THE ASSOCIATIONS OF EMOTION REGULATION AND EMOTIONALITY WITH FOOD FUSSINESS IN PRESCHOOL-AGED CHILDREN

Master's Thesis

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Master's Programme in

Human Nutrition and Food-Related Behavior

April 2022

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Title
The associations of emotion regulation and emotionality with food fussiness in preschool-aged children

Study track
Human nutrition

Level	Month and year	Number of pages
Master's Thesis	April 2022	55

Abstract

Background: It is known that the dietary patterns adopted in childhood tend to persist into adulthood. Since unhealthy diet is, for instance, a considerable risk factor for non-communicable diseases, it is important to promote the formation of healthy eating habits in children. Food fussiness, a rather common phenomenon in preschool-aged children, is an eating behavior that can adversely affect diet quality. Additionally, it can have other adverse effects on the child and the whole family. It can cause stress in caregivers, for instance. Temperament and emotion regulation are among the various individual and environmental factors that can influence children's eating behaviors. There is evidence on the association between food fussiness and temperament, especially dimensions of emotionality and negative affectivity. More emotional temperament has been linked with higher food fussiness. However, few studies have investigated whether emotion regulation could be associated with food fussiness.

Objectives: The objective of this study was to examine the associations of emotion regulation and emotionality to food fussiness in preschool-aged children, and to examine whether emotion regulation interacts with emotionality in predicting food fussiness. These associations were separately examined for anger, fear, sadness, and positive emotions / exuberance. A secondary objective was to examine the prevalence of fussy eating behavior.

Methods: This study was cross-sectional using the baseline data of a feasibility study which tested the effectiveness of an educational mobile application among preschool-aged children in Finland and in Poland. 326 children participated in the study at baseline, and 298 had complete data of the food fussiness measure. Emotion regulation and emotionality were assessed with the Emotion Questionnaire, and food fussiness was assessed with a subscale of the Children's Eating Behavior Questionnaire (CEBQ), which both are caregiver-report questionnaires. Linear regression models were used to examine the associations of emotion regulation and emotionality to food fussiness. The prevalence of food fussiness was examined according to cut-offs for the CEBQ subscale (3.00 for moderate or higher food fussiness and 3.33 for severe fussiness), and the difference in the prevalence between the Polish subsample and the Finnish subsample was examined with a chi-square test.

Results: The (down)regulation of anger was negatively associated with food fussiness (p=0.022). Emotionality was not associated with food fussiness, in terms of any of the emotions, nor did emotionality and emotion regulation interact. In addition, the prevalence of moderate or higher food fussiness (cut-off 3.00) was significantly (p=0.049) higher in Poland (61%) than in Finland (49%).

Conclusions: These results suggest that emotion regulation, possibly specifically in relation to anger, is associated with fussy eating behavior. The direction of the association between anger regulation and food fussiness was in line with previous studies on the association between emotion regulation (or parallel concepts) and food fussiness. The possible causal relationship and mechanisms are subjects for further research.

Keywords
Emotion regulation, emotionality, food fussiness, picky eating, children

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Tiedekunta	Osasto
Maatalous-metsätieteellinen tiedekunta	Elintarvike- ja ravitsemustieteiden osasto

Tekijä
Jenna Rahkola

Työn nimi
Tunteiden säätelyn ja emotionaalisuuden yhteys valikoivaan syömiseen

Opintosuunta
Ihmisen ravitsemus

Työn laji	Aika	Sivumäärä
Maisterintutkielma	Huhtikuu 2022	55

Tiivistelmä

Tausta: Lapsena opittujen ruokailutottumusten tiedetään olevan melko pysyviä ja voivan säilyä jopa aikuisuuteen. Koska epäterveellinen ruokavalio on yksi kansantautien merkittävä riskitekijä, on tärkeää edistää terveellisten ruokailutottumusten muodostumista jo varhain lapsuudessa. Valikoiva syöminen on suhteellisen yleinen ilmiö päiväkoti-ikäisillä lapsilla, ja se voi vaikuttaa lapsen ruokavalion laatuun epäsuotuisasti. Tämän lisäksi sillä voi olla muitakin negatiivisia vaikutuksia lapseen ja myös hänen läheisiinsä. Se voi esimerkiksi aiheuttaa stressiä lapsen huoltajissa. Temperamentti ja tunteiden säätely ovat tekijöitä, jotka lukuisten muiden yksilöllisten ja ympäristötekijöiden tavoin voivat vaikuttaa lapsen syömiskäyttäytymiseen. Useissa tutkimuksissa on havaittu yhteys temperamenttipiirteiden, erityisesti negatiivisen emotionaalisuuden (negative affectivity/emotionality), ja valikoivan syömisen välillä. Korkeampi negatiivinen emotionaalisuus on yhdistetty valikoivampaan syömiseen. Tunteiden säätelyn yhteydestä valikoivaan syömiseen tiedetään puolestaan hyvin vähän.

Tavoitteet: Tämän tutkimuksen tavoitteena oli tutkia tunteiden säätelyn ja emotionaalisuuden yhteyttä valikoivaan syömiseen päiväkoti-ikäisillä lapsilla sekä sitä, onko tunteiden säätelyllä ja emotionaalisuudella yhdysvaikutusta. Näitä yhteyksiä tutkittiin erikseen kiukun, pelon, surun ja positiivisten tunteiden / elämänilon suhteen. Lisäksi toisena tavoitteena oli tarkastella valikoivan syömisen esiintyvyyttä.

Menetelmät: Tämä oli poikkileikkaustutkimus hyödyntäen alussa kerättyä aineistoa pilottitutkimuksesta, jossa testattiin mobiilisovelluksen vaikuttavuutta kasvisten ja hedelmien hyväksyttävyyden lisäämisessä päiväkoti-ikäisillä lapsilla Puolassa ja Suomessa. Alussa tähän pilottitutkimukseen osallistui 326 lasta, joista 298:lta saatiin tiedot valikoivasta syömisestä. Huoltajat arvioivat lastensa tunteiden säätelyä ja emotionaalisuutta tunnekyselyllä (EQ), ja valikoivaa syömistä osiolla lapsen syömiskäyttäytymiskyselystä (CEBQ). Tunteiden säätelyn ja emotionaalisuuden yhteyksiä valikoivaan syömiseen tutkittiin lineaarisilla regressiomalleilla. Valikoivan syömisen esiintyvyyttä tarkasteltiin sen mittarille (CEBQ) luotujen raja-arvojen avulla (kohtalainen tai vakavampi valikoivuus: 3.00, pelkkä vakavampi valikoivuus: 3.33), ja Puolan ja Suomen aineistojen esiintyvyyksien eroa tarkasteltiin khiin neliö -testillä.

Tulokset: Parempi kiukun hillintä oli yhteydessä vähemmän valikoivaan syömiseen ($p=0.022$). Mihinkään tunteeseen liittyvä emotionaalisuus ei ollut yhteydessä valikoivuuteen, eikä emotionaalisuuden ja tunteiden säätelyn yhdysvaikutuksia havaittu. Kohtalaisen tai vakavamman valikoivuuden (raja-arvo 3.00) esiintyvyys oli Puolan (61%) osa-aineistossa tilastollisesti merkitsevästi ($p=0.049$) korkeampi kuin Suomen osa-aineistossa (49%).

Johtopäätökset: Tulokset viittaavat siihen, että tunteiden säätely, mahdollisesti erityisesti kiukun suhteen, on yhteydessä valikoivaan syömiseen. Havaittu kiukun säätelyn ja valikoivan syömisen välinen yhteys on samansuuntainen verrattuna aiempiin tutkimuksiin, jotka ovat tutkineet tunteiden säätelyn (tai verrattavissa olevien käsitteiden) ja valikoivan syömisen yhteyttä. Mahdollinen kausaalisuhde ja vaikutusmekanismit ovat tärkeitä jatkotutkimuskohteita.

Avainsanat
Tunteiden säätely, emotionaalisuus, valikoiva syöminen, lapset

Ohjaajat
Henna Vepsäläinen, Reetta Lehto

Missä säilytetään
HELDA – Helsingin yliopiston digitaalinen arkisto

Acknowledgements and an account of the student's contribution

The baseline data of a feasibility study that tested the effectiveness of an educative mobile application in increasing fruit and vegetable acceptancy was utilized in this thesis. That study was a part of an EIT (European Institute of Innovation & Technology) Food –funded Food School Network project. I was not a part of the data collection but worked with raw data. I was responsible for data cleaning and variable construction regarding the variables needed in this thesis. I was also responsible for designing and conducting the statistical analyses according to my research questions as well as for their tabulation, reporting, and interpretation, but my supervisors guided me along the way. Therefore, I wish to express my gratitude to my supervisors Henna Vepsäläinen and Reetta Lehto for their valuable help and comments as well as their encouraging support. In addition, this thesis is going to be utilized in writing a scientific article for publishing.

Abbreviations and acronyms

WHO = World Health Organization

ECEC = Early Childhood Education and Care

ER = emotion regulation

ARFID = Avoidant/Restrictive Food Intake Disorder

CEBQ = The Children's Eating Behavior Questionnaire

ALSPAC = Avon Longitudinal Study of Parents and Children

ERC = The Emotion Regulation Checklist

EQ = The Emotion Questionnaire

CBQ = The Children's Behavior Questionnaire

EAS = Emotionality, Activity, and Sociability (Temperament Survey for children)

ECEC = Early Childhood Education and Care

GDPR = General Data Protection Regulation

PAPA = The Preschool Age Psychiatric Interview

BRIEF-P = The Behavior Rating Inventory of Executive Function -Preschool version

ADHD = Attention Deficit Hyperactivity Disorder

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1 INTRODUCTION

Eating behaviors develop early in childhood, and research suggests that these behaviors and dietary patterns adopted in childhood tend to persist, possibly even into adulthood (1,2). It is plausible to think that early acquired healthy eating habits are easier to maintain. One common concern worldwide, especially in Western countries, is the amount of vegetables and fruits children consume. For example, According to Health Behaviour in School-aged Children, WHO collaborative study (2017/2018), almost half of European adolescents did not eat fruits or vegetables daily, and this proportion was the highest in Finland (3). In addition, a recent study with a sample of 766 preschool-aged children from across Finland found that only 1% of the children consumed the recommended amount (≥ 5 servings/day) of fruits, vegetables, and berries (4), albeit it cannot be known whether the consumption was close to the recommended level. Another common indicator of a healthy diet that is also noted in many nutrition recommendations is dietary variety or diversity (5). Since unhealthy diet is, for instance, a considerable risk factor for non-communicable diseases, such as cancers and cardiovascular diseases (6), it is important to promote the formation of healthy dietary patterns in children. In order to do that children's eating behaviors and food consumption as well as their determinants or contributors should be thoroughly understood.

Various intrinsic and extrinsic factors can influence children's eating behavior and food intake (7,8). In terms of extrinsic factors, particularly home and early childhood education and care centers (ECEC) are sites of importance for preschool-aged children. To set an example, food availability shapes children's eating habits (7,9). Furthermore, caregivers have a substantial role in the formation of children's eating behavior (7). For instance, parental feeding practices as well as their own eating habits likely have an impact (7,10). Children learn about food and eating especially through social modelling; caregivers can serve as models for food acceptance, for example (11). The intrinsic or individual factors that influence children's eating behavior and food intake include gender and food preferences, among others (7,8). Emotions are also known to be able to affect eating (12). Linked to this, more emotional temperament has been associated with emotional overeating, for instance (13). In addition, poor emotion regulation (ER) has been associated with overeating behaviors (14).

Many of these factors likely have complex relationships not only with eating behavior but with each other as well (7), and understanding the intrinsic factors that contribute to the child's food behavior is important also because they can influence how the child responds to different environmental factors. For example, temperament has been identified as a focal factor in how children behave and interact with caregivers in the feeding environment (15).

One eating behavior that has been associated with certain dimensions of temperament is food fussiness (8). More emotional temperament has been associated with higher food fussiness (8). Even though definitions of food fussiness (or e.g., picky eating) vary, it generally refers to eating behavior described by rejection of a substantial number of food items that can be familiar as well as unfamiliar (16). Food fussiness seems to be fairly common among young children (16–18). It has been observed that fussy eating behavior may result in unfavorable effects on food intake, such as lower vegetable consumption and lower dietary variety (10,17). In addition to the child, food fussiness can affect others around them (10). It is often worrying or stressful for caregivers, for instance (10,18). Even if food fussiness wouldn't cause broad risks for health and growth at the time, it has been identified as an important target for research and interventions – especially more persistent and more severe forms of food fussiness (19). If the tendency to experience aversive emotional states (negative affectivity/emotionality) is related to fussy eating behavior, it can be speculated whether the ability to regulate the emotional states could be associated with food fussiness as well. Hence, this thesis investigates the associations of emotion regulation and emotionality to food fussiness.

2 LITERATURE REVIEW

2.1 Overview of food fussiness in children

Young children are only learning about food and eating. Particularly between two and three years of age children start to identify and categorize food items and reason about food (11). Hence, it is natural for them to be more sensitive and doubtful in eating situations compared to adults – especially, if a food item doesn't match the properties of acceptable food in the child's cognition (11). For instance, children can be more sensitive to reject food based on it having changes in texture, and especially visual abilities of food seem to be important for children (11). In addition, children, in general, naturally prefer sweet taste and avoid bitter tasting foods (20). However, it is a familiar observation that children's eating behavior and food preferences vary considerably. One behavior in which differences can be noted is whether children usually eat the food that is offered to them. Food fussiness is a concept that describes this kind of food refusal behavior (11). Even though definitions of food fussiness (or e.g., picky eating) vary, generally, it describes forms of food rejections that can target both unfamiliar and familiar food items (16,21). It has been observed that food fussiness can contribute to poor diet quality (18); thus, it poses a health risk. In this section, I will cover food fussiness more closely. First, I will discuss the current definitions, assessment methods as well as prevalence and trajectories of food fussiness. Then, I will briefly review the factors associated with food fussiness based on recent reviews.

2.1.1 Definitions of food fussiness

A single well-defined and widely accepted definition of food fussiness does not exist. It is a broad concept that encompasses a variety of child and caregiver behaviors in its varying definitions (16,18,22). It has even been proposed to be more of an umbrella term for a range of characteristics in a child's eating and behavior at mealtimes perceived by a caregiver or researcher (17,23). In addition to this, food fussiness is not the only term that is used. Other terms include, for example, picky eating and selective eating.

However, the core of the definitions is that food fussiness describes a form of food rejections or, in other words, unwillingness to eat or try some foods (16,22). Even though food neophobia, that is, reluctance to try novel foods is a separate concept, the definitions of food fussiness generally include an element of food neophobia (16,21,22). Hence, both familiar (meaning foods that the child has

tasted or tried) and unfamiliar foods can be rejected. In addition, the definitions usually include either reduced dietary variety, reduced amount of food or both as a result of the rejection of foods (16,22). For example, Hafstad et al. (24) defined food fussiness as "consumption of an insufficient amount or inadequate variety of food through rejection of food items". Furthermore, the child having strong food preferences is a commonly mentioned characteristic of a fussy eater, and some definitions include some other specific aspects of eating, such as slowness in eating (16,22). Wolstenholme et al. (23) criticized the current definitions of food fussiness for not clearly discriminating fussy eating behaviors from other forms of food refusal, such as due to allergy, medical conditions, or religious choices.

One commonly accepted definition (by Dovey et al. (21)) is: "Consumption of an inadequate variety of food through rejection of a substantial number of foods that are familiar, as well as unfamiliar; this may include an element of food neophobia and can be extended to include rejection of specific food textures" (16). I noted that, like this one, the definitions usually indicate that the amount of food or number of food items rejected must be at a significant level so that the behavior can be considered food fussiness. Thus, rejecting just a few foods or only occasionally is not enough for someone to be described as a fussy eater. However, this significant level has not been precisely defined, or at least it varies along with the definitions and assessment methods. Some definitions seem to determine the significance or severity of the refusal behavior by including some of its consequences. For example, effects like having to provide the child a different meal from the rest of the family or interference with daily routines to an extent that is problematic to the parent, child, or their relationship, are used (16,22).

Since the definitions are inconsistent, also the boundaries of which are clinically significant eating problems, and which are merely aberrant eating behaviors are not clear. In the majority of the literature, food fussiness or picky eating is not a diagnostic category but a descriptive term (16,25). One quite recently developed eating disorder category is avoidant/restrictive food intake disorder (ARFID), which describes "patients who struggle with impaired and distressing eating behaviors and symptoms and who lack weight and body image-related concerns associated with anorexia nervosa and bulimia nervosa" (26). It has been stated that more severe forms of food fussiness may meet the criteria for ARFID if they lead to significant adverse health or psychosocial outcomes (25). Additionally, according to Taylor et al. (16) food fussiness is sometimes seen as being on the spectrum of feeding or eating problems, fussiness being at one end and eating disorders at the other. In this thesis, food fussiness is used as a term that describes a certain kind of eating behavior – not as an eating disorder/diagnostic category.

2.1.2 Assessment of food fussiness in children – questionnaires

When it comes to the methods used to identify or measure food fussiness in children, there is variation in accordance with the definitions. Food fussiness can be assessed, for example, by observing the child during mealtimes (8,25), but the most commonly used tools are questionnaires in which a caregiver assesses the child's eating behavior (10,16). Hence, what is assessed is the caregiver's perception of a child's eating behavior. The objectivity and reliability of these caregiver-report measures can be questioned but one major strength they have is that caregivers can evaluate their children's typical behavior in naturalistic environments.

The quantitative questionnaire methods can be roughly divided into two categories: using existing validated questionnaires and using study-specific question(s) (16). Moreover, one differentiating factor is whether food fussiness is assessed with just one question or with a multi-item questionnaire (16). The interpretation of the study results depends on the choice of the assessment method, and all the methods have their strengths and weaknesses. The single questions like "Is your child a picky eater?" with a "Yes/No" answer can be simpler to interpret and straightforwardly categorizes children to being a picky eater or not (18). However, one problem with them is that they rely on caregivers' notions of what food fussiness is (if definition is not provided by researchers before assessment), and those notions can vary among the caregivers and differ from the researchers' definition (18,25,27).

The strength of the more complex multi-item questionnaires is that they can provide more detailed and accurate knowledge on food fussiness, as they cover more of the many facets of food fussiness (17). Moreover, multi-item questionnaires don't require the caregiver to define food fussiness (16,18), because they assess specific aspects of children's behavior around food and mealtimes. However, the degree of food fussiness is always judged by the caregiver – be it evaluating whether a child is choosy or very choosy or evaluating how often a behavior is expressed. Nevertheless, comparing the results of different studies is easier if the same validated questionnaire has been used.

The requirements for categorizing a child as picky (or whether that classification can or even needs to be made) are influenced by the assessment method: which behaviors and/or characteristics are assessed and what is the response scale. Hence, the definition of food fussiness that is adopted in a study should match the assessment method used. Unlike the single questions, multi-item questionnaires do not automatically categorize the child. They usually yield continuous variables that describe the child as more or less fussy. Therefore, thresholds need to be determined if categorization is the objective.

One very commonly used (10,28) multi-item questionnaire is a food fussiness subscale from The Children's Eating Behavior Questionnaire (CEBQ) (29) – a measure used in this thesis as well. It is a six-item subscale that evaluates whether the child eats a variety of foods, the child's reactions to new foods and how difficult the child is to please with meals. Thus, it includes elements of food neophobia as well. It has been analyzed in studies using latent profile analysis, standard deviation scores of scale scores, and mean score (16). This shows that even the analysis of the same scale can vary. Other multi-item questionnaires include Child Feeding Questionnaire, Lifestyle Behavior Checklist and Stanford Feeding Questionnaire, for instance (16,18).

2.1.3 Prevalence and trajectories of food fussiness in children

Despite the inconsistencies in the definitions and assessment methods of food fussiness, especially studies that use measures that classify children into two (fussy or not) or more categories (e.g., never fussy, sometimes fussy, always fussy), are able to report estimates of prevalence. These estimates have had a wide range. For example, in a sample of 4-year-olds in the Netherlands (30) the prevalence of "fussy eaters" was 5.6%. The fussy eaters were defined by high scores on food avoidance scales (satiety responsiveness, food fussiness, and slowness in eating) on the CEBQ (latent profile analysis). Xue et al. (31) reported a prevalence of 59% in Chinese 7–12-year-old children. They measured fussiness with a question: "Do you consider your child as having picky eating behavior?" with three response categories: 1) never picky, 2) somewhat picky, and 3) always picky, and classified a child as picky if the answer was 2 or 3. In a meta-analysis by Chong Cole et al. (28), the prevalence of picky eating in 4–30-months old children was 22% based on studies that had a dichotomous categorization of picky eating. If the food fussiness subscale of the CEBQ is used prevalence cannot be reported since it is usually treated as a continuous variable. However, Steinsbekk and colleagues (32) have proposed cut-offs to identify moderate or higher (3.0) and severe (3.33) fussiness based on that subscale, and Sandvik et al. (33) used these cut-offs in a Swedish sample of preschoolers resulting in a prevalence of 47% for moderate or higher fussiness and a prevalence of 30% for severe fussiness.

The wide range in the estimates is likely partly due to the variation in the definitions and assessment methods of food fussiness, even though at least age and cultural environment likely contribute to that as well (16,18). One factor that clearly influences the prevalence estimate is the degree of fussiness that is used as the threshold of being categorized as picky (19). In a narrative review, Samuel et al. (17) noted that in studies where more stringent threshold or criteria for picky eating was used (e.g., "very picky eater" or "choosy most of the time") the estimates of prevalence were much lower than

in studies like the one mentioned above where the prevalence of 59% also included "somewhat" responses to the assessment question (31). Additionally, the problem with the definitions has been demonstrated within a single study: Goh et al. (34) reported that "always a picky eater" responses to a single question yielded a prevalence of 25% but when a list of typical behaviors was provided for the caregivers, as help for evaluating their child, the prevalence increased up to 50%.

When it comes to the trajectories of food fussiness, there seems to be some consensus about it, to some extent, being a normal developmental and temporary phase that children outgrow. This has been explained, at least, by food fussiness being an expression of emerging autonomy and agency (35), and the food neophobic behavior is thought to protect against the ingestion of potentially harmful substances (21,22). In addition, like already mentioned, young children are still learning about food – especially the food categorization system is developing (11). However, the evidence on the developmental trajectories remains scant (11,17,18,22,25), particularly due to the lack of longitudinal data. Nevertheless, according to reviews (18,22,25), the most frequently reported peak age for the prevalence of food fussiness is around two and three years. For example, in a study by Cardona Cano et al. (36) the prevalence of picky eating was 27% at the age of 1.5 years, 28% at three years of age, and 13% at the age of six years. However, there are also reports of no or little change in the prevalence by age during childhood (16,18). Moreover, in one study (37) the prevalence increased from the age of two years to the age of nine years, whereas the incidence decreased over this period, being the highest in early childhood and declining to very low levels by the age of six years. These findings were interpreted as indicating that picky eating tends to persist throughout childhood, although 58% of the picky eaters remitted after a two 2-year period. Additionally, there is some evidence on food fussiness persisting even into adulthood (18,25). Hence, it is likely, that both transitory and more persistent forms of fussy eating exist, and some studies have indeed found evidence of differing trajectories of food fussiness (16,36–38). For instance, in the Avon Longitudinal Study of Parents and Children (ALSPAC) -cohort conducted in the UK (16,39) the prevalence of food fussiness at each age (24, 38, 54 and 65 months) was between 9.7% and 15% but 3.5% of the children were picky throughout the study, and early onset picky eating (first report at 24 or 38 months) was more frequent than later onset (first report at 54 or 65 months). All in all, however, food fussiness seems to be mainly a phenomenon of early childhood even though the age of onset seems to vary.

2.1.4 Factors associated with food fussiness

Several factors are likely involved in shaping a child's eating behavior and food preferences, and it is generally thought that interactions between genes and environment are involved (9,13). A quite large body of research, consisting mainly of cross-sectional studies, has examined factors associated with or correlates of food fussiness in different populations (8,10,17,18,28). The studied factors include biological, psychological, and behavioral factors concerning both the caregiver and the child, and some environmental, especially relational, factors – child temperament and parental feeding styles, for instance. This chapter shortly explores the frequently detected associations based on recent reviews on food fussiness. Even though firm causal conclusions cannot be drawn since the studies are mostly cross-sectional, I have divided the factors into possible predictors or determinants and possible consequences of food fussiness, in accordance with the reviews. Figure 1. presents an overview of these factors.

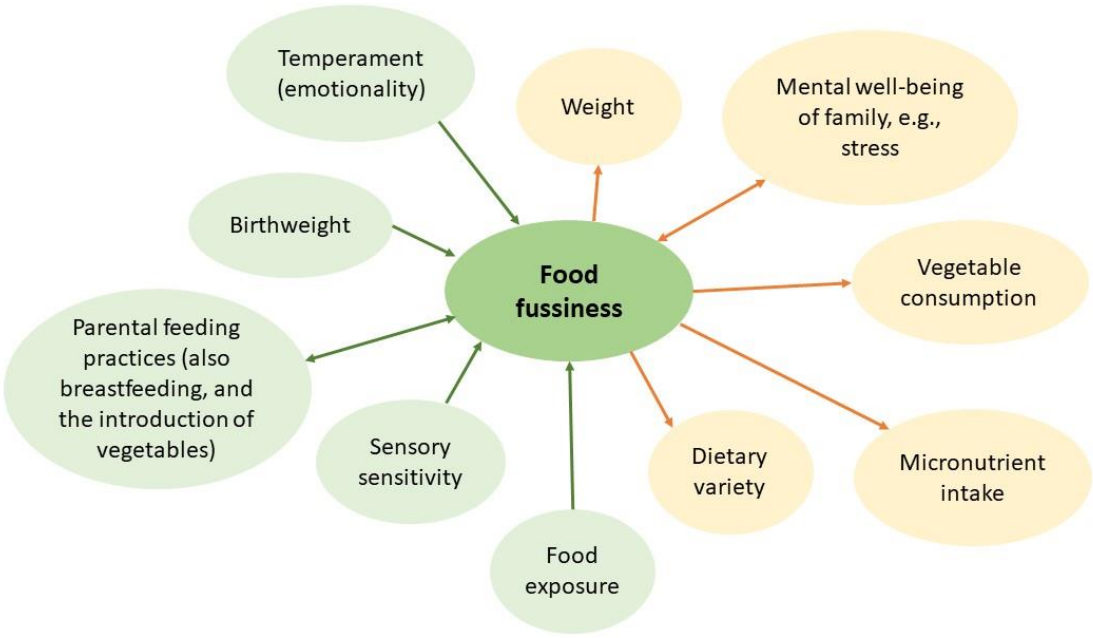

Figure 1. Frequently detected or studied possible determinants and consequences of food fussiness. Green color indicates determinants, and orange color indicates consequences. Possibly bidirectional associations are indicated with a two-way arrow.

Predictors

Summarizing the child's intrinsic or genetic factors associated with food fussiness, some evidence (e.g., from twin studies), including studies on only food neophobia, suggests that food fussiness has quite high heritability – estimates have ranged from moderate to high (up to 78%) (8,9,18,22). For instance, genetic variation in sensitivity to bitter taste (9,11,18) and other genetic components that contribute to food preferences (22) possibly influence whether food fussiness develops. This is supported by the fact that increased sensory sensitivity (8,10,18,25) or tactile defensiveness (11) has been frequently associated with food fussiness. In qualitative studies, parents of picky eaters have also frequently claimed their child to have sensory sensitivity (23). There is some discrepancy regarding the association of gender with food fussiness but based on recent reviews most studies report no difference by gender (8,18,25,28), though there are results showing food fussiness to be higher either in boys or in girls (8,10), and results suggesting that more severe fussiness might be more prevalent in boys (25). Moreover, there is cross-sectional and longitudinal evidence of an association between lower birthweight and food fussiness (8,25), but also studies reporting null results (children aged ≤ 2) (28). Some secondary diagnoses, such as autism spectrum disorder, have also been associated with food fussiness (10). Furthermore, child's negative affectivity and high emotionality and some other features of temperament/personality (10,13,25) have been associated with higher food fussiness (including food neophobia) quite consistently, and parents have attributed their picky children's behavior to temperamental features in qualitative studies as well (23).

When it comes to factors concerning caregivers, several caregiver behaviors, especially regarding food and eating, have been associated with child's food fussiness. Breastfeeding (ever having breastfed) and longer duration of it, but also early (at 4 to 5 months of age) introduction of vegetables may be protective against food fussiness (9,18,25). However, the evidence is not consistent, and according to a review by Cole et al. (28) it is even mixed among children aged ≤ 2 years. Additionally, the flavor profile of the breastmilk caused by maternal diet may influence the association between breastfeeding and food fussiness (9,22). Of overall parenting styles, authoritarian parenting (or non-responsive) has been most commonly reported to be linked with increased picky eating in children (9,10). Of feeding styles specifically, greater parental pressure to eat and overall control of the child's intake have been most frequently associated with higher food fussiness (9–11,13,18,28), whereas responsive parenting, and structured responses to food (structuring mealtimes) may be protective factors (9,10,28). Moreover, a review by Chilman et al. (10) identified caregivers eating with their children as a potential protective factor. Additionally, parents' own diet and eating behavior can have an effect – especially maternal healthy eating has been linked to lower food fussiness (10,11,18).

These may influence through modeling, which is an important way of learning (11). Regarding caregivers' intrinsic factors, parental, especially maternal, age has been associated with food fussiness, but the results have been contradictory regarding the direction of the association, though there are more results of younger age being associated with picky eating (10,18,25). Furthermore, mother's mental health can contribute to child's food fussiness: particularly maternal depressive and anxiety symptoms have been associated with an increased likelihood of the child being a picky eater (10,18), and mother's negative affectivity (temperament dimension) has been associated with more food fussiness in the child (18,25).

Children's eating is embedded to the relationship between them and their caregiver(s) (10). Thus, the role of child-caregiver interactions in food fussiness is likely complex, and it has been suggested that the association between certain feeding practices and food fussiness can be bidirectional (11,13,18,23). For example, it has been reported that the child's food fussiness can cause the caregiver to pressure the child to eat which, in turn, aggravates food fussiness (10,11). Additionally, caregiver stress is likely involved in this as well since parental stress has been linked to child's food fussiness, and child's food fussiness has been linked to parental stress (10). On the other hand, a systematic review (23) of qualitative studies on children's fussy eating behaviors found more qualitative evidence for child's eating behavior (or other characteristics) affecting parental feeding practices than vice versa, because there were more reports of parents changing their behavior due to the child.

Of other extrinsic factors, there is some evidence of lower socioeconomic status being associated with higher food fussiness (10,25), but there are also null results (28). Possibly partly linked to this, food availability at home, especially of fruits and vegetables, may also influence food fussiness so that lower availability predicts higher fussiness, because children are less likely to accept a food item that they don't have frequent exposure to (9).

Consequences

As Taylor and colleagues (18) state, the primary consequence of food fussiness concerns its effects on dietary intake, which are included in many of the definitions of food fussiness, and which are potential mediators for adverse health outcomes. However, evidence on these effects is not consistent. The effect with most evidence is that high food fussiness is associated with lower vegetable intake (or that picky eaters eat less vegetables than non-picky), and lower meat (including fish, but possibly excluding processed meat) intake is a frequent observation as well (9,17,18,22,23,28). In terms of energy intake, evidence inclines to there not being a significant difference between picky and non-

picky children but there are also both studies showing increased intake and studies showing decreased intake (17,18,28). Evidence regarding micronutrients is similarly mixed. According to a recent review (18) lower intakes of zinc and iron in picky eaters compared to non-picky eaters are most reported but earlier reviews have reported about some other micronutrients, such as vitamins A and C, as well (9,17). However, the intake of zinc and iron are most often below the recommended intakes (although often in non-picky eaters as well) (9,17). Nevertheless, food fussiness does not seem to be a serious risk for inadequate micronutrient intakes (9,17,18). Intake of dietary fiber, which tends to be low in all children, has also been detected to be lower in picky eaters than in non-picky eaters in some studies (16–18). Even though restricted dietary diversity or variety is considered one of the main characteristics of a fussy eater, the reviews reported surprisingly little research on that, but it does suggest that diversity and variety are lower in picky eaters than in non-picky eaters or that they eat a smaller range of different food items (16,18,23,28). The evidence regarding vegetable intake, energy intake and micronutrient intake (iron and zinc) is supported by one of the very few studies (ALSPAC) that has been able to examine detailed long-term differences in diet in a large sample of picky and non-picky children (18,39). It also showed that the effects can be stronger if food fussiness is persistent.

As can be inferred based on the evidence on dietary intake, results concerning health and growth outcomes are also inconclusive. Additionally, the results are mostly limited to growth outcomes (18). Regarding the association of food fussiness with weight outcomes, according to reviews (17,18,22), one of which examined specifically the association in question (40), no clear conclusion can be drawn. The results range from "no association" to associations with under- or overweight. If picky eating increases the risk of being overweight, it might be due to a high intake of palatable energy-dense foods, which don't seem to be commonly rejected by picky eaters (22). On the other hand, Taylor et al. (18) state that there seems to be a subgroup of picky eaters who are at risk of being underweight, and the review by Brown et al. (40) supports this because the association between picky eating and underweight was detected in studies (although there were only three) that classified children as severe (e.g., referred to a feeding specialist) or persistent (e.g., for 3 years in a row) picky eaters.

In terms of other possible consequences, food fussiness in childhood has been identified as a possible risk factor for later eating disorder development (18,25). Additionally, food fussiness might affect others around the fussy child because it is embedded in the relationship between the child and caregivers. One finding is that food fussiness can cause stress and concern in caregivers and result in a negative atmosphere (or emotional climate) at mealtimes and problems in relationships inside the family (10,16,18,22,23,25) – due to, for example, conflicts at mealtimes.

To conclude, although there are various uncertainties and inconclusive evidence concerning food fussiness – its definition, effects and factors associated with it – there is an agreement that it is a phenomenon that should be identified. Additionally, interventions to prevent and diminish it as well as to support parents of picky eaters are considered important. Especially, identifying the more severe cases can be crucial since food fussiness may not be a serious health concern unless the restriction is extreme. Hence, further studies on the determinants or contributors of food fussiness are needed. In terms of these, it seems that the etiology of food fussiness is multifactorial, including unmodifiable factors, such as genes, and more modifiable factors, like parenting practices.

2.2 Emotion regulation and temperament – focus on children and the context of eating

Emotions are known to be able to affect food intake and eating behaviors (12). Both emotions/feelings that are induced by food and those that are unrelated to food can have an influence (12). Especially negative emotions have been associated with increased eating, but also decreased eating (12), and not only in adults but in children as well (13,29). Moreover, emotion regulation, which refers to physiological, cognitive and behavioral processes used to manage emotional arousal (41,42), likely plays a role in these associations – for example, a link between poor ER and overeating has been found in children and adolescents (14). In addition, eating itself can be used as a strategy to regulate negative emotions – a strategy that also parents use to regulate their child's emotions (27). Furthermore, temperament, especially its emotion-related aspects, has been linked to different eating behaviors, such as emotional eating, in children (13). In this section, I will first introduce the general concept of ER and its development in the preschool age as well as the concept of temperament. Temperament is included here because it contains the concept of emotionality as well as aspects of emotion-related regulation (41,43,44). Then, I will briefly discuss how ER is measured in children.

2.2.1 Emotion regulation and its development at preschool age

Like in the case of food fussiness, there are varying conceptualizations of emotion regulation, and for further complication, there are other similar terms, such as affect regulation, coping strategies, and self-regulation, which are closely related concepts to ER (43,45). However, it is generally accepted that ER is a multifaceted process that is under perpetual modification across the life span (45,46).

Cole et al. (47) included both "emotion as regulating and emotion as regulated" in the concept of ER. Others have included only the latter (45,48), and I will focus on that perspective as well. Eisenberg et al. (49), for instance, have defined ER as processes people use to manage and change if, when and how they experience emotions and the motivational and physiological states related to emotions, as well as how emotions are expressed behaviorally. In addition, these processes can change the intensity, duration, or quality of emotions (45). Furthermore, ER is closely linked to adaptation to environment, and it is thought to be used to achieve some kind of goal – for example, a social goal or just to modulate the emotional state (45,48).

One division that can be made regarding ER processes is that some of them are conscious or willfully executed and others occur outside of conscious awareness (45,50). Another division is that there is intrinsic ER (regulating one's own emotions), also termed as emotion-related self-regulation (48), and extrinsic or external ER which means that emotions are regulated with the help of another person, such as a parent (45,48). According to Gross' process model of ER (45), the ER strategies can be implemented in different stages of the emotion-generative process or that different strategies primarily affect the process at certain points. These stages are situation, attention, appraisal, and response. Some examples of ER strategies, that are seen also in preschool-aged children, include directing attention, like shifting it away from stimuli that elicits negative emotions, and physical or verbal venting, such as screaming and hitting (51). These are presumably utilized quite late in the emotion-generative process – when emotion is already evoked.

It is clear that there are individual differences in ER, and that ER can be more or less successful, or one can have difficulties in ER (45,50) of which the term emotion dysregulation is also used (52). As Gross (45) states, the overall goal of ER is to "influence emotions in ways we think will increase the chance that they will be helpful rather than harmful". Hence, the main factor in determining whether ER is successful is whether it leads to appropriate functioning and adaptation to environment, for example, has beneficial effects on health (42,53). Generally, especially the downregulation of negative emotions seems to be widely adaptive in everyday life (45). In addition to the general ability to be well-regulated, the strategies that are used in the regulation can be adaptive or maladaptive (42,45). One strategy that can be maladaptive is using food to regulate emotions because it can contribute to the development of obesity, for instance (54). In addition, the suppression of emotional expression has been associated with overeating behaviors in the presence of negative emotions among children and adolescents (14). However, what complicates things is that appropriate adaptation depends upon the person's characteristics, the situation and the person's goals in that situation (45).

The foundation of ER development is in genes, for example, in terms of neurophysiology (55) and temperament. Additionally, it originates from an infant's early ability to self-regulate their internal physical and emotional states (56). During childhood, emotional competence, including ER, is still developing, and this development occurs simultaneously and in transaction with the development of social, neurophysiological, cognitive, and language domains (55). In general, as ER abilities develop over time they become more complex and elaborate (56). However, there are probably individual differences in the pace at which ER develops. Preschool age has been identified as an important period for emotional development (46).

Even though, in the toddler and preschool years, caregivers are still largely involved in regulating the child's emotions (external ER), the child's intrinsic regulation – regulation of one's own behavior – develops rapidly (56). Moreover, the whole family and other relations, especially peer relations, increasingly facilitate learning about ER in social interactions (56). While the more automatic processes, such as shifting attention, are still strongly present, especially effortful control (temperament dimension) and executive functions, that are considered important for ER, develop (50,56). Hence, particularly willful ER starts to improve at this age, and children learn more sophisticated internal ER strategies that involve more complex cognitive processes (56). For instance, children begin to increasingly understand and use display rules that are "culturally defined rules that guide a person's decision to alter emotional behavior consistent with the demands of the social context" (55).

2.2.2 Temperament and its link to emotion regulation

Temperament is defined as a biologically-based, early-developing predisposition to react to environmental stimuli and to behave a certain way, and it is thought to be relatively stable over time (57). With regard to emotions, temperament influences the speed and extent of emotional reactions or, in other words, how easily and how intensely emotions are aroused by different stimuli (41). This has been termed as emotionality or emotional reactivity (41,57,58). In addition, at least some temperament theories include facets of emotion regulation (e.g., under the concept of self-regulation (43)), or if not included in the concept, at least temperament provides a foundation for the development of ER (47,50). Hence, it contributes to some of the individual differences in ER.

Rothbart and colleagues (59) conceptualized temperament as consisting of three higher order dimensions in preschool-aged children: surgency, effortful control, and negative affectivity. Effortful control describes "children's ability to choose a course of action under conditions of conflict, to plan

for the future, and to detect errors" (57). It is assessed with the dimensions of inhibitory control, attention control, perceptual sensitivity, and enjoyment of low-intensity activities (57,59). Effortful control is thought to, at least partially, reflect ER abilities, especially in terms of focusing and shifting attention, which is considered to be one ER strategy as well (48,50), and inhibitory control, which refers to the ability to inhibit a dominant response and/or activate a non-dominant response (60). In terms of eating behavior, for example, lower inhibitory control has been associated with more eating in the absence of hunger (13).

Another temperament dimension depicted by Rothbart et al. (59) is negative affectivity which describes a child's tendency to experience negative/aversive emotional states. It is assessed with the dimensions of discomfort, sadness, fear, anger/frustration, and soothability (loading negatively). Thus, it reflects the child's emotional reactivity and is comparable to the concept of (negative) emotionality (41,58) but the soothability aspect also reflects regulatory abilities concerning emotions (41). When it comes to eating behavior, higher negative affectivity has been associated with emotional overeating, for instance (13).

It seems, that there is controversy over whether the reactive dimension of emotions (emotionality or negative affectivity) is a part of ER or should be treated as a separate phenomenon or concept – especially concerning whether emotion can be separated from its regulation and particularly whether displays of emotion can be considered as indications of ER (41,47,48,53). Nevertheless, there is evidence that emotional reactivity or emotionality and ER are related, and both contribute to the production of behavior (44,53). Although evidence has not been consistent, they may also interact in predicting some outcomes – especially social adaptation outcomes have been studied, at least regarding temperamental regulation (41,43,44,61). ER moderating the association between emotionality and social adaptation outcomes has been speculated and studied, and so has emotionality moderating the association between ER and social adaptation (43,44). For example, in a study by Moran et al. (61) effortful control moderated the association between emotional reactivity and adjustment: preschool-aged children high in fear and frustration who also had lower effortful control exhibited more externalizing problems. Hence, since emotionality or negative affectivity as well as emotion regulation have been associated with some eating behaviors (13,14), it can be speculated that interactive effects of the reactive dimension of emotion and emotion regulation could be observed in relation to eating behavior as well. It seems reasonable to assume that the ability to downregulate negative emotions appropriately, can influence the effects those emotional states could have on eating – decreasing or increasing.

2.2.3 Measuring emotion regulation in children

Emotion regulation can be assessed using several methods, such as observational/experimental (laboratory tasks) methods, questionnaires reported by self and others, and physiological measures (50,53). Here, I will discuss questionnaires in more detail since one of them is used in this thesis as well. Self-report measures are likely unsuitable for children younger than six years because it is thought that children at this age group lack the skills to self-monitor (53). Hence, caregiver-report questionnaires are widely used in this age group and are the focus of this subchapter. The limitation or problem with caregiver-report measures is that some characteristics of the caregiver, the child or their relationship, such as caregiver psychopathology and child's gender, can affect the caregiver's perceptions (53). In addition, social desirability can skew the answers (53). As opposed to laboratory tasks, one major strength of these questionnaires is that caregivers can assess their children's typical behavior in natural settings, across a number of contexts.

A few validated caregiver questionnaires to measure ER in children exist (51,53,62), and they measure slightly different facets or characteristics of ER. I noted differences in, for example, to what extent they measure typical and general tendencies in ER abilities across situations, or how much they take the context into account, whether they assess the general extent to which children are well-regulated or dysregulated, and whether they measure how children regulate their emotions (which strategies they employ). To set a few examples of these questionnaires, the Emotion Regulation Checklist (ERC) (63) assesses situationally appropriate affective displays, empathy, and emotional self-awareness with an emotional regulation subscale and lack of flexibility, dysregulated negative affect, and mood lability with a lability/negativity subscale. The Emotion Questionnaire (EQ) (41) assesses children's ability to downregulate their emotions by themselves or with the help of someone separately for different emotions. Additionally, one recently developed questionnaire, The Early Emotion Regulation Behavior Questionnaire (51), assesses which behavioral emotion regulation strategies children employ in both positive and negative emotional contexts.

In addition to measures that directly address ER, many temperament questionnaires have also been used in ER research (62). They include a varying number of items that reflect ER abilities. The Children's Behavior Questionnaire (CBQ) (59) assesses the temperament dimensions by Rothbart et al. (59) that, like discussed earlier, are considered to indicate the ability to regulate emotional states as well, to some extent. Soothability and especially attentional control, a part of effortful control, are assessed in other temperament questionnaires as well (e.g., the Short Temperament Scale for Children (64) and the Colorado Childhood Temperament Inventory (65)). Another frequently used measure of

temperament, the Emotionality, Activity, and Sociability (EAS) Temperament Survey for children, in turn, does not include items that would directly reflect ER abilities.

2.3 Associations of emotion regulation and temperament with food fussiness

In addition to the fact that emotions, including emotion-related temperament features and emotion regulation, can affect, for example, overeating (12–14), emotional factors may be important concerning food fussiness as well. Like already mentioned, reviews have linked food fussiness with emotion-related dimensions of temperament (10,13,25). However, emotion regulation in relation to food fussiness has not been mentioned in these reviews. Therefore, I searched for studies on the association between ER and food fussiness. However, since I was able to find only one study that measured specifically ER, and because emotionality is also examined in this thesis, I decided to include temperament (especially features that reflect emotion regulation and emotional reactivity) into my search as well. Thus, I will now briefly review studies that have examined the associations of emotion regulation or temperament to food fussiness in preschool-aged children. I conducted a literature search in Scopus with the following search terms: (temperament OR "negative affect*" OR "effortful control" OR emotionality OR "excecutive cognitive function*" OR "emotion regulation") AND ("food fussiness" OR "picky eat*" OR "selective eat*" OR "fussy eat*" OR "food avoidan*" OR "food reject*"). I included studies where the age group involved preschool years (3–6), at least partly. No restrictions were made for the definitions of food fussiness or for the assessment methods of temperament and food fussiness. After excluding a few studies that included only younger or older children than the target age group here, this search yielded 14 studies. Their basic characteristics and main results concerning the associations of interest are presented in table 1. These studies were all conducted in developed countries – most of them either in the USA or UK. The samples of these studies were somewhat more diverse than their geographical locations albeit there were still mainly Caucasian/white and socioeconomically advantaged participants.

Table 1. Characteristics and main results of studies on the association of temperament and emotion regulation with food fussiness.

Cross-sectional studies

Reference	Sample	Assessment method of temperament/ER	Assessment method of food fussiness	Main results concerning ER/temperament and food fussiness
Powell et al. (66) 2011 UK	3–6-year-olds N = 104	EAS Temperament Survey for children.	The food fussiness subscale of the CEBQ.	Emotionality was positively correlated with food fussiness score, and higher emotionality was associated with higher food fussiness in a regression model. Shyness, sociability, and activity were not significantly related to food fussiness.
Haycraft et al. (67) 2011 UK	3–8-year-olds N = 241	EAS Temperament Survey for children.	The food fussiness subscale of the CEBQ.	Emotionality was positively correlated with food fussiness. Shyness, sociability, and activity were not significantly related to food fussiness.
Brown et al. (68) 2018 USA	3–4-year-olds N = 506	A mean of the anger, soothability, impulsivity, and inhibitory control subscales of the CBQ. - Higher score indicates a more difficult temperament (increased reactivity and negative affect).	The food fussiness subscale of CEBQ.	More difficult temperament was associated with higher food fussiness score (correlation and regression).
Liew et al. (69) 2020 USA	4–6-year-olds N = 221	The CBQ Short Form: - Negative affectivity and effortful control	Food avoidance trait: satiety responsiveness, slowness in eating, fussiness, and emotional undereating subscales from the CEBQ. - one variable	Negative affectivity was not associated with food avoidance, but it was positively associated with only the food fussiness subscale. Lower effortful control was associated with higher levels of food avoidance.
Searle et al. (70) 2020 Australia	2–5-year-olds N = 205 (Socioeconomically disadvantaged city)	Short Temperament Scale for Children (STSC): - Sociability, flexibility/reactivity and persistence dimensions - Higher score indicates easier temperament.	The food fussiness subscale of CEBQ.	An easier temperament correlated with lower food fussiness score.
Rendall et al. (71) 2022 UK	3–5-year-olds N = 79	The emotionality subscale of the EAS Temperament Survey for children.	The food fussiness subscale of CEBQ.	Higher emotionality was associated with higher food fussiness score (regression).

Table 1. Continues

Longitudinal observational studies

Reference	Sample	Assessment method of temperament	Assessment method of food fussiness	Main results concerning ER/temperament and food fussiness
Jacobi et al. (72) 2003 USA	Followed from birth to 5.5 years of age. N = 135	The CBQ	"Is your child a picky eater?", 5-point Likert scale. - A score of at least 3 (sometimes) had to be endorsed for both years and a score of 4 (often) had to be endorsed for at least 1 year	Picky eaters had a higher concomitant[a] negative affectivity. No significant differences with surgency and effortful control.
Hafstad et al. (24) 2013 Norway	Followed from the age of 1.5 years to the age of 4.5 years (3 time-points). N = 727	The EAS Temperament Survey for children.	Lack of appetite and food fussiness items from the Behavior Checklist.	Higher emotionality predicted increases in picky eating over the study period (in a fully adjusted model). Shyness, sociability, and activity were not significantly related to food fussiness (in a fully adjusted model).
Reis et al. (73) 2015 Canada	Followed from 3 months of age to 72 months of age. N = 156	The Early Childhood Behavior Questionnaire (ECBQ). - Inhibitory control item	The food fussiness subscale of the CEBQ.	Inhibitory control at age 18 months was negatively associated with food fussiness at 72 months of age (correlation and regression).
Steinsbekk et al. (74) 2017 Norway	Followed from the age of 4 years to the age of 6 years. N = 997 (Children with higher Strengths and Difficulties questionnaire scores were oversampled)	The CBQ - Negative affectivity and surgency	A semi-structured psychiatric interview, The Preschool Age Psychiatric Assessment (PAPA) - No pickiness and moderate/severe pickiness	Children's negative affectivity was positively correlated with pickiness at baseline. Temperamental traits at baseline were not associated with pickiness at follow-up.
Kidwell et al. (27) 2018 USA	3–5-year-olds at baseline, 6-month follow-up. N = 297	The CBQ - Negative affectivity	Single dichotomous question "Do you think your child is a picky eater?"	Higher negative affectivity was associated with higher odds for being a picky eater both concurrently and longitudinally.
Zohar et al. (75) 2020 Israel	2–5-year-olds at baseline, 2 follow-ups at two-year intervals. N=1055 at baseline. - 109 picky eaters and 106 non-picky eaters for the follow-ups.	The EAS Temperament Survey for children Executive function: the BRIEF-P - Emotional control and shifting subscales	Time-point 1: single dichotomous item from the CBCL. Time-point 2: Food fussiness subscale of CEBQ (cut-off 3.3). Time-point 3: Median of a variable "absolutely not" (number of food items from a total of 44 that the child reported not being willing to eat), derived from the Foods I like and dislike -questionnaire.	Picky eaters had more negative emotionality at baseline. Temperament at baseline did not predict picky eating at later time-points. Higher emotional control score was associated with picky eating at baseline, and it predicted picky eating at time-point 3.

Table 1. Continues

Reference	Sample	Assessment method of temperament	Assessment method of food fussiness	Main results concerning ER/temperament and food fussiness
Steinsbekk et al. (76) 2020 Norway	Followed biennially from 4 years of age to 10 years of age. N = 997 (Same sample than in the other study by Steinsbekk et al. (74))	The CBQ.	The food fussiness subscale of the CEBQ.	Higher negative affectivity as well as lower effortful control at age 4 predicted higher food fussiness at age 6. Higher negative affectivity and lower effortful control at age 6 predicted higher food fussiness at age 8 and at age 10. Higher surgency at age 6 predicted less food fussiness at age 8 and 10.
Fernandez et al. (38) 2020 USA	Followed from the age of 4 to the age of 9, 5 time-points. N = 317 (Low-income mother-child dyads)	The Emotion Regulation Checklist: Measures emotional regulation and emotional lability/negativity.	The food fussiness subscale of CEBQ. - Latent class growth modeling -> trajectories of picky eating	A low picky-eating trajectory was associated with higher emotional regulation, and lower emotional lability compared with the medium and high trajectories.

a) Unlike in the other studies, picky eating was assessed before temperament (picky eating at the ages of 4 and 5, and temperament at the age of 5.5).
Abbreviations: UK, United Kingdom; USA, The United States of America; EAS, Emotionality, Activity and Sociability; CEBQ, Children's Eating Behavior Questionnaire; CBQ, Children's Behavior Questionnaire; STCS, Short Temperament Scale for Children; PAPA, The Preschool Age Psychiatric Assessment; BRIEF-P, the Behavior Rating Inventory of Executive Function -preschool version; CBCL, the Child Behavior Checklist.

The results suggesting an association between emotion regulation and food fussiness are mostly from longitudinal studies. Moreover, very different measures of ER or related concepts have been used. Only one study, conducted in the USA, examined specifically emotion regulation (38). In that study the children with a low level of picky eating across the study period had a higher score on the emotion regulation subscale and a lower score on the lability/negativity subscale of the ERC at baseline compared with the children that had medium or high level of pickiness. Some other results support this association: In a sample of 2–5-year-old Israeli children higher emotional control score of an executive function measure (indicating more difficulties in emotional control) was associated with being a picky eater at baseline and predicted picky eating 4 years later (75). Furthermore, The results of Liew et al. (69) and Steinsbekk et al. (76) suggest that lower effortful control might contribute to more food avoidant behavior, including fussiness, and Reis et al. (73) found that higher inhibitory control, that pertains to the effortful control dimension, in infancy was associated with less food fussiness in later childhood. Like already mentioned, effortful control dimension of the CBQ (59) is thought to reflect abilities needed for effective ER (50,60). Thus, the results of these studies suggest that, in addition to the association between emotional reactivity and food fussiness, ER could be associated with food fussiness, and that this association could be negative.

As can be seen from the table 1, relationships between temperament dimensions and food fussiness were detected in each of the cross-sectional studies. All of them measured food fussiness with the subscale from the CEBQ. A few different assessment tools of temperament were used but (negative) emotionality or negative affectivity (parallel concepts) were consistently positively associated with food fussiness. The results from longitudinal studies that examined emotionality or negative affectivity were not entirely consistent, but four out of six studies found a longitudinal association between higher score on those dimensions and higher food fussiness. In one of these studies (72), temperament was assessed at a later time-point than food fussiness. In addition, in the only study that measured ER with the ERC, like already mentioned, lower emotional lability was associated with lower food fussiness (38). Some of the items of the lability/negativity subscale indeed are similar to the items of emotionality or negative affectivity. However, it also includes positive emotions/exuberance, and items that could be argued to reflect regulatory processes as well (e.g., “Can modulate excitement in emotionally arousing situations” (77)). Moreover, in a sample of 3–6-year-old UK children higher emotionality was associated with higher satiety responsiveness and more slowness in eating (measured with the CEBQ) (66) – eating behaviors that some consider to be characteristics of picky eating as well. In addition, negative affectivity was prospectively associated with these eating behaviors in a Norwegian study (76).

Some of the studies also found associations with other temperament dimensions. Steinsbekk et al. (76) found that higher surgency at age six predicted less food fussiness a few years later but another study by Steinsbekk et al. (74) did not find association between surgency and food fussiness. Additionally, effortful control, that, like already mentioned, provides evidence for the association between ER and food fussiness, was associated with food fussiness in two out of three studies. Furthermore, two cross-sectional studies used an easy-difficult temperament score. Brown et al. (68) derived it from specific scales of the CBQ, and Searle et al. (70) derived it from the Short Temperament Scale for children (64). Those scores thus contain various temperament dimensions, including both aspects of emotional reactivity and regulation. In both studies more difficult temperament (characterized especially by increased negative emotionality or negative affect) was associated with higher food fussiness.

Because there are differences in several factors in these studies that I reviewed, it is difficult to find an explanation for the lack of longitudinal association between emotionality or negative affectivity and food fussiness in the studies by Steinsbekk et al. (74) and Zohar et al. (75) (four out of six studies found an association). These null results may be due to inadequate sample size or inadequate adjusting for confounders, for instance, or merely due to chance. What is interesting is that, a later study by Steinsbekk et al. (76), that utilized the same sample than the earlier one (74), did detect longitudinal associations between temperament and food fussiness. These studies used a different food fussiness measure which is probably the main reason for the different result. The rather large variation in the assessment methods of food fussiness has been identified as a problem. Additionally, this later study (76) could not account for the baseline level of food fussiness.

A few different explanations have been suggested for the associations between the temperament dimensions and food fussiness. One explanation regarding emotionality is that a more emotionally reactive child may react strongly around food and within feeding interactions (24,66). This might cause conflict in these interactions and negatively influence the atmosphere during mealtimes and thus lead to fussy eating behavior (24,66). Furthermore, especially concerning food fussiness that includes food neophobia, more emotional children feel fear and other related emotions more easily and intensely, and fear makes humans more reluctant to try new foods (21,76). Additionally, regarding inhibitory control, Reis et al. (73) suggested that better control and lower impulsivity might lead to greater enjoyment of food in general which could be protective of food fussiness, if it is reflected in dietary variety, for instance. Liew et al. (69) also speculated that children with low effortful control may be fussier because they are not able to override the likely reflexive/reactive

fussy responses around food and activate an alternate response. This probably involves regulation of emotional reactions as well.

Conclusions of causal relationships cannot be drawn from cross-sectional data alone. Longitudinal data provides more reliable evidence on that but, in the case of food fussiness and temperament, etiological conclusions can still be questioned. One reason for this is that genetic covariance between temperament and eating behaviors have been reported (76), and Brown et al. (68) claimed that "Picky eating might be a behavioral manifestation of a temperament characterized by greater emotionality". Moreover, the fact that temperament can, to some extent, change throughout life, for example, due to variations in parenting and the home environment, can cause biased results if this possible change is not accounted for in the longitudinal research (76). In addition, a source of bias termed common rater bias must be kept in mind if both temperament and eating behavior are assessed by a same person.

In conclusion, emotional factors can affect eating behavior, and research has provided evidence on this also regarding food fussiness. Based on these studies that I reviewed here, the association between (negative) emotionality or negative affectivity and food fussiness seems to be quite well established. There is both cross-sectional and longitudinal evidence. Additionally, there is some evidence that emotion regulation is associated with food fussiness, and based on the studies reviewed here, better emotion regulation (less difficulties) could be a protective factor. However, the evidence on that is scant. The construct of ER being rather complex and multidimensional, studies investigating different facets of it are likely warranted in order to obtain comprehensive knowledge. The measures of ER (including temperament) have been rather general in previous research on food fussiness, and some seem to mix items of emotionality with items of regulation. Moreover, Stifter and Moding (15) have pointed out the possible differing outcomes of the different emotions that pertain to the negative affectivity dimension of temperament when investigating eating behaviors and temperament. Different negative emotions, for instance, can produce very different behavior (15). Hence, separating the assessment of emotionality and ER for different emotions could be fruitful in future research. Furthermore, the interaction of these constructs has not been studied in relation to food fussiness (or any eating behavior, to my knowledge). There is evidence of the interaction in relation to other outcomes (e.g., externalizing disorders) (43), and both ER and especially emotionality have been associated with food fussiness, thus studying their interaction seems reasonable. Hence, this thesis aims to investigate the associations of ER and emotionality to food fussiness.

3 AIMS AND OBJECTIVES

The aim of this study is to extend the literature on the possible predictors of food fussiness in preschool-aged children. As presented in the literature review, there is evidence on the associations between emotionality, emotion regulation and food fussiness (e.g., 8,24,38,75,76). However, especially the evidence on the association of emotion regulation with food fussiness is scant. Moreover, a different measure of emotionality and emotion regulation than in previous studies is used here. This measure assesses these concepts separately for different emotions. Additionally, to my knowledge, the associations of emotionality and ER to food fussiness have not been studied in Finnish or Polish populations.

Hence, the objective is to study the independent direct associations of emotion regulation and emotionality with food fussiness, ER being the primary interest, and additionally, to examine whether emotionality and emotion regulation interact in predicting food fussiness: whether emotion regulation moderates the association between emotionality and food fussiness. A secondary objective is to examine the prevalence of food fussiness in the total sample as well as in the Finnish and Polish subsamples. My research questions are as follows:

1. Are emotion regulation and emotionality associated with food fussiness in Finnish and Polish preschool-aged children? Associations examined separately for anger, fear, sadness, and positive emotions.
2. Do emotion regulation and emotionality interact in predicting food fussiness in Finnish and Polish preschool-aged children? Associations examined separately for anger, fear, sadness, and positive emotions.
3. What is the prevalence of food fussiness among Polish and Finnish preschool-aged children, and does it differ between the countries?

Based on previous research (8,38,75,76), regarding the first research question, my hypothesis is that lower/poorer regulation of the negative emotions (anger, fear, and sadness), and higher emotionality of the negative emotions are associated with more food fussiness. I do not have a hypothesis for the positive emotions, because the measures of previous research focus on negative emotions, or emotions have not been separated in the variables derived from the questionnaires. The second question is exploratory since it has not been studied before. It is included here because there is some evidence of the interaction regarding other outcomes (41,44). Since negative emotionality and negative affectivity have been associated with food fussiness (8), it could be speculated that if one is

able to regulate the negative emotional states well the association between negative emotionality would diminish.

4 MATERIALS AND METHODS

4.1 Study data

The data used in the present study is obtained from a feasibility study (78) that pilot tested the effectiveness of an educative mobile application in increasing vegetable and fruit acceptancy among 3–6-year-old children in Polish and Finnish early childhood education and care (ECEC) centers. The study was a part of an EIT (European Institute of Innovation & Technology) Food –funded Food School Network project. The application was primarily designed to increase vegetable and fruit acceptancy among children but also to support the development of self-regulation and social skills. In the present study, the baseline data from the feasibility study is used, thus the design of the present study is cross-sectional. The baseline data was gathered in September 2019.

4.2 Participants

The sample consists of preschool-aged children and their caregivers. The participating ECEC centers were recruited using convenience sampling. In Finland, ECEC center directors from 12 public centers in Helsinki were contacted and asked to participate in the study. Of those, seven consented, and 14 groups from these centers agreed to take part in the study. All children in these groups were invited to participate by sending informed consent forms to the legal guardians by letter via the centers. This resulted in 130 consenting participants (56 % of those invited).

In Poland, four ECEC centers agreed to participate in the study. These centers consisted of one public ECEC center in the countryside (Wilczyn) and two public (Międzylesie-Warsaw; Piaseczno-Warsaw) and one private (Kobyłka-Warsaw) ECEC centers in large urban agglomerations. The University of Warsaw research team organized meetings to introduce the study to the legal guardians of the participating children and ECEC professionals, and the informed consents were requested from the guardians in these meetings. Altogether 196 children (92% of those invited) and their legal guardians

gave consent to participate. Hence, altogether 326 children from these two countries participated in the study at baseline.

4.3 Ethical considerations

The present study, that used the baseline data of another study (78), did not involve any major ethical issues. The measures used in the present study are all questionnaires. Hence, they are not invasive. Additionally, the questionnaires do not involve any highly sensitive questions. The baseline data collection did not interfere much with the everyday life of the participants; burden on the participants mainly consisted of time and effort put into filling questionnaires and forms which were delivered home via the ECEC centers, so the participants did not need to do any extra travelling for the study.

In terms of respecting the autonomy of the participants, written informed consents were obtained. Participation to the study was voluntary. The participants could withdraw from the study at any time without a specific reason and without consequences.

As regards to privacy and data protection, all data is handled confidentially according to Personal Data Act (GDPR) and Good Scientific Practice/responsible conduct of research (79). In Finland, the data was pseudonymized, and in Poland it was anonymized. Only the team members have access to the data.

In Finland, the Education Division of the City of Helsinki granted a research permit for the study, and the University of Helsinki Ethical Review Board in Humanities and Social and Behavioral Sciences deemed the study to be ethically acceptable (Statement 35/2019). In Poland, the Ethics Committee of the Faculty of Psychology of the University of Warsaw evaluated the ethicality of the study procedure and accepted it.

4.4 Measures

Background questionnaire

Caregivers of the children filled in a questionnaire concerning background information on their children and themselves. Caregivers were asked to report their children's gender and birthdate as well as their own level of education.

In terms of variable construction, a variable that indicates the highest education among the caregivers of a child was constructed, and that variable was dichotomized: lower education (upper secondary/vocational school or lower), and higher education (Bachelor's Degree or higher). The original response options were comprehensive school, upper secondary school, vocational school, Bachelor's Degree, Master's Degree, Licentiate or Doctoral Degree, and other. Seven caregivers had reported "other" as their educational level but had not clarified what that education was, and therefore those were handled as missing values.

The Emotion Questionnaire (EQ) – short version

Caregivers filled in the short version of the Emotion Questionnaire by Rydell et al. (41), which assesses children's emotionality and emotion regulation (specifically downregulation of the emotion in question) separately for different emotions (anger, fear, sadness and positive emotions/exuberance). The short version consists of two emotionality statements and two ER statements for each emotion, and they are answered on a five-point Likert-scale (1 = doesn't apply at all, 5 = applies very well to my/this child). The emotionality statements assess the frequency and intensity of emotional reactions, and the ER statements include intrinsic and extrinsic downregulation. The statements are presented in table 2.

This questionnaire was developed to assess emotionality and ER aspects of the separate emotions and to minimize the risk of confounding measures of emotion with measures of social adaptation (41). During the development of this questionnaire, it was validated in 5–6-year-old Swedish children (41). Rydell et al. (41) reported adequate internal consistency estimates (Cronbach's alpha) from 0.65 to 0.79 and test-retest reliability (correlation) from 0.62 to 0.79, albeit only for the long version. Construct and discriminant validity (except for sadness) was demonstrated in relation to the CBQ (59), a measure of temperament, and Rydell et al. (41) deemed it adequate: the emotionality scales were the most consistently related to the anger, fear, and smiling and laughter scales of the CBQ, and the regulation scales, except for fear which had quite weak associations, mainly had associations with the soothability, attentional focusing, and inhibitory control scales.

As regards to variable construction, one emotionality variable and one emotion regulation variable were constructed for each emotion. The emotionality and ER variables were constructed by computing the mean of the two emotionality items, and the mean of the two ER items, respectively. In order to do this, the item evaluating the children's ability to regulate their own emotions was reverse coded. Hence, higher ER variable mean indicates better ER abilities, and higher emotionality

mean indicates higher emotionality. Additionally, to better correspond to the measures used in previous studies (58,59), the negative emotions were combined by computing the mean of the emotionality variables of anger, fear, and sadness as well as the mean of the regulation variables of anger, fear, and sadness.

Table 2. Items of the Emotion Questionnaire – short version (41).

Anger
"My child often becomes angry and falls in a bad mood." EM
"When angry or in a bad mood, my child reacts strongly and intensely." EM
"It is easy for others, for instance a parent, to calm him/her down." ER
"He/she has difficulties calming down on his/her own." ER (R)
Fear
"My child often gets frightened and worried." EM
"When frightened and worried, he/she reacts strongly and intensely." EM
"It is easy for others, for instance a parent, to make him/her calm down." ER
"He/she has difficulties making him/herself calm down." ER (R)
Sadness
"My child often becomes sad." EM
"When sad, my child reacts strongly and intensely (e.g., cries, screams)." EM
"It is easy for others, for instance a parent, to make him/her feel better (e.g., by comforting, distracting or talking things through)." ER
"He/she has difficulties finding something to make him/herself feel better." ER (R)
Positive emotions/exuberance
"My child often gets happy, excited and in an exuberant mood." EM
"When in an exuberant mood, my child reacts strongly." EM
"It is easy for others, for instance a parent, to make her/him quiet down." ER
"He/she has difficulties quieting down on his/her own." ER (R)

Abbreviations: EM, emotionality; ER, emotion regulation; R, reverse coded.

The Children's Eating Behavior Questionnaire (CEBQ) – Food fussiness

The Food fussiness subscale of the CEBQ is an instrument that assesses caregiver's perceptions of their children's food fussiness (29). It consists of six statements that evaluate the child's reactions/attitudes towards foods and willingness to eat in feeding situations. The statements are presented in table 3. Each statement is rated on a five-point Likert-scale (1="never", 2="seldom", 3="sometimes", 4="often", and 5="always") according to how often the statement is true for the child.

The CEBQ was developed to assess eating behaviors or eating styles in children aged three to eight years, especially for research on the early precursors of obesity or eating disorders (29). Evaluation of the existing literature and interviews with parents were utilized in its development (29). It is widely used in measuring children's food fussiness (16). The food fussiness subscale has been validated against observational methods (80,81), and, for example, against a structured psychiatric interview (the Preschool Age Psychiatric Interview (PAPA)) (32). Wardle et al. (29) reported a test-retest reliability (correlation) of 0.87 and a Cronbach's alpha value of 0.91 (internal consistency) for the food fussiness subscale. In this sample the Cronbach's alpha value was 0.89.

Table 3. The items in the food fussiness subscale of the Children's Eating Behavior Questionnaire (29).

"My child enjoys tasting new foods." R
"My child enjoys a wide variety of foods." R
"My child is interested in tasting food s/he hasn't tasted before." R
"My child refuses new foods at first."
"My child decides that s/he doesn't like food, even without tasting it."
"My child is difficult to please with meals."

Abbreviations: R, reverse coded.

In terms of variable construction, a mean score was computed for the items in the Food fussiness subscale. First three items were reverse coded, so that a higher mean score would indicate more fussiness. In addition, in order to investigate the prevalence of food fussiness, cut-offs proposed quite recently by Steinsbekk et al. (32) were used to construct two binary variables: one with the cut-off 3.00 (moderate or higher food fussiness) and one with the cut-off 3.33 (severe fussiness).

Regarding questionnaire respondents, there were only a few cases where different caregivers had answered to the background, emotion, and food fussiness questionnaires. Hence, I decided to use only the respondent of the food fussiness questionnaire as a questionnaire respondent variable in analyses, since food fussiness was the dependent variable. Only six respondents had answered "other", ergo they were handled as missing data.

4.5 Statistical analyses

Altogether, 298 participants (91.4%) had completely filled the food fussiness subscale and formed the analytic sample. All the participants with completed data of the variables used in each of the analyses in question were included in the respective analysis. All the analyses were performed using SPSS (IBM SPSS version 28.0, Armonk, NY, USA). Statistical significance was set at $p < 0.05$ for all analyses.

Descriptive statistics, distributions and outliers were examined first. The food fussiness variable was approximately normally distributed according to its histogram (albeit not according to Kolmogorov-Smirnov test ($p<0.001$)). Out of the emotion variables, only anger emotionality could be considered adequately normally distributed (albeit also not according to Kolmogorov-Smirnov test ($p<0.001$)). Moreover, there were no apparent outliers in the variables. All of the values were inside the response scale ranges of the questionnaires; there were likely no errors in the data entry. The differences in the prevalence of food fussiness between the countries were investigated with the chi-square test. Correlations between emotionality, emotion regulation, and food fussiness variables were investigated next.

Linear regression models were used to examine the associations of ER and emotionality with food fussiness, and the interactions between emotionality and ER in predicting food fussiness. Separate regression models were constructed for each emotion to avoid multicollinearity risk and overfitting the model. First, unadjusted models with only the respective regulation and emotionality variables were tested separately. Then, unadjusted models including the emotionality x ER interaction terms were tested, and lastly, adjusted models for the independent associations of the regulation and emotionality variables. Child's age, gender, caregiver educational level, country, and questionnaire respondent were included as confounders in the adjusted regression models, even though, besides respondent and country, there were few associations between them and the main variables (examined with correlations, T-tests, or Mann-Whitney tests). However, age and gender have been used as confounders in some previous studies on food fussiness and temperament (24,66–68,75). Regarding educational level, it seems plausible to think that it could influence food fussiness and ER, for example, through parenting practices. In addition, the emotionality and ER variables were confounders for each other when examining their independent associations. The assumptions of normality of residuals (normal probability plot) and homoscedasticity (scatter plot of predicted values and residuals) were adequately met in the models.

5 RESULTS

5.1 Descriptive statistics

The characteristics of the children and their caregivers are shown in table 4. A slightly larger proportion of the children were girls. There were more participants from Poland. In addition, most families had at least one adult with a higher education (bachelor's degree or higher). Furthermore, most of the respondents to the questionnaires were mothers.

Table 4. Characteristics of the study sample (N=298).

Categorical variables	**N (%)**
Gender	
Girl	153 (51.3)
Boy	141 (47.3)
Missing	4 (1.34)
Country	
Finland	118 (39.6)
Poland	176 (59.1)
Missing	4 (1.34)
Caregiver's educational level	
Lower education	60 (20.1)
Higher education[a]	231 (77.5)
Missing	7 (2.35)
Questionnaire respondent	
Father	37 (12.4)
Mother	251 (84.2)
Missing	10 (3.36)

Table 4. Continues.

Continuous variables	Mean (SD)	Scale[f]	Min/max
Child age (years)	4.83 (1.21)		2/7
Food fussiness	3.04 (0.79)	1/5	1/5
Emotionality[b]			
Anger	2.81 (1.01)	1/5	1/5
Fear	2.00 (0.89)	1/5	1/4.5
Sadness	2.19 (0.83)	1/5	1/4.5
Positive emotions	4.23 (0.75)	1/5	1/5
Negative emotions[c]	2.34 (0.71)	1/5	1/4.33
Emotion regulation[d]			
Anger	3.59 (0.91)	1/5	1/5
Fear	3.79 (0.89)	1/5	1/5
Sadness	3.91 (0.79)	1/5	1/5
Positive emotions	3.65 (0.89)	1/5	1/5
Negative emotions[e]	3.76 (0.72)	1/5	1/5

Abbreviations: SD, standard deviation.
a) Bachelor's degree or higher.
b) Emotionality variables are a mean of two emotionality items from the Emotion Questionnaire.
c) Mean of the emotionality variables for anger, fear, and sadness.
d) Regulation variables are a mean of two regulation items from the Emotion Questionnaire.
e) Mean of the regulation variables for anger, fear, and sadness.
f) Response scale of the measure.

The table 4. also displays means and standard deviations for the main variables. The prevalences of moderate or higher and severe food fussiness according to the cut-offs by Steinsbekk and colleagues are presented in table 5. for the whole sample, and for the Finnish and Polish subsamples. The prevalence of food fussiness was higher in the Polish subsample than in the Finnish subsample but only the difference in the prevalence of moderate or higher food fussiness between the countries was statistically significant.

Table 5. Prevalence of moderate or higher and severe food fussiness.

	Total sample (N=298) % (N)	Finland (N=118) % (N)	Poland (N=176) % (N)	P-value[c]
Moderate or higher[a]	56.0 (167)	49.2 (58)	60.8 (107)	**0.049**
Severe[b]	41.3 (123)	35.6 (42)	44.9 (79)	0.112

a) Cut-off 3.00 for the mean of the food fussiness subscale of the Children's Eating Behavior Questionnaire.
b) Cut-off 3.33 for the mean of the food fussiness subscale of the Children's Eating Behavior Questionnaire.
c) Chi-square test for the difference between the countries.

5.2 Correlations

Correlations between emotionality, emotion regulation and food fussiness can be seen in table 6. The emotionality and regulation variable pairs for anger, fear, and sadness were negatively correlated with each other but the emotionality and regulation variables concerning positive emotions were not correlated. Moreover, the emotionality variables of the negative emotions were positively correlated with each other, supporting the rationality of constructing the combined variables out of the negative emotions, as an addition. Furthermore, all the regulation variables were positively correlated with each other. Food fussiness had a significant correlation only with anger regulation, and that correlation was negative.

Table 6. Correlations between emotionality, emotion regulation and food fussiness. Correlations between emotionality-regulation pairs are bolded.

	1	2	3	4	5	6	7	8
1. Anger emotionality								
2. Anger regulation	**-0.409*****							
3. Fear emotionality	0.264***	-0.177**						
4. Fear regulation	-0.215***	0.549***	**-0.328*****					
5. Sadness emotionality	0.373***	-0.226***	0.434***	-0.142*				
6. Sadness regulation	-0.190**	0.478***	-0.197***	0.543***	**-0.173****			
7. Positive emotionality	0.066	-0.008	-0.083	0.056	-0.106	0.095		
8. Positive regulation	-0.239***	0.486***	-0.224***	0.488***	-0.144*	0.420***	**0.014**	
9. Food fussiness	0.096_a	-0.149*	-0.018	-0.103	0.031	-0.094	-0.095	-0.108

a) Pearson correlation (otherwise Spearman's rho).
*** = p < 0.001
** = p < 0.01
* = p < 0.05

5.3 Linear regression analyses

The results of the linear regression analyses are displayed in table 7. Concerning the independent association of ER with food fussiness, only the regulation of anger was significantly associated with food fussiness – both in the unadjusted and in the adjusted model. Higher anger regulation was associated with lower food fussiness score. The regulation of negative emotions had a significant negative association with food fussiness in the unadjusted model but not anymore in the adjusted one

In addition, the association of the regulation of positive emotions was quite close to significance in the unadjusted model (p=0.069) and in the unadjusted interaction model (p=0.054). Regarding the independent association of emotionality with food fussiness, except for positive emotionality in the interaction model, none of the emotionality variables had a significant association with food fussiness. Furthermore, none of the interactions of emotionality and regulation were statistically significant. Overall, the coefficients of determinations (R^2) of the models were small. That is likely mostly due to the fact that food fussiness is a multifactorial eating behavior. The highest R^2 was in the adjusted model of anger – it explained 6.8% of the variance in food fussiness.

Out of the confounding variables, questionnaire respondent was a significant predictor of food fussiness in every model. Mothers evaluated their children as having less fussiness than fathers. However, of note, evaluation by mothers and fathers of the same child are not compared here. Country was a significant predictor in models of anger, sadness and positive emotions. Polish children were perceived as fussier by their caregivers than Finnish children. Moreover, gender was a significant predictor in the model of fear, so that boys were perceived as fussier but the p-value was very close to 0.05. The results of these associations need to be taken with extra caution because they were not the primary interests of this study.

Table 7. Associations of ER and emotionality variables to food fussiness and the interaction of emotionality and ER.[a]

Anger				
Model	Adjusted R^2 (p-value)	B	95% CI	P-value
Unadjusted ER (N=272)	0.020 (0.010*)			
Anger regulation		-0.137	[-0.241, -0.032]	0.010*
Unadjusted EM (N=272)	0.006 (0.113)			
Anger emotionality		0.076	[-0.018, 0.170]	0.113
Unadjusted interaction (N=267)	0.014 (0.082)			
Anger regulation		-0.192	[-0.495, 0.111]	0.214
Anger emotionality		-0.061	[-0.419, 0.297]	0.738
Regulation x emotionality		0.023	[-0.075, 0.120]	0.645
Adjusted (N=252)	0.068 (0.001**)			
Anger regulation		-0.140	[-0,259, -0.021]	0.022*
Anger emotionality		0.027	[-0.079, 0.134]	0.617
Child age		0.055	[-0.033, 0.143]	0.217
Child gender (boy)		0.191	[-0.004, 0.387]	0.055
Country (Poland)		0.293	[0.082, 0.503]	0.007**
Respondent (mother)		-0.389	[-0.670, -0.108]	0.007**
Caregiver education (higher)		0.035	[-0.216, 0.286]	0.783

Table 7. Continues.

Fear				
Model	Adjusted R^2 (p-value)	B	95% CI	P-value
Unadjusted ER (N=272)	0.003 (0.165)			
Fear regulation		-0.076	[-0.183, 0.031]	0.165
Unadjusted EM (N=272)	-0.003 (0.726)			
Fear emotionality		-0.019	[-0.127, 0.088]	0.726
Unadjusted interaction (N=270)	0.000 (0.375)			
Fear regulation		-0.150	[-0.385, 0.084]	0.208
Fear emotionality		-0.152	[-0.530, 0.225]	0.428
Regulation x emotionality		0.028	[-0.077, 0.132]	0.604
Adjusted (N=255)	0.044 (0.011*)			
Fear regulation		-0.086	[-0.207, 0.036]	0.167
Fear emotionality		-0.049	[-0.171, 0.073]	0.432
Child age		0.018	[-0.069, 0.105]	0.684
Child gender (boy)		0.196	[0.001, 0.390]	0.049*
Country (Poland)		0.207	[-0.009, 0.424]	0.061
Respondent (mother)		-0.424	[-0.704, -0.144]	0.003**
Caregiver education (higher)		-0.014	[-0.263, 0.234]	0.909
Sadness				
Model	Adjusted R^2 (p-value)	B	95% CI	P-value
Unadjusted ER (N=274)	0.005 (0.133)			
Sadness regulation		-0.092	[-0.213, 0.028]	0.133
Unadjusted EM (N=270)	-0.002 (0.532)			
Sadness emotionality		0.037	[-0.079, 0.152]	0.532
Unadjusted interaction (N=270)	-0.001 (0.442)			
Sadness regulation		-0.054	[-0.384, 0.276]	0.746
Sadness emotionality		0.094	[-0.452, 0.639]	0.736
Regulation x emotionality		-0.018	[-0.158, 0.121]	0.796
Adjusted (N=255)	0.047 (0.008**)			
Sadness regulation		-0.067	[-0.199, 0.064]	0.316
Sadness emotionality		0.070	[-0.057, 0.197]	0.279
Child age		0.045	[-0.044, 0.133]	0.321
Child gender (boy)		0.180	[-0.015, 0.375]	0.070
Country (Poland)		0.277	[0.051, 0.502]	0.016*
Respondent (mother)		-0.434	[-0.717, -0.151]	0.003**
Caregiver education (higher)		-0.009	[-0.264, 0.246]	0.946
Positive emotions				
Model	Adjusted R^2 (p-value)	B	95% CI	P-value
Unadjusted ER (N=270)	0.009 (0.069)			
Positive regulation		-0.100	[-0.207, 0.008]	0.069
Unadjusted EM (N=273)	0.005 (0.123)			
Positive emotionality		-0.099	[-0.225, 0.027]	0.123
Unadjusted interaction (N=269)	0.017 (0.056)			
Positive regulation		-0.613	[-1.236, 0.010]	0.054
Positive emotionality		-0.538	[-1.071, -0.005]	0.048*
Regulation x emotionality		0.122	[-0.020, 0.264]	0.092
Adjusted (N=254)	0.053 (0.005**)			
Positive regulation		-0.085	[-0.194, 0.024]	0.127
Positive emotionality		-0.092	[-0.220, 0.037]	0.161
Child age		0.047	[-0.039, 0.134]	0.283
Child gender (boy)		0.161	[-0.031, 0.352]	0.099
Country (Poland)		0.236	[0.031, 0.440]	0.024*
Respondent (mother)		-0.418	[-0.695, -0.141]	0.003**
Caregiver education (higher)		-0.043	[-0.290, 0.203]	0.730

Table 7. Continues.

Negative emotions				
Model	Adjusted R^2 (p-value)	B	95% CI	P-value
Unadjusted ER (N=278)	0.012 (0.036)			
Negative regulation		-0.139	[-0.270, -0.009]	0.036*
Unadjusted EM (N=272)	-0.001 (0.412)			
Negative emotionality		0.056	[-0.078, 0.190]	0.412
Unadjusted interaction (N=278)	0.006 (0.203)			
Negative regulation		-0.231	[-0.627, 0.164]	0.250
Negative emotionality		-0.143	[-0.733, 0.447]	0.633
Regulation x emotionality		0.039	[-0.118, 0.197]	0.624
Adjusted (N=263)	0.047 (0.007)			
Negative regulation		-0.133	[-0.286, 0.019]	0.087
Negative emotionality		0.024	[-0.134, 0.182]	0.763
Child age		0.040	[-0.046, 0.126]	0.363
Child gender (boy)		0.189	[-0.003, 0.381]	0.054
Country (Poland)		0.215	[-0.004, 0.434]	0.055
Respondent (mother)		-0.405	[-0.682, -0.128]	0.004**
Caregiver education (higher)		-0.001	[-0.249, 0.247]	0.992

a) Separate linear regression models were created to test the associations for each emotion.

Abbreviations: B, regression coefficient estimate; CI, confidence interval; ER, emotion regulation; EM, emotionality.

** = $p < 0.01$

* = $p < 0.05$

6 DISCUSSION

The objective of this study was to investigate the independent associations of emotion regulation and emotionality with food fussiness, and whether emotion regulation and emotionality interact in predicting food fussiness. In addition, the prevalence of fussy eating behavior, based on cut-offs for the CEBQ subscale score (proposed by Steinsbekk et al. (32)), was examined. Novel aspects in this study were that ER and emotionality were assessed separately for anger, fear, sadness, and positive emotions/exuberance, and that ER and emotionality were treated as separate variables and also adjusted for each other when examining their independent associations to food fussiness.

6.1 Principal results

The results were partly in accordance with my hypothesis which was that the regulation of anger, fear and sadness would be negatively associated with food fussiness, and the emotionality of those emotions would be positively associated with food fussiness. Indeed, one association between ER and food fussiness was found in the adjusted models. Better (down)regulation of anger was associated with lower food fussiness. Regulation of negative emotions (mean of the regulation variables of anger, fear and sadness) was significantly negatively associated with food fussiness in the unadjusted model but not in the adjusted one. On the contrary to previous research (8) and my hypothesis, none of the emotionality variables were associated with food fussiness. In addition, no interactions between emotion regulation and emotionality were found indicating that in this sample emotion regulation did not moderate the association between emotionality and food fussiness.

6.2 Comparing results to previous research

The prevalence of food fussiness. The food fussiness mean in this sample was over a cut-off (3.00) for moderate or higher picky eating proposed by Steinsbekk et al. (32), and it was slightly higher than in several previous studies with similar samples (33,66,67,71). Previous research has yielded a wide range of prevalence estimates for food fussiness (~5% to ~70%) (16,17) but the prevalence, moderate or higher (56%) and severe (41%), in the total sample of the present study was closer to the high end of that range. The wide prevalence range of previous studies has been observed in preschool-aged children (albeit also among other ages) and mainly in Western developed countries, like USA and UK, although including some Eastern countries, especially China (16,17). The assessment methods

of food fussiness have varied, and they have mostly been other than the CEBQ (16,17), since it is usually treated only as a continuous variable. However, according to Samuel et al. (17), in studies that have reported a prevalence closer to the low end of the range have usually used more stringent levels of fussiness to classify the children as fussy eaters (e.g., very/always picky). Hence, the wide range of prevalence estimates is likely mainly due to the variation in the assessment methods of food fussiness. In the present study the prevalence of moderate or higher fussiness was significantly higher in Polish children compared to Finnish children (61% versus 49%, p=0.049). Of note, there may be problems with statistical power – especially the size of the Finnish subsample was rather small (N=118). In the study where the cut-offs for the CEBQ food fussiness subscale were created (32), 26% (assessed with PAPA) of the children were moderately or severely picky eaters, and 4.9% displayed severe pickiness. Those children (N=752) were Norwegian and 6 years old, but the different prevalence compared to this study is probably due to the different assessment method. The cut-offs have also been tested in a Swedish sample (N=1272) of 3–8-year-olds (33). In that sample 47% were moderately or severely picky, and the proportion of severely picky eaters was 30%. These values are closer to the values in the Finnish sample of this study. It can be speculated that this could be explained by the fact that Sweden is likely culturally closer to Finland than Poland. The prevalence of food fussiness in the Swedish sample might also be more accurate because of the bigger sample size, or the inclusion of also 7- and 8-year-olds might affect as well.

Emotion variables. The distributions of the emotion variables were partially similar to distributions in the validation study of the EQ by Rydell et al. (41) (albeit those variables were derived from the long version). The emotionality variables of negative emotions, except for anger emotionality, were positively skewed (more children with lower emotionality), and the regulation variables of anger, sadness and positive emotions were negatively skewed (more children with better regulation). However, the positive emotionality variable was negatively skewed in the current sample, unlike in the validation study where it was positively skewed. Additionally, unlike in the validation study where fear regulation was not skewed, it was also negatively skewed in this sample. Regarding the intercorrelations of these emotion variables, the emotionality and regulation variable pairs for anger, fear, and sadness were negatively correlated with each other which is consistent with what Rydell et al. (41) reported in the validation study. However, contrary to what they reported, the emotionality and regulation variables concerning positive emotions were not correlated in this sample. Moreover, the fact that all the regulation variables were positively correlated with each other suggests that regulation capacities tend to encompass all emotions (41); if one has good regulation it likely applies to all emotions.

The association of ER to food fussiness. The direction of the association between anger regulation and food fussiness in this study was similar to the associations of overall ER or related concepts to food fussiness found in previous studies (38,69,73,75,76). However, especially the measures of ER differ from the one used here. Fernandez et al. (38) who found that higher emotion regulation was associated with belonging to a low picky eating trajectory over five years (4-year-olds at baseline) in the USA, used the emotional regulation subscale of the ERC to assess ER. This subscale is said to assess situationally appropriate affective displays, empathy, and emotional self-awareness (63). As a matter of fact, the other subscale of the ERC (lability/negativity) is said to assess lack of flexibility, mood lability, and dysregulated negative affect (63), thus it likely also measures regulation. In addition, it has two items that I argue to be the most similar with the ER items of the questionnaire used in this study. Those are: "Can recover quickly from upset or distress", and "Can modulate excitement" (77). Hence, it seems that both subscales of the ERC assess aspects of emotionality as well as regulation. Lower score on the lability/negativity subscale was also associated with lower food fussiness in the study by Fernandez et al (38).

Moreover, executive function is considered to reflect abilities needed for effective ER, and an executive function measure, the BRIEF-P (82) questionnaire, contains an emotional control subscale. In an Israeli study by Zohar et al. (75), a higher score on that subscale – indicating more problems in controlling emotions – was associated with baseline picky eating (item from the Child Behavior Checklist) and with picky eating four years later (Foods I like and dislike -questionnaire). The children were 2–5 years old at the baseline. However, the emotional control subscale does not have items similar to the ER items of the Emotion Questionnaire used here. Some of the items (e.g., "Easily upset" and "Reacts more strongly than others" (83)) are more comparable to the emotionality items of the EQ. However, an item "Stays disappointed for long periods" (83) could perhaps be seen as an outcome of poorer downregulation – not being easily soothed, and for example, an item: "Volatile/angry outbursts" (83) is an outcome of dysregulated anger (84). Hence, it seems that this emotional control subscale of the BRIEF-P also assesses both emotionality and regulation.

Additionally, effortful control, a self-regulatory dimension of temperament (and overlaps with executive function), is not a measure of ER but is thought to reflect ER abilities (43,50). Hence, a higher effortful control may indicate better ER as well. In a Norwegian study (69,76) higher effortful control at age four predicted lower fussiness at age six, and higher effortful control at age six predicted lower fussiness at the ages of eight and ten. A cross-sectional negative association was also found among 4–6-year-olds in the USA (69). Additionally, Reis et al. (73) found that inhibitory control (that pertains to the effortful control dimension) assessed at 18 months of age was negatively associated

with food fussiness assessed at 72 months of age in Canada. Of note, Rydell et al. (41) validated the Emotion Questionnaire against specific items of the CBQ (59), a measure of temperament, and most of the regulation items (particularly for anger and positive emotions) were related to soothability, attentional focusing and inhibitory control scales of the CBQ. The soothability subscale is included in the dimension of negative affectivity, and attentional focusing and inhibitory control pertain to the effortful control dimension. All in all, previous studies and the present study suggest that the potential association between ER and food fussiness would be negative even though some of the measures in previous studies seem to assess aspects of emotionality as well.

No association between emotionality and food fussiness. The fact that the emotionality variables were not significantly associated with food fussiness in this study does not support the association between negative emotionality or negative affectivity and food fussiness found in many previous studies (8). Especially the mean of the emotionality variables of anger, fear, and sadness (negative emotionality) computed in this study is comparable to those concepts, and it did not have an association with food fussiness. Higher (negative) emotionality (EAS temperament survey (58)) or higher negative affectivity (CBQ) have had a positive association with food fussiness – among varying age ranges but including preschool aged children – in several cross-sectional (66,67,69,71) and several longitudinal observational studies (24,27,72,76). However, the assessment methods are not identical to the one used in this study, and sample sizes have differed. This study, in fact, had a somewhat larger sample than some of the previous studies – especially the cross-sectional ones.

6.3 Interpreting the results

This seems to be the first study that, among research on food fussiness, properly separated the assessment of emotionality and its regulation and included them in the same model predicting food fussiness (albeit the absolute separation of these two concepts is controversial (43)). The EAS temperament survey for children, which includes the emotionality subscale, does not have items that would directly assess any regulatory aspects of emotion; thus they are not accounted for in studies using that measure. Additionally, both subscales of the ERC seem to have items assessing both emotional reactivity and regulation (77). Moreover, the negative affectivity dimension also includes soothability, which describes downregulation of emotion. Thus, previous studies have either not adjusted for regulation, or the variables have mixed emotionality and regulation. In addition, only the regulation of anger (not emotionality) had an association in this study. Hence, could it be that the association between these concepts and food fussiness is, in fact, either entirely or more attributable

to the regulatory aspects related to emotions. Could the ability to regulate negative emotional states be more important than whether one is highly emotionally reactive? However, when regulation is not accounted for the association between negative emotionality and food fussiness shows. This can also be speculated because a child appearing to be highly emotional can also, in fact, indicate poorer ER (41). However, the lack of association between emotionality and food fussiness in the unadjusted models of this study does not support this.

The fact that only the regulation of anger – not other emotions – was significantly associated to food fussiness suggests that out of the negative emotions specifically anger (and in this sample only its regulation) would be related to food fussiness. Earlier research has not examined anger, or other emotions, separately but the measures include anger. Anger is measured in the negative affectivity dimension of the CBQ – as well as are fear and sadness. However, the emotionality dimension of the EAS questionnaire does not distinguish these emotions but refers to the general feeling of upset, and fussing and crying, which makes it more difficult to compare to. The theory behind it, however, restricts it into anger and fear, and their developmental precursor, distress (58). Nevertheless, the anger statements of the EQ include being angry or falling in a bad mood, ergo it likely overlaps with the items of emotionality in the EAS. In addition, the ERC evaluates both positive and negative emotions, including anger.

Contemplating the possible mechanisms by which anger regulation could influence fussy eating behaviors, indirect effects through caregiver-child interactions could be speculated. Child temperament has been identified as an important factor in how children behave in the feeding environment, interact with caregivers in feeding situations and influence parental feeding practices (15). For example, enhanced availability and autonomy support (feeding practice) mediated the association between temperament and vegetable consumption among Finnish preschoolers (85). One proposed explanation for how negative emotions, and therefore likely also their regulation, could contribute to fussy eating behavior is that children expressing high negative emotionality may react strongly to food and within feeding/eating situations which may contribute to a negative atmosphere and result in food refusal (24,66). That in mind, out of the studied emotions, anger may be the most likely to contribute to adverse caregiver-child interactions or even conflicts at mealtimes since especially dysregulated anger can lead to problematic behavior, such as tantrums (41,84). Perhaps this may also lead parents to use feeding practices that can result in or exacerbate fussy eating behavior, such as pressuring the child to eat (10,23). Of note, Lepinioti et al. (86) found that parent-reported conflicts during mealtimes were positively associated with picky eating, albeit the study was cross-sectional – thus the causal relationship is unclear.

It could be speculated whether emotional undereating can partly be responsible for food rejections among fussy eaters when feeling, for example, anger – perhaps especially if it cannot be downregulated. It is deemed natural that appetite and food intake decreases when intense (negative) emotional arousal is present (12). Additionally, emotional undereating and food fussiness subscales of the CEBQ have been reported to correlate (25,29) and were combined with satiety responsiveness and slowness in eating to indicate food avoidance trait in one study (69). However, according to Stifter and Moding (15), it is more plausible that anger, being an "approach emotion" would result in overeating, and fear that is related to withdrawal or avoidant behavior, in turn, would result in undereating. This is supported by the fact that fear has been linked to food neophobia (13,21). The food fussiness subscale used in this study contains items that reflect food neophobia. However, in the present study, neither fear emotionality nor regulation were associated with food fussiness.

When thinking about specifically regulation, it can be speculated that good regulation could inhibit or diminish the negative emotional reactions around food or other emotional states that can affect eating. It has been speculated that children who have high effortful control would be able to inhibit the fussy reactions to food which are likely reactive/reflexive and to activate an alternative and more appropriate response (69). These likely involve emotional aspects as well. Moreover, Reis et al. (73) speculated that better control, including emotional, and lower impulsivity might lead to greater enjoyment of food in general. This could be protective of food fussiness, if it is reflected in liking of a variety of different foods, for instance (73). Hence, to summarize, if the child's anger is involved in the fussy reactions to food or in the aversive interactions with caregivers at mealtimes, it seems plausible that the downregulation of anger would be important in diminishing or inhibiting food fussiness. However, all of these speculated mechanisms assume that the child feels anger or is upset specifically at mealtimes.

Parenting practices or feeding practices were not assessed in the present study, but they may be important confounders in research on temperament or ER and food fussiness, since they have been associated with both food fussiness (10) and temperament (15,70). However, if parenting practices or feeding practices mediate the effects of temperament or ER on food fussiness, they cannot be considered as confounders. Stifter and Moding (15) have also pointed out that "In many cases, direct effects of temperament on eating behavior are non-significant, likely due to the bi-directional and transactional nature of the parent-child relationship".

Research on food fussiness has been mostly conducted in developed countries, and this study does not break that pattern. However, it is important to point out the possible effects of cultural aspects

concerning this study because data from two countries was utilized, albeit both of them are European developed countries. In addition, the prevalence of food fussiness indeed was higher in the Polish subsample than in the Finnish subsample. Furthermore, country was a significant predictor of food fussiness in the models of positive emotions, sadness and anger. For example, Taylor et al. (16) have pointed out that culture should be taken into account when studying food fussiness, and more research in developing countries is needed. Cultural background likely shapes parenting styles and feeding practices (16), and it could be speculated that food- and eating-related cultural differences can affect the development of picky eating. In addition, these probably influence caregivers' perceptions of food fussiness in a child (16), and perhaps also influence how caregiver's interpret the assessment questions. However, culture probably is an even more important aspect to consider when studying emotions and their regulation. Culture influences, among other things, rules of appropriate emotional display and behavior in emotion-evoking situations through, for example, emotion-related norms and values of the culture (87). Hence, culture also influences caregiver emotion socialization. That, in turn, shapes the development of a child's emotional competence by contributing to the child's expression, regulation and understanding of emotion, for instance (87).

6.4 Strengths and limitations

One of the strengths of the present study was that food fussiness was measured with a widely used and validated tool, which is beneficial particularly for the comparison of studies. Furthermore, even though, to my knowledge, the Emotion questionnaire is not that extensively validated, and it has not been used in studies on food fussiness, it had novel aspects. It was designed to measure emotionality and emotion regulation as separately as possible, and emotionality and ER were used as separate variables. Additionally, the EQ measures these concepts separately for different emotions. In addition, the fact that there were participants both from Finland and Poland, increased the cultural variation in the sample, albeit they both are developed Western countries. Thus, the results may be generalizable to a larger number of populations versus if there were data only from one country. Moreover, the sample size in the current study was somewhat larger than in some former studies on the associations of ER (or related concepts) or emotionality to food fussiness (e.g., 66,71,73). Furthermore, there are strengths in the use of confounders. Especially the fact that there were enough other caregivers than mothers (in this case fathers) who had evaluated their children so that it could be accounted for was an advantage. In previous research mostly only mothers have evaluated the children (24,27,38,66,68,71,73,75). In addition, the educational level has not been used as a

confounder in many former studies (27,66,68,71,75), but it seems plausible that the educational level of a caregiver could affect the child's emotion regulation and food fussiness at least through some parenting practices or the above-mentioned caregiver emotion socialization.

There are limitations that need to be considered when interpreting and generalizing the results of this study. Firstly, the cross-sectional design of this study does not allow causal interpretations. Hence, it is possible that food fussiness influences anger regulation rather than vice versa, or the association could be bidirectional. However, prior studies (including longitudinal) support the direction that emotion regulation would be a predictor of food fussiness (38,69,73,75,76). In addition, the association between anger regulation and food fussiness might still be partly or completely caused by another factor that was not taken into account in this study – confounding due to unknown or unmeasured confounding factors is always an issue in observational studies. For example, caregivers' mental health or temperament and income level of the family as well as parental food fussiness are potential confounders that were not measured. In addition, Steinsbekk et al. (76) noted that genetic covariance between temperament and eating behavior has been reported; it is possible that food fussiness and temperament features that have been linked to it (high emotionality and low regulation) might stem from common genes. Hence, this covariance might, at least partly, explain the association found in this study as well. In addition, one source of error and bias is the fact that the methodology used in this study was designed for the application feasibility study (78) – not for the research questions examined here. Hence, for instance, sample size was not calculated for this study and could be inadequate, and confounding factors were not chosen for the purposes of this study.

The sample of this study was rather homogenous especially concerning caregivers' educational level. It is rather common that participation rate is higher among socioeconomically advantaged participants. Moreover, especially the Finnish subsample consisted only of ECEC centers located in Helsinki – the capital of Finland. The Polish subsample was somewhat more heterogenous, including both rural and urban centers, as well as both public and private. Nevertheless, these subsamples were not representative of the entire preschool population in these countries. These factors limit generalizability to sociodemographically different populations. However, the fact that the preschools were mostly public can mean that there was more variation in socioeconomic status in this sample than if the proportion of private preschools were higher. These results may also not be generalizable to other ages, since especially ER develops with age (56). Furthermore, Poland had a higher participation rate than Finland (92% versus 56%). This may partly be due to differences in the recruitment procedures. In Poland the research team went to present the study into the ECEC centers where also caregivers were present, and the informed consents were obtained during those visits,

whereas in Finland, no such meetings were organized but the informed consent forms were sent to caregivers via the centers. Although the fact that all of the children in the participating groups were asked to take part in this study is favorable in terms of generalizability, it also poses potential problems because there might have been children with, for example, autism spectrum or ADHD diagnoses, both of which have been associated with at least food fussiness (10) and may have potentially distorted the results.

6.4.1 Methodological considerations

Biases and errors concerning the measurement tools need to be addressed as well. First of all, one weakness is that, to the best of my knowledge, neither the EQ nor the food fussiness subscale of the CEBQ have been validated in Poland or Finland. Additionally, to my knowledge, the EQ has not been validated in 3–4-year-olds. However, it has similarities with the CBQ which has been validated in this age group (59). Secondly, the short version of the EQ is likely less reliable than the full version – one reason being that the full version also provides some contexts (e.g., for anger: "My child is forbidden to do something he/she wants to do") (41) for evaluating the concepts which may help caregivers. Thirdly, regarding common method biases, perhaps the most relevant for this study is common rater bias (88) since both the emotion regulation and food fussiness of the child was evaluated by a same person (except for few cases). This can be an issue, for example, because it is common for people to want to appear consistent and rational in their responses (88). Thus, they might look for similarities in the questions or organize information in consistent ways (88). The fact that caregivers have attributed their child's fussy eating behavior to the child's temperament in qualitative studies (23) imply that the participants of this study might have already thought that there is an association between the assessed concepts and might have therefore responded to the questionnaires in a way that distorts the real relationship. Moreover, social desirability bias may have skewed the answers to the questionnaires (88) – perhaps especially for the EQ. This might be the case especially for the positive emotionality items because a particularly large proportion of the children were evaluated to have high positive emotionality (the mean was 4.23, strongly positively skewed distribution). Overall, it could be speculated that children's negative emotions can be underestimated, and positive emotions overestimated due to social desirability, for example, if caregivers consider these as indicators of their attributes as a parent. Another potential bias that particularly regarding psychometric measures concerns the willingness to use the extreme ends of a Likert scale – some people are more willing than others regardless of the actual level of the measured construct they have (88). The reliability and accuracy of caregivers' perceptions of their child's attributes and behavior

should be taken with caution altogether, even if the questionnaires are validated, because different caregiver or child characteristics, such as caregivers' mental health or temperament (15), can influence the perceptions. Other potentially influencing factors include caregivers having differing interpretations of the questions and having varying amounts of experience with other children which affects the range of different children they compare their own to (15). Moreover, the fact that questionnaire respondent was a significant predictor of food fussiness in this study, although not being a variable of interest in the research questions, remarks that it could be beneficial if more than one person, e.g., two parents, filled in these kinds of questionnaires since the perceptions may vary. These mentioned sources of bias may be especially prevalent since all the questionnaires were filled at home and approximately at the same point in time – separating the measurements temporally and by location are ways to reduce these sources of bias (88). Additionally, at home the caregivers are more likely to be distracted when filling the questionnaires.

Reflecting the complexity and ambiguousness of the constructs of food fussiness and emotion regulation (including temperamental), the assessment methods of these constructs require further discussion. With regards to the food fussiness questionnaire, albeit being a widely used validated measure of food fussiness, the subscale of the CEBQ can have some limitations. Steinsbekk et al. (32) reported that this measure may not be reliable in separating moderate food fussiness from more severe cases. This seems possible also in the light of the results of this study because the prevalence of severe food fussiness was not much lower than that of moderate or higher. Steinsbekk et al. created the cut-offs for the subscale of the CEBQ using the psychiatric assessment (PAPA), and particularly the risk of false positives was high when only severe fussiness was screened with the cut-offs. Brown et al. (68) also mentioned that it is thought that this measure captures "typical" fussiness, that is, milder forms of fussiness that can be considered developmentally normal for children. The subscale of the CEBQ assesses food fussiness by statements about how the child behaves and reacts around food (29). It does not directly measure whether the assessed behavior leads to any of the possible consequences of food fussiness, like limited amount of food eaten, substantially reduced dietary diversity, or having to provide different meals from the rest of the family. This could be one reason for the inability to detect severe cases. Regarding the items of this questionnaire, I argue that specifically the items "My child enjoys a wide variety of foods" and "My child is difficult to please with meals" leave more room for subjective interpretations. It can be speculated, for instance, that caregiver's notions of what is a wide variety of foods might differ notably. Nevertheless, this measure is likely more reliable and accurate than asking a single question, such as "Is your child a picky eater?". Considering the assessment or identification of food fussiness in general, one factor that can

complicate things is the seemingly quite large between-person variance in the forms of food fussiness. For instance, different types of foods can be rejected among picky eaters, even though, for example, vegetables are commonly rejected (17,18). This affects the nutritional consequences of food fussiness. Additionally, picky behavior might change in different situations/contexts, and the food preferences of some children may fluctuate often (23), for instance. This is a problem because these individual differences in how food fussiness manifests (including severity and persistence) can be important factors in determining whether it needs intervention, especially because the adverse consequences of food fussiness likely vary as a function of these factors (17). In addition, it could be speculated that the determinants of food fussiness might be different for different forms. A commentary by Zucker et al. (19) claims that it is common for children to be choosy about food occasionally and that it probably is adaptive and even beneficial. However, more severe and more often occurring and persistent fussiness is not adaptive nor common (19). Additionally, relying on caregivers to assess their children's fussy eating behaviors can be questioned; caregivers may misinterpret the child's self-assertion and personal preferences in eating (75), for instance. However, food fussiness, like young children's eating in general, is intertwined with the interactions between the child and the caregivers, and it can affect the caregiver as well (10). From this point of few, caregiver-report measures could be considered reasonable.

In terms of emotion regulation, the Emotion Questionnaire, that is largely comparable to certain items in the CBQ, assesses the ability to downregulate anger, fear, sadness and positive emotions/exuberance by oneself or by the help of another person (41). It is thus a rather general and crude measure of ER – not providing detailed information on the regulation processes. According to Gross (45), the downregulation of negative emotions is generally, in many cases, adaptive. However, sometimes upregulation can be appropriate, and, for example, if the downregulation is done by suppressing emotions, it is likely maladaptive in the main (45). Moreover, this measure seems to only assess regulation that happens quite late in the emotion-generative process – when emotion is already well developed, but regulation occurring in other stages in that process could be important as well (albeit it is probably almost impossible to measure regulation occurring at these different stages in children). Furthermore, one quite major limitation of this questionnaire is that it does not assess which regulation strategies are used by the child and the caregiver; it does not provide information on how the downregulation happens. This is a potential problem because different strategies can have very different effects (42,45). For example, regarding eating behavior, if a caregiver uses food to sooth the child (as an emotion regulation strategy), it may lead the child to overeat as a response to negative emotions (13). On the other hand, it could be speculated that it might also increase the liking of foods

(often energy-dense, like confectionary) that are used for these purposes, and thus increase pickiness towards healthier foods. Other strategies, in turn, can potentially have opposing effects. Furthermore, the debate about the difficulties in separating emotion (emotionality) from its regulation (43,47,53) concerns this questionnaire as well. Caregivers evaluate their child's emotions and their regulation mainly based on what is expressed outwards. While this is considered a valid method, there is a possibility that, for example, a child who is low in emotionality, is evaluated as having good regulation, even though it might not be true (41). It might be that both the emotionality items and regulation items of the EQ partly reflect both constructs. However, it seems probable that if a child is highly emotional, they would also tend to have difficulties in regulation. This is supported by the significant negative correlation seen between the emotionality and regulation variables demonstrated in this study as well.

6.5 Implications and future research

Because eating behaviors develop early in childhood and tend to be stable over time (1,2), thus having potential implications for health also later in life, it is important to find ways to promote the formation of healthy eating habits already in young children. Food fussiness is one eating behavior that can compromise this and therefore also have adverse effects for health (10,17,18). Research on the determinants of food fussiness sheds light on the factors that could be modified in order to prevent the development of fussy eating behavior, or to diminish it. It can also inform the help and guidance that is provided for the caregivers on how to react to and manage with fussy children, since it is often worrying for caregivers. Thus, this type of research forms an initial knowledge base for designing interventions and eventually clinical practice. Especially also knowledge concerning what kind of individual factors should be taken into account in interventions for different fussy eaters is important. One solution likely does not fit all food fussy children. In the case of preschool-aged children, knowledge on determinants of food fussiness might be utilized in the planning of ECEC curriculum as well.

The present study adds to the literature on possible determinants of food fussiness assessed with the CEBQ subscale in preschool-aged children. It seems that emotion regulation aspects may be involved in the development or continuation of fussy eating behavior. Hence, supporting the development of socioemotional skills, including emotion regulation, in children could also aid in the prevention or management of food fussiness. The intrinsic factors of children, that are characteristic for fussy eaters, can also inform what kind of parenting or feeding practices caregivers should employ since, for

example, children with different temperaments may respond differently to the same feeding practice (13,15). Thus, for example, mealtimes could be structured according to the child's individual characteristics, and in a way that diminishes fussy behavior. When it comes to the association between anger regulation and food fussiness found in this study, perhaps at mealtimes caregivers could try to create an atmosphere that would cause as little feelings of anger as possible.

However, more research is needed to replicate and confirm the association found in this present study, and to further investigate the role of ER, including the mechanisms through which it might affect food fussiness. Especially longitudinal research is required to investigate the cause-and-effect relationship. In addition, assessing food fussiness and ER at several time points would provide information on their trajectories and the associations over time. This is particularly important for discovering the optimal time for interventions. Eventually, of course, interventions would be ideal – assuming that children's emotion regulation can be influenced by interventions.

One subject of study concerning food fussiness, that could be fruitful, is studying the emotional aspects, including regulation, specifically at mealtimes. Regarding the assessment tool of food fussiness, future research could focus more on studying the determinants of severe and more persistent forms of food fussiness, although adequate sample sizes might then be more difficult to obtain. The CEBQ subscale used here may not capture the more severe forms well. The PAPA could be more accurate in that, but perhaps a more comprehensive questionnaire than the CEBQ subscale should be developed. Chilman et al. (10) have called for a "more holistic standardised tool that captures both the intrinsic and extrinsic features and impacts on others" in order to more readily and consistently identify food fussiness. As complementary research, it could also be beneficial to study the actual dietary intake as an outcome in addition to fussy eating behavior. One assessment tool that could be fruitful in studying particularly the associations between ER and food fussiness is the Lifestyle Behavior Checklist (89). A few of its items assess food refusal or emotion-related behavior at mealtimes: "Complains about food", "Whinges or whines about food", "Throws a tantrum about food", "Yells about food", "Behaves disruptively at mealtimes (e.g., throws food, leaves his/her seat)", and "Refuses to eat food presented". Another useful tool or method in studying emotions and their regulation at mealtimes could be the Ecological Momentary Assessment (90).

In terms of the assessment of ER, future research could benefit from using tools that asses the ER strategies children employ especially because of the difficulties in differentiating emotionality from ER. At least one questionnaire that assesses these strategies in preschool-aged children exists (51). In addition, the interaction of emotionality and ER could be studied with a person-centered approach as

well. Furthermore, I concur with the remark by Taylor et al. (16) that more research in different countries with different cultures or in more ethnically diverse samples is needed – especially in developing countries or lower-income countries. In addition, the proportion of socioeconomically disadvantaged samples and participants should be increased.

7 CONCLUSIONS

The present study represented novel insights into the role of emotions in fussy eating behavior among preschool-aged children. This was the first study that, compared to previous research on food fussiness, assessed emotionality and emotion regulation separately for anger, fear, sadness, and positive emotions/exuberance. Additionally, emotionality and ER were separated more accurately than in previous research. In this study the downregulation of anger was significantly negatively associated to food fussiness. The direction of this association was in line with previous research on food fussiness and ER or parallel concepts. The results of this study suggest that specifically anger would be associated with food fussiness, and that it would be specifically its regulation. Neither the emotionality of anger nor any of the other emotions had a significant association with food fussiness. Thus, this study does not support the frequently found association between emotionality measured with the EAS Temperament Survey for children, or negative affectivity measured with the CBQ and food fussiness but implies that these associations might in fact be due to only anger. In addition, based on the results of this study, ER and emotionality do not interact in predicting food fussiness. However, these results need to be replicated, and these associations need to be studied with more robust designs. Particularly the causal relationship requires confirming as well as the mechanisms through which emotion regulation could influence food fussiness. Finally, this study gives support to further studying the association between emotion regulation and food fussiness. Investigating different emotions separately seems fruitful, and emotionality and emotion regulation should be controlled for with each other.

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