower effortful control at age 6 has been linked to higher EE at age 8 (Steinsbekk et al., 2020).

Parental feeding practices have also been shown to play a role in their child's eating behaviour. Specifically concerning EE, parental use of food as a reward and restrictive feeding practices at 3–5 years of age have been found to predict higher EE at 5–7 years (Farrow et al., 2015). This suggests that parents may inadvertently encourage EE through their feeding strategies. For instance, parents may offer snacks when a child is bored or feeling upset (Stone et al., 2023), teaching children that EE may be a valid means to regulate their emotions. Importantly, research has shown that these processes and factors do not operate in isolation; rather, they are interconnected and influence each other. Children with temperaments characterised by low levels of orienting/regulation at 3 months old have been found to display higher EE at 3 years (Ju et al., 2024). The authors further found that this relationship may be mediated by less supportive caregiver responses to the child's emotions at 18 months. Additionally, parental food restriction and use of food as a reward may mediate the relationship between high negative affect and EE (Stone et al., 2022). Similarly, use of coercive control practices has been related to poor emotion regulation abilities and increased EE in 4–5yr olds (Baker & Fuglestad, 2024). Overall, these findings suggest that parenting, child temperament, and emotion regulation abilities may interact to determine EE in early childhood, potentially through reciprocal relationships (Steinsbekk et al., 2018). Yet, while these factors contribute to children's eating behaviours, we still lack a clear understanding of the mechanisms underlying EE (Chawner & Filippetti, 2024).

A child's ability to accurately read and respond to internal cues allows them to regulate their needs effectively. However, we know very little about how infants and children learn to identify, appraise, and assign value to their own sensory percepts. Theoretical models have highlighted the importance of an integrated approach that considers both caregiver behaviours and infant characteristics (Filippetti, 2021; Fotopoulou & Tsakiris, 2017; Montirosso & McGlone, 2020). In the current study, we aimed to examine how parental feeding practices, child temperament, and toddlers' abilities to regulate their internal states, influence 18-month-old toddlers' eating behaviour in response to a perturbation of internal (emotional) state and in the absence of hunger. Although we did not directly measure interoception, we manipulated internal emotional states and examined how toddlers regulated their responses to a mildly stressful task compared to a control task. We hypothesise that toddlers would consume more energy Eating in the Absence of Hunger (EAH) when subjected to a mildly stressful task compared to a control task. We further predicted that toddlers would consume more energy EAH if they displayed higher behavioural reactivity (a measure of temperament) in response to the stressor (versus control), and if parents reported using feeding practices including using food to regulate emotions, or using food as a reward, more frequently.

2. Methods

2.1. Participants

Seventy-one 18-month-old (±1 month) toddlers (42 females) were recruited to participate. Toddlers were recruited via email or phone call from a database consisting of parents from the East of England, UK, who had previously expressed an interest in taking part in psychological research. All toddlers invited to participate were born full term (37–41 weeks). Toddlers were excluded from participating if they had allergies to ingredients in three or more snack food items that were available (none excluded), if they did not eat lunch in the laboratory (none excluded), or if they became fussy/uncooperative and it was not possible to conduct the experiment (N = 2 excluded). Prior to recruitment, ethical approval for the study was obtained from the University of Essex Research Ethics Committee (ETH2122-0126).

We conducted an a-priori power analysis (using the R package 'pwr') to determine the sample size required. As no previous research has reported similar analyses in infant and toddler populations, we used a medium effect size based on research findings with 3–7 year old children (Blissett et al., 2010; Farrow et al., 2015). To detect an effect size of $f^2 = 0.18$, with a significance level of 0.05 and power of 0.80, 75 participants were required to conduct a multiple regression with one interaction effect. However, this minimum number of participants was not met due to time constraints on the study and difficulties with the recruitment of 18-month-old toddlers.

2.2. Design

An experimental, repeated measures design was used. Parents completed an online survey prior to attending the laboratory. Toddlers then took part in both the experimental (emotional state perturbation) and control (no emotional state perturbation) conditions in a counterbalanced order, a week apart. The main outcome of interest was the amount of energy (kcal) consumed in each condition EAH. The study preregistration can be viewed on OSF (https://osf.io/f6t8z).

2.3. Procedure

Before their lab visit, parents completed an online survey and were instructed not to feed their toddler for 2 h prior to attending the sessions. Upon arrival, the toddler was given the opportunity to familiarise themselves with the environment and play with toys whilst the procedure was explained to the parent. The parent then indicated when the toddler was hungry or ready for lunch and both were taken to a room equipped with a highchair and tray. Due to COVID-19 restrictions at the time of ethical approval and when the study began, parents prepared and provided lunch for their toddler. They were asked to feed their toddler as they usually would at home, until their child appeared full and was no longer interested in eating (e.g. indicated by toddler meal termination cues). Pictures and weights of each food were taken before and after eating. Since we relied on two spaced-apart meals to assess the toddler's eating behaviour—acknowledging that such behaviour can vary significantly between meals and days—we also asked parents whether they believed their toddler ate more or less than usual. For full details of the lunch, see also *Lunch* in Section 2.4 below.

After a 10-min break, during which the toddler could play with toys in the reception area, the toddler and parent returned to the lunch room for the experimental part of the study. Parents were asked to "minimally interact" with their toddler, and to only engage their toddler if they became upset. The toddler then took part in both the control and experimental conditions, with a one-week washout period between the conditions. The order of conditions was both randomised and counterbalanced across participants. The experimental task involved the Laboratory Temperament Assessment Battery (Lab-TAB) “attractive toy behind a barrier” task, designed to evoke an emotional perturbation in the toddler (Goldsmith & Rothbart, 1996) (described below in ‘Materials’). By selecting this well-validated, standardized task, we aimed to induce an emotional state likely to evoke emotional eating (i.e. frustration and anger) while avoiding strong emotional arousal that could interfere with appetite (e.g. fear) (Macht, 2008; Barnhart et al., 2020). The control condition involved free play with the same attractive toy. During each task, the toddler’s behaviour was video-recorded for the purposes of subsequent behavioural analyses and coding.

Immediately after the control and experimental conditions, the toddlers were provided snacks and toys for an EAH task (Fisher & Birch, 1999) (see also *Eating in the absence of hunger (EAH) and snack foods* in Section 2.4 below). There were 12.5 min between the end of lunch and the start of the EAH task. If the toddler was allergic to any ingredients in the snacks provided, this snack was removed. Only 2 toddlers had snacks removed due to allergy, each with 1 snack being removed (5 snack foods were presented instead of the usual 6). During the EAH task, the parent was reminded not to interact with the toddler, encouraging no interference with the toddler’s eating or playing behaviours. The task lasted up to 10-min (Mean = 8 min 13 s) for most visits (N = 85 observations), or until the toddler became disinterested (N = 23 observations), fussy (N = 13 observations), or threw all food onto the floor (N = 13 observations). At the end of the task, the uneaten food was weighed to calculate energy consumed.

Following the second lab visit, parents were fully debriefed as to the aims of the study. The height and weight of the toddler were measured to calculate body mass index (BMI) and the toddler was given a storybook to take home as a gift for participating. A summary of procedures is displayed in Fig. 1.

2.4. Materials

2.4.1. Online survey

Parents completed an online survey containing demographic questions, along with questionnaires addressing the toddler’s eating traits, parental feeding practices, and the toddler’s temperament. Toddler eating traits were measured using the Child Eating Behaviour Questionnaire (CEBQ: Wardle et al., 2001) subscales of enjoyment of food ($\alpha = 0.89$, AVE = 0.80), food responsiveness ($\alpha = 0.79$, AVE = 0.51), and emotional over ($\alpha = 0.72$, AVE = 0.66) and under ($\alpha = 0.74$, AVE = 0.50) eating. Parent feeding practices were measured using the Comprehensive Feeding Practices Questionnaire (CFPQ: Musher-Eizenman & Holub, 2007) subscales use of food to regulate emotions ($\alpha = 0.58$, AVE = 0.41) and use of food as a reward ($\alpha = 0.73$, AVE = 0.66). Lastly, temperament was also measured using the Early Childhood Behaviour Questionnaire (ECBQ: Putnam et al., 2006), using the negative affect ($\alpha = 0.72$, AVE = 0.26), surgency ($\alpha = 0.52$, AVE = 0.16), and effortful control ($\alpha = 0.56$, AVE = 0.13) subscales. Overall, reliability was acceptable for most scales, although lower reliability was observed for CFPQ use of food to regulate emotions and ECBQ surgency and effortful control subscales. Parents were also asked in the survey how frequently their toddler eats each of the snack items that were presented in the EAH task, and whether their toddler had any allergies.

2.4.2. Lunch

Parents supplied the toddler’s lunch items consisting of at least two foods and a drink. This arrangement was necessary due to lingering COVID-19 restrictions at the time of ethical approval, which prevented the use of a standardized meal. Parents were instructed that they could also bring their own lunch if they typically ate with their child (parents also ate lunch in 49/134 observations). Lunch items were weighed and photographed before and after eating to estimate calorie consumption. If food packaging was available, the nutrition information was used for energy calculation; otherwise, energy content was estimated using the

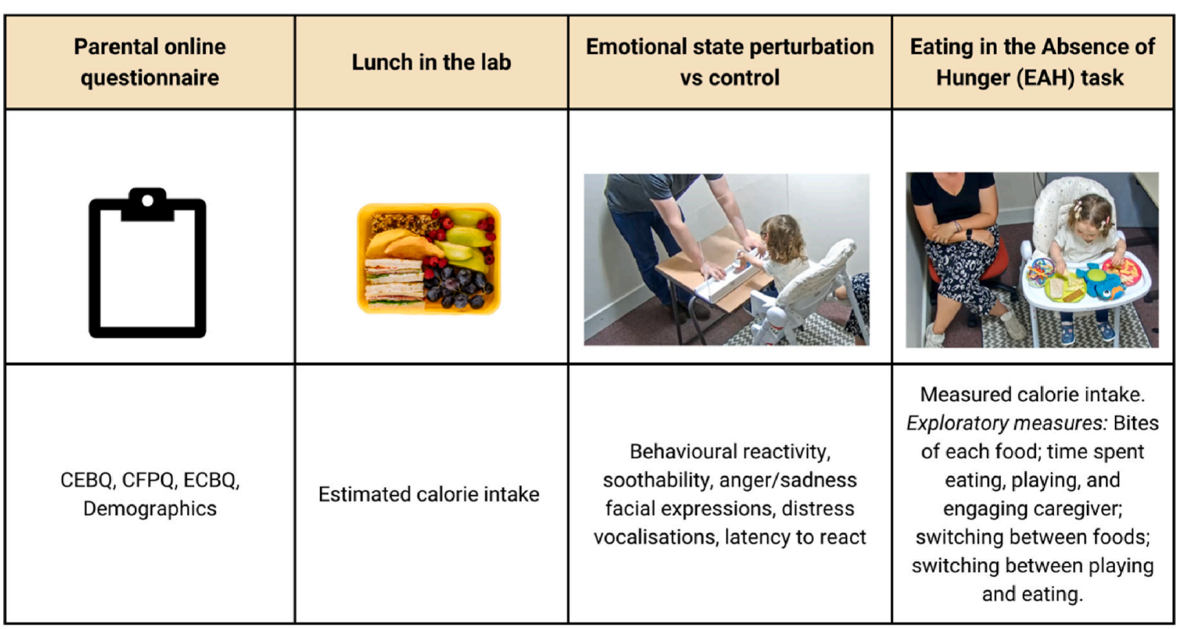

Fig. 1. Experimental protocol of the study.
Note. An overview of procedure tasks, timings/order, and measures collected at each stage. Before their lab visit, parents completed an online survey including demographics, and questionnaires addressing the toddler’s eating traits, parental feeding practices, and child temperament. On the days of the lab visits, parents provided lunch for their toddler and calorie intake was estimated for each participant. After lunch and a 10-min break, the participants underwent the emotional state perturbation or control condition (their order randomised and counterbalanced across participants). Measures of behavioural reactivity, soothability, facial expressions, distress vocalizations, and latency to react were taken from each participant in both conditions. This was immediately followed by the Eating in the Absence of Hunger (EAH) task, whereby participants were presented with a set of snacks and toys. Calorie intake from the EAH task was the primary outcome measure of this study.

McCance and Widdowson (2014) composition of foods. The parent and toddler were not given a time limit in which to eat lunch, ensuring they could consume as much as they wanted and that slowness in eating did not affect reaching satiation. Therefore, lunch durations had a large range between 12 and 40 min. The parent signalled to the experimenter when they believed the toddler had finished eating and felt full. We relied on the caregivers' familiarity with their child's usual hunger and fullness cues, which is supported by existing literature as a valid proxy in young children (Hetherington, 2020, pp. 373–389; Yu et al., 2025).

2.4.3. Emotional perturbation (experimental) and control tasks

Following a short break after lunch, the toddler took part in either a control task or experimental task. For the experimental (emotional perturbation) condition, the toddler was seated in a high-chair with a table (63 cm wide x 56 cm deep) in front of them. The parent was seated behind the toddler to their right, approximately 50 cm away. The Lab-TAB "attractive toy behind a barrier" paradigm (Goldsmith & Rothbart, 1996) was used to elicit an emotional perturbation (e.g. emotions of frustration, anger, or sadness) by the toddler. The task began when the experimenter brought the attractive toy into the toddler's view, demonstrated how it worked and gave it to the toddler. The attractive toy had a round bottom part so that it could wobble or spin around, but not fall over. It also had a bell inside that made noise when it was moved. The toddler was then allowed to play with the toy for 15 s before the experimenter placed a transparent Plexiglas barrier (40 cm high x 40 cm wide) in front of the toddler (within their reach). The experimenter then gently took the toy back from the toddler and placed it directly behind the barrier. The toy was left behind the barrier for 30 s, after which the experimenter returned it to the toddler. This procedure was repeated two more times for a total of three trials. In contrast with the Lab-TAB manual, the toy was *not* returned after the third trial, as the purpose of this episode was to elicit an emotional perturbation so that the influence of this perturbation on the toddler's subsequent eating behaviour could be assessed. The entire episode lasted for 2 min and 15 s and at the end of the condition, the EAH task followed immediately.

The control task setup was exactly the same as in the experimental condition, using the same attractive toy and room positioning. However, in this condition, the toddler played freely with the attractive toy for 2 min and 15 s (comparable with the experimental task time). The control task commenced when the experimenter gave the toddler the toy. During the task, the experimenter minimally interacted with the toddler. They maintained a neutral facial expression and gazing towards the toddler's chest to avoid direct eye contact. The experimenter interacted only as needed to redirect the toddler's attention back to the toy and to prevent any negative emotions from arising during the interaction. At the end of the condition, the EAH task followed immediately.

2.4.4. Eating in the absence of hunger (EAH) and snack foods

The EAH protocol was adapted from previous studies (Asta et al., 2016; Birch et al., 2003), with the main difference being the toddler was in a highchair with restricted freedom to move around the room. The toddler was provided with a tray containing two novel toys and two plastic plates each with three types of high energy density (HED) snack foods (see Fig. 1 EAH task). The toys were provided as an alternative to eating, should the toddler have wanted to play instead of eat (i.e. as an alternative method of regulating emotions). The decision for these toys to be novel was due to the emotional nature of the manipulation, insofar confounding may be introduced through previous emotional connection or comfort associated with a familiar toy. The snacks presented were selected based on a) having none of the main allergens, gluten or soya (where possible), b) previous studies investigating toddlers' EAH (Schultink et al., 2021), c) varying across sweet and savoury taste dimensions, and d) observations from our pilot data. Snack food items are presented in Table 1, along with detailed nutritional information.

2.5. Data preparation and analyses

2.5.1. Behavioural data preparation

Coding and scoring of the Lab-TAB "attractive toy behind a barrier" task was performed according to the Lab-TAB manual version 3.1 (Goldsmith & Rothbart, 1996). Toddler's behaviours were coded for intensity of facial expression of anger or sadness (0–3), distress vocalisations (0–5) and behavioural struggle (0–4) for both experimental and control conditions. We also recorded how long it took for the toddler to react with a behavioural expression of anger or sadness (latency to react), as well as the duration for which the toddler displayed facial expressions associated with anger or sadness (soothability, i.e. duration of emotional perturbation).

To score these behaviours, each Lab-TAB trial was split into six 5-s epochs. Behaviours occurring within each epoch were averaged across the 6 epochs of the same trial to give an overall behavioural reactivity score. This was calculated for each of the three trials separately. The two trials with the highest reactivity scores (facial expression, vocalisation and struggle) were then used to create a composite (summed) variable of behavioural reactivity intensity of the toddler. A higher composite score indicates higher emotional expression and reactivity.

Three trained research assistants who were blind to participants' other variables (e.g., parental feeding style) coded the video recordings of participants, with second coding occurring for 26 (37 %) participants. Coding training consisted of familiarisation with the Lab-TAB coding system, coding a minimum of 3 videos together with an experienced coder, and coding a minimum of 5 videos independently within a small margin of error (5 %) to other coders. Both coders 2 and 3 s coded the same videos as coder 1. Intraclass correlation coefficient (ICC) was calculated based on intensity score ratings to indicate interrater reliability, based on a mean rating ($k = 3$), consistency agreement, 2-way mixed effects model ($ICC = 0.94$), which indicated high agreement between observers.

2.5.2. EAH video coding

Coding behaviours in the EAH task was performed using Noldus Observer XT [version 16]. Video coding was completed for 65 participants with 2 videos (experimental and control) and for 4 participants with only 1 video (only one visit completed), totalling 134 videos. Three coders coded videos. Example coded behaviours include time eating and time playing (duration behaviours), and bites of each food, swapping between food or playing and eating, and throwing toys or food (frequency behaviours). Behavioural definitions were determined based on

Table 1
Nutritional information for the foods used in the Eating in the Absence of Hunger task.

Food item and brand	*Amount served (g)*	*Energy content served (kcal)*	*Energy density (kcal/g)*	*CHO/100g (g)*	*Protein/100g (g)*	*Fats/100g (g)*
Rich tea biscuits (*McVitie's*)	~10	~46	4.6	71.1	7.2	15.7
Carrot and orange organic oaty bar (*Piccolo*)	~20	~77	3.87	52	6.6	13
Organic rice cakes (*Clearspring*)	~10	~39	3.88	82	8	2.3
Banana fruity puffs (*Kiddylicious*)	~6	~27	4.46	72	7.3	14.2
Pom-bear (*Intersnack*)	~6	~30	5.03	61	3.7	26
Veggie straws (*Kiddylicious*)	~6	~35	5.76	61	6.2	26

Note. List of snack foods used for the Eating in the Absence of Hunger (EAH) task. For each food offered to the participants, the table includes amount served, energy content, energy density and other nutritional information (CHO, protein, fats). All companies producing the products are labelled in brackets.

previous literature (Pearce et al., 2022). The full coding scheme with definitions of behaviours is presented in the **Supplementary material A**. For each pair of videos second coded, the average Cohen's kappa and percentage agreements for all frequency behaviours (k = 0.84, percentage agreement = 85 %), and all duration behaviours (k = 0.76, percentage agreement = 85 %) were calculated. Cohen's Kappa was used as a measure of reliability to determine agreement between coders as to whether the behaviour occurred and at which time it occurred. If behaviours were coded by both coders within a 1-s (frequency behaviour) and 3-s (duration behaviour) buffer period, this was classed as an agreement between coders.

2.5.3. Anthropometrics

The toddler's body mass index (BMI) was calculated and transformed into age and sex-standardized z-scores (BMI-z) based on the WHO Child Growth Standards (https://www.who.int/tools/child-growth-standards/standards) for boys and girls aged 0–60 months, using the R package "anthro" v1.0.1.

2.5.4. Data analyses

To determine differences in energy consumed EAH across experimental conditions, multiple linear regression models were conducted. In the primary analysis, experimental condition, parent feeding practices [use of food to regulate emotions and use of food as a reward], eating traits [food responsiveness, emotional overeating], and temperament traits measured by questionnaire [ECBQ] and the LAB-Tab "attractive toy behind a barrier" task [behavioural reactivity, latency to reach, time to soothe], were input in the model as predictors of total energy EAH. Laboratory visit number (visit 1 or 2) and estimated lunch energy intake were entered into the model as covariates. Each model was then adjusted for repeated measures using cluster robust standard errors and cluster robust confidence intervals. All data cleaning and analyses were conducted using R version 4.2.3 using packages "tidyverse" v2.0.0, "lmtest" v0.9-40, "sandwich" v3.1-0, and "sjPlot" v2.8.15.

3. Results

3.1. Descriptive statistics

3.1.1. Participants

Of the 71 participants who visited the laboratory, 65 (41 females) toddlers completed two visits, and 4 toddlers (4 male) completed only 1 visit (total sample, N = 69). Toddlers completing 1 visit did not complete the second visit due to fussiness (N = 1) and parental cancellation (N = 3). Toddlers were excluded from analyses if they did not co-operate with study procedures at either visit (N = 2). Toddlers were mostly white/British. Full demographic information is presented in Table 2.

3.1.2. Food familiarity for EAH snack items

For an EAH snack food item to be considered familiar, toddlers had to have eaten it at least 1 to 3 times within the past month. For each individual snack offered familiarity fluctuated, with 78 % of toddlers familiar with vegetable straws, whilst only 39 % of toddlers were familiar with banana puffs. However, across all foods offered, only one child (~1.5 %) was unfamiliar with all snack foods. 78 % of the sample was familiar with at least half (three) of the snacks provided.

3.1.3. Behavioural measures and manipulation checks

Table 3 displays the descriptive statistics for variables included in the main analyses, per-experimental condition. Toddlers consumed on average 155 kcal during lunch (IQR = 119), regardless of condition (as lunch occurred before experimental manipulation). The experimental manipulation then indicates that our perturbation of emotional state was successful, as behavioural reactivity scores (Fig. 2) were higher ($t(63) = -7.03$, $p < 0.001$, mean difference = −3.36) and time to soothe (Fig. 3) [duration of emotional perturbation as measured by facial

Table 2
Demographic information of participants.

Participant characteristics	
Total toddlers, Female (%)	69, 41 (59)
Toddler age (in days) at visit 1, Mean (SD)	553 (19)
Days between visit 1 and 2, Mean (SD) [Range]	8 (3) [5–21]
Ethnicity of toddler, N (%)	
White	61 (88)
Other	8 (12)
Household income, N (%)	
Up to £24,999	2 (3.08)
£25,000 to £49,999	20 (30.77)
£50,000 to £74,999	20 (30.77)
£75,000 to £99,999	12 (18.46)
£100,000 or more	8 (12.31)
Prefer not to answer	3 (4.61)
Parental education, N (%)	
Further education (A-levels, BTEC, etc.)	17 (26.15)
Undergraduate degree (College or university)	25 (38.46)
Postgraduate degree	18 (27.69)
Other	5 (7.69)
Toddler zBMI, Mean (SD)	1.03 (1.06)

Note. Toddler zBMI is relative to the median BMI of children of the same age and sex (https://www.who.int/tools/child-growth-standards/standards).

Table 3
Descriptive statistics for predictor and outcome variables per experimental condition.

	Condition	
Descriptives,M (SD) [Range]	Control	Experimental
Total kcal EAH	42 (30.8) [0–126]	48.1 (37.1) [0–155]
Estimated energy consumed at lunch (kcal)	164.83 (99.91) [10.9–605]	148.7 (93.7) [5.3–397]
Behavioural reactivity	1.96 (3.1) [0–15.5]	5.3 (3.8) [0–16.5]
Soothability (s)	3.1 (6.5) [0–29]	9.3 (8.9) [0–28]
Latency to react (s)	25 (9.2) [1–30]	19.3 (11) [1–30]

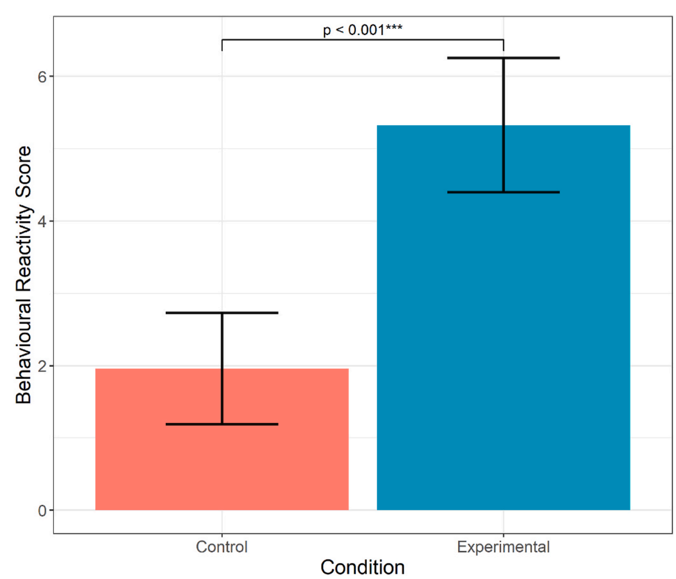

Fig. 2. Behavioural reactivity during both conditions.
Note. Manipulation check showing behavioural reactivity during both control (playful interaction) and experimental (emotional perturbation) conditions. Error bars show standard errors.

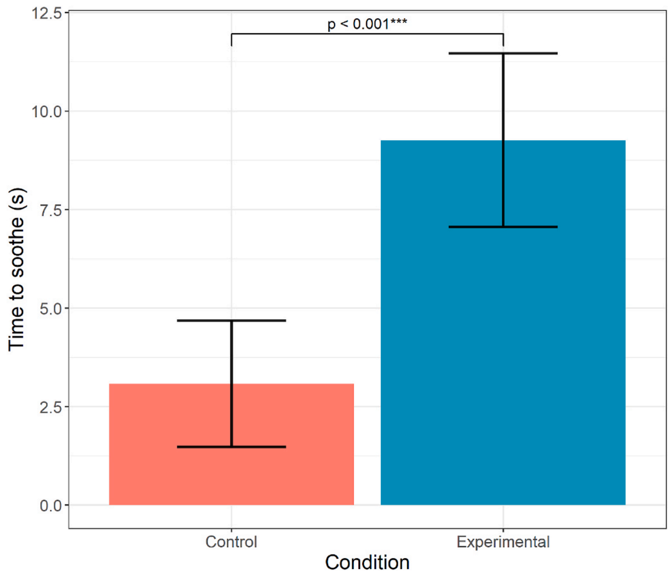

Fig. 3. Time to soothe during both conditions.
Note. Manipulation check illustrating toddlers' time to soothe after behavioural reactivity during both control (playful interaction) and experimental (emotional perturbation) conditions. Error bars show standard errors.

expressions] was longer (t(63) = −5.26, p < 0.001, mean difference = −6.19), in the experimental condition compared to control condition. Behavioural reactivity and soothability were further found to be highly correlated (control: R = 0.71, p < 0.001; Experimental: R = 0.61, p < 0.001). As there is potential for high multicollinearity, only behavioural reactivity is reported in the following models, due to soothability being more likely to have floor and ceiling effects (e.g. in the control condition, little emotional perturbation may result in 0 soothability, because this was not required). Furthermore, latency to react was shorter for toddlers during the experimental condition task than the control task (t(63) = 3.74, p < 0.001, mean difference = 5.67 s). Lastly, during the EAH task, toddlers consumed more energy in the experimental condition compared to the control condition, although this difference in kcal was not statistically significant (t(63) = −1.727, p = 0.2, mean difference = −5.29 kcal) (Fig. 4).

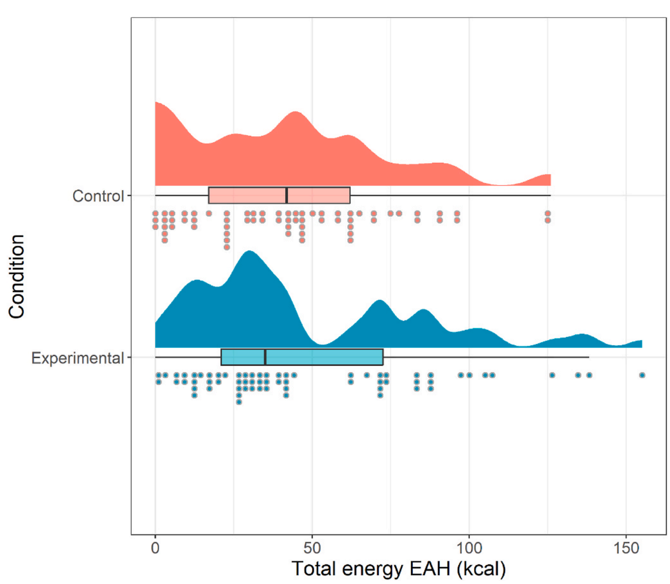

Fig. 4. Energy consumed in each condition.
Note. Raincloud plot illustrating the density and mean amount of energy consumed Eating in the Absence of Hunger in each condition, along with boxplots further showing the distribution of the data. The graph was created in R using the 'ggplot2' v3.5.1 and 'ggdist' v3.3.2 packages.

3.2. Energy consumed EAH

As the experimental design was counterbalanced, we tested order effects on the main outcomes (**Supplementary material B**) to determine whether emotional carryover effects or novelty effects existed between visits. No main effect of the first condition (experimental vs. control) was found. However, toddlers consumed more energy EAH at the first visit than they did at the second visit (main effect of visit number), β = −9.71 (SE = 3.89), p = 0.014. No interaction was present between first condition and visit number. For all subsequent analyses, we included visit number as a covariate to account for this effect.

Toddlers who consumed more calories at lunch also had increased energy intake during EAH (Table 4). During the experimental tasks, we found that toddlers displaying higher behavioural reactivity consumed more calories EAH ($p = 0.008$). This was irrespective of experimental condition, which did not produce a significant main effect. Although we observed higher behavioural reactivity scores in the experimental condition (Fig. 2), it is likely that the analysis was underpowered to detect any interaction effect between these two factors, despite EAH increasing for toddlers that show higher behavioural reactivity in the experimental condition (Fig. 5). Additionally, toddlers whose parents use feeding to regulate emotions ate fewer calories in the EAH task. The full model is presented in Table 4, with only significant predictors displayed in model 1 and condition and interaction effects added to address our main hypotheses in model 2. No main effects were found for parents using food as a reward (CFPQ), Emotional overeating traits (CEBQ), temperamental traits (ECBQ), or toddler's latency to react, nor were interaction effects present with condition.

3.3. EAH task exploratory analyses

As experimental condition did not predict energy EAH, exploratory analyses were performed to investigate toddler's behaviour during the EAH task and how this may be associated with snack food intake. Fig. 6 illustrates the average percentage of time toddlers spent either eating, playing, or attempting to interact with their caregiver during the EAH task. Toddlers spent most of their time eating, followed by playing, and a small proportion of their time attempting to interact with their caregiver. No differences were found between experimental conditions.

We next investigated further behaviours that may predict amount of energy consumed during EAH. Longer duration of the EAH task (up to 10 min) indicated more energy consumed. Similarly, the quicker toddlers started to eat after the task began, the more calories consumed (**Supplementary material C**). Latency to play or interact with caregiver did not predict amount eaten. Additionally, frequency behaviours (**Supplementary material D**) indicate that the more times the child swapped between food items, the more energy they consumed. However, frequencies for playing, engaging caregiver, and swapping between eating and playing did not predict energy EAH. Lastly, higher rates of playing per minute indicated fewer calories consumed EAH (**Supplementary material E**). Rates for eating and engaging caregiver did not predict calories eaten.

In addition to eating, playing with toys and attempting to interact with caregivers were alternative options to help regulate emotions. Whilst condition and behavioural reactivity did not predict total time spent playing, a main effect was found for experimental condition on total time attempting to interact with the caregiver. Toddlers in the experimental condition spent longer (seconds) interacting with caregivers (b = 27.05 [95 % CI = 7.26–46.85], SE = 10.12, p < 0.001) than they did during the control condition, although no effect was found for behavioural reactivity or any interaction effects.

Table 4
Regression models for total energy EAH.

	Total kcal EAH: Model 1					Total kcal EAH: Model 2				
Predictors	*Estimates*	*CI*	*Std. Error*	*t-value*	*p-value*	*Estimates*	*CI*	*Std. Error*	*t-value*	*p-value*
(Intercept)	56.85	26.34–87.36	15.66	3.63	< **0.001**	57.73	27.59–87.86	15.58	3.71	**< 0.001**
Visit number [2]	−8.62	−16.30–−0.93	3.94	−2.18	**0.031**	−8.22	−15.59–−0.85	3.81	−2.16	**0.033**
Estimated lunch calorie intake	0.09	0.02–0.16	0.03	2.60	**0.010**	0.09	0.02–0.15	0.03	2.56	**0.012**
Behavioural reactivity	1.69	0.46–2.92	0.63	2.68	**0.008**	0.13	−1.65 – 1.90	0.92	0.14	0.890
CFPQ Use of food to regulate emotions	−12.26	−24.01–−0.52	6.03	−2.03	**0.044**	−11.78	−23.32–−0.23	5.97	−1.97	0.051
Condition [Experimental]						−4.40	−16.75 – 7.95	6.39	−0.69	0.492
Condition [Experimental] * Behavioural reactivity						2.26	−0.41 – 4.94	1.38	1.64	0.104
Observations			137					137		
R^2/R^2 adjusted			0.138/0.112					0.15/0.11		
F			(4132) = 5.27, p < **0.001**					(6130) = 3.872, p = **0.001**		

Note. Models selected by which variables added to the explanatory power of the model. Model 2 also includes the variable 'Condition' as this is central to the experiment, however it did not add to overall model fit. Statistically significant p-values (p < 0.05) are in bold.

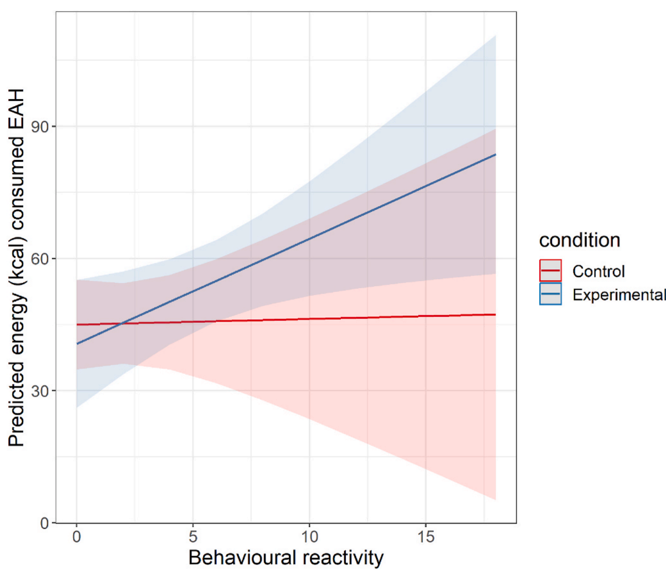

Fig. 5. Interaction between condition and behavioural reactivity on energy consumed.
Note. Non-significant interaction (b = 2.26, *95 % CI* [-0.41 – 4.94], p = 0.104) effect between conditions (control vs experimental) and behavioural reactivity on energy consumed.

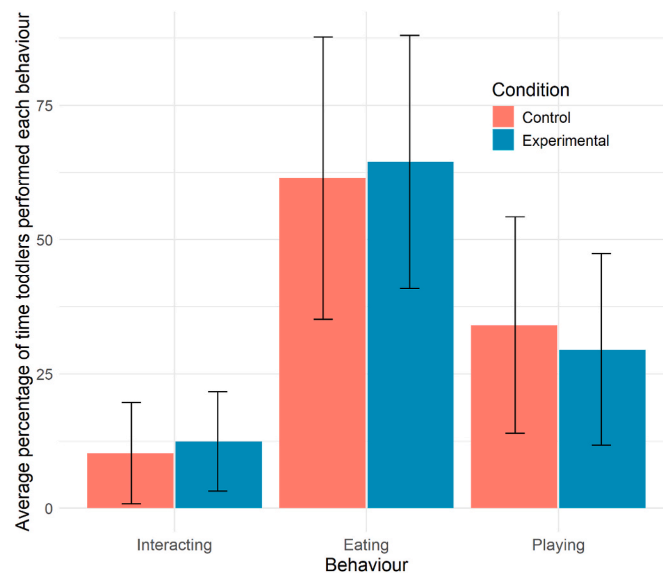

Fig. 6. Toddlers' behaviour during the EAH task in both experimental and control conditions
Note. Average percentage of the EAH task duration spent either attempting to interact with the caregiver, eating, or playing, per each experimental condition. Error bars represent standard deviations.

4. Discussion

This study set out to examine how parental feeding practices, child temperament, and children's abilities to regulate their internal states, influence 18-month-old toddler's eating behaviour in response to a perturbation of emotional state. We found that, although on average experiencing a mild emotional perturbation did not affect how much energy was consumed EAH, certain factors may increase the possibility of using food to regulate emotions. Specifically, toddlers who displayed higher behavioural reactivity in response to the emotional perturbation also consumed more energy EAH, yet this result was independent of experimental condition. Additionally, and contrary to our hypotheses, higher parental use of feeding to regulate their child's emotions was associated with fewer calories EAH. Exploratory analyses further found that across conditions, toddlers spent most of their time eating in the EAH task. Toddlers also spent longer trying to engage their caregiver in response to the emotional perturbation, compared with the control condition.

Regardless of the emotional context, toddlers who displayed higher behavioural reactivity also showed increased EAH. This finding is in line with prior research with older children, showing that trait temperament – specifically high reactivity and negative affect – are linked with EE both cross-sectionally (Holley et al., 2020; Messerli-Bürgy et al., 2018) and longitudinally (Steinsbekk et al., 2018, 2020). To our knowledge, our study is the first to show that heightened behavioural reactivity is significantly associated with increased EAH as early as 18 months. While we did not find a significant interaction between behavioural reactivity and condition (emotional perturbation versus control task), the effect of behavioural reactivity on EAH is likely to have been influenced by the experimental condition due to the emotional perturbation (see Fig. 5). It is possible that our sample size may not have been sufficient to detect this interaction effect or that the lack of a group effect (i.e. not all toddlers [nor all adults] eat in response to emotions and in the absence of hunger) could have masked a possible interaction between behavioural reactivity and condition.

Additionally, given that we did not find behavioural reactivity to interact with the emotional demands of the situation (emotional perturbation [experimental] vs control task), it is possible that its effect on EE may be dispositional in nature. That is, toddlers that are generally more reactive may show higher susceptibility to EAH, which, over the longer term and under specific contextual factors, could increase the likelihood of EE (Chawner & Filippetti, 2024). Indeed, the Lab-TAB was originally designed to assess aspects of temperament that are generally stable over time (Gagne et al., 2011; Goldsmith & Rothbart, 1996; Planalp et al., 2017). As we did not find associations between parental report of child temperament and calorie intake in the EAH, it is possible that our behavioural assessment using the Lab-TAB captured particular expressions of temperament under emotionally relevant situations that broad, parent-reported measure may instead overlook. Overall, future well powered longitudinal studies could help elucidate how these relationships evolve over time and how early temperamental traits may interact with environmental influences to shape EE.

Contrary to our hypothesis, we found that parental use of food to regulate emotions predicted fewer calories EAH. This is a surprising finding, considering that research has consistently shown a positive association between parental emotional feeding and child emotional eating (Blissett et al., 2010; Braden et al., 2014; Rodgers et al., 2014; Steinsbekk et al., 2018). This result may be interpreted in a number of ways. Firstly, parents in this sample reported low levels of feeding to regulate emotions (all reporting between never, rarely, or sometimes). Although comparable with the studies cited above, low levels of emotional feeding could mean that 18-month-old toddlers are less familiar with these practices than older children, who may have more experience with emotional feeding and therefore EE. Young children learn food preferences and eating behaviours through repeated exposures (Hetherington et al., 2015). Therefore, if exposure to emotional feeding episodes is infrequent (i.e. sometimes, rarely), there may be fewer opportunities for toddlers to learn and associate food and eating with regulating negative emotions. Consequently, the effect of parental use of food to regulate emotions may only become evident prospectively (Farrow et al., 2015; Steinsbekk et al., 2018). A further interpretation could speculate that 18-month-olds have some adaptive strategies in place to regulate emotions which may, at this specific developmental time, trump parental feeding practices. In our study, we found that toddlers display other emotion regulatory skills than eating, including playing and interacting with their caregiver, and they do so significantly more in response to the emotional perturbation than the control condition (Fig. 6). It may be that the use of adaptive emotion regulation strategies at this stage counteract any (infrequent) parental use of food as a regulatory tool. Finally, it is of course possible that other relevant unmeasured and confounding variables (e.g. shared genetic influences, such as inherited traits linked to executive functions that make both child and parent more prone to EE; La Barrie et al., 2021) could help explain the reported association between parental use of food to regulate emotions and calorie intake in the EAH task. Future larger studies may be able to include these measures to fully capture the complexity of EE behaviours.

We showed that toddlers that consumed more calories at lunch also had increased energy intake during the EAH tasks. This effect has been noted in recent studies with children, demonstrating that 3-6-year-olds with avid eating profiles display high food responsiveness, enjoyment of food, and EE (Pickard et al., 2023). This eating behaviour profile reflects high food approach tendencies and is characterised by an increased likelihood to EE. The research also showed that both parental (restrictive feeding practices and emotional feeding) and child factors (greater surgency) are associated with an avid eating profile. In our study, the finding that toddlers who ate more calories during lunch also ate more calories during the EAH tasks may suggest that toddlers who consume more calories when food is available may have lower awareness of internal hunger and satiety cues and render them more susceptible to maladaptive eating behaviours such as EE.

4.1. Strengths, limitations and future research directions

The laboratory setup of this study brings several advantages, including the ability to control the emotional perturbation and energy intake of the toddlers. However, this also has the limitation of lacking ecological validity as the laboratory environment might not capture children's true response to emotional perturbations when they are in their typical, everyday settings (Chawner & Filippetti, 2024). In this unfamiliar lab setting, toddlers might not demonstrate EE in the same way they would at home. This could explain why only toddlers with certain temperamental dispositions would show increased food consumption in the EAH tasks, and those that EE at home (as indicated by parental questionnaire response), may not transfer their learning to EE into a new context. As EE behaviours might not be consistent across different environments, to fully capture the complexity of EE behaviours future studies should examine the role of different contexts in predicting the likelihood of EE to occur.

Relatedly, the emotional perturbation chosen for the study may not have promoted EE in toddlers. For example, ending the task (and therefore the cause of frustration) may have been enough on its own to overcome the emotional perturbation the toddler experienced. Once the task and toy causing frustration were removed, there may no longer be a need to regulate emotions further by eating, playing, or seeking the caregiver. It could also be that such minor emotional perturbations may not be enough to outweigh feelings of satiation. Instead, it is possible that the EAH task encourages external eating with food availability, meaning some toddlers may eat in response to food cues, rather than emotional state. Although this was not directly tested in this study, perhaps only toddlers with good appetite self-regulation, emotion regulation, and inhibitory control may refrain from eating. Future research could aim to elucidate individual differences in EE by examining the types and intensities of emotional perturbation required for an individual to EE (if the child is an 'emotional eater'), in addition to examining the roles of appetite-self regulation and inhibitory control on the development of EE.

Additionally, there are further strengths and limitations surrounding the lunchtime procedure. Firstly, parents supplied the toddler's lunch, which although reduces control over the experiment (e.g. food type, variety and energy density), could also solve a practical issue by potentially removing confounding from unfamiliarity and dislike of novel foods or meals. This approach could therefore minimise the likelihood of toddlers not eating if a less familiar, standardized meal was provided. As the primary aim of the meal was for the toddler to become satiated before the EAH task, the parent provided meal represents a trade-off between ecological validity and experimental control. Whilst we preserved the authenticity of mealtime dynamics by allowing parents to provide familiar foods in a naturalistic manner, it necessitates releasing some control of meal characteristics, such as food type, portion size, energy density, variety, and meal duration, which are difficult to isolate without compromising ecological validity. Relatedly, a further limitation arises due to the inability to accurately capture satiation of the toddler at the end of lunch. This is due to their young age and limited communication abilities. Without invasive measures of gastric distension or hormone detection, satiation is not currently possible to measure accurately, and we therefore relied on behavioural cues of the toddler and parent's interpretation of toddler cues to indicate the end of a meal and infer satiation (Hetherington, 2020, pp. 373–389; Yu et al., 2025).

In the present study, we combined the use of questionnaire measures of temperamental and eating traits, with behavioural measures that provide a more nuanced indication of dispositional temperament and eating profiles. This is important because questionnaire subscales do not always converge with behavioural measures (Bongers & Jansen, 2016) and therefore both methods allowed us to gather a comprehensive picture of the variables of interest. Indeed, parental reports in this study did not predict toddler's behaviour in the lab, meaning that these questionnaires may be measuring constructs that do not fully overlap with those assessed by direct observation. It may be possible that parental questionnaires capture aspects of children's behaviour as seen in everyday settings, and that behavioural tasks (such as the Lab-TAB and EAH tasks in our study) may reveal more situational responses.

Longitudinal studies and situational assessment methods (e.g. ecological momentary assessment) may help to clarify patterns and behavioural habits that underlie EE, as well as to investigate which aspects of children's temperament, parental practices, or environmental contexts are most critical in facilitating the development of EE.

4.2. Conclusion

Our study examined how parental feeding practices and child temperament are associated with 18-month-old toddler's EE behaviours. We show that an emotional perturbation alone is not enough to evoke EE responses by toddlers, as evidenced by lack of a main effect for experimental condition. However, for individual toddlers exhibiting higher behavioural reactivity to an emotional perturbation, EE increased in the absence of hunger. We also found that higher parental use of feeding to regulate their child's emotions was associated with fewer calories EAH. As parents in the sample reported infrequent use of food to regulate emotions, we speculate that toddlers' emotion regulation strategies at this stage may counteract any parental use of food as a regulatory tool. Indeed, following emotional perturbation, toddlers spent longer attempting to engage caregivers, suggesting the use of adaptive regulation. This suggests that 18-month-olds with poorer self-regulation abilities may be more likely to engage with EE behaviours when faced with an emotional perturbation. Overall, our findings point to the importance of examining the complex interplay between children's temperament, parental practices, or environmental contexts that may increase susceptibility to EE in early life.

CRediT authorship contribution statement

Liam R. Chawner: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation. **Sayaka Kidby:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Maria Laura Filippetti:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Ethical statement

Ethical approval was received from the University of Essex Department of Psychology Research Ethics Committee (reference number: ETH2122-0126).

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Declaration of competing interest

The authors declare no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2025.108263.

Data availability

The data necessary to reproduce the analyses presented here are publicly accessible on the Open Science Framework: DOI 10.17605/OSF.IO/WQMD4.

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