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The Role of Emotions, Personality traits, and Sensory Sensitivity in Preadolescents' Food Preferences

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The Role of Emotions, Personality Traits, and Sensory Sensitivity in Preadolescents' Food Preferences

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Philosophiae Doctor (PhD) Thesis

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Preface

The thesis was conducted as part of the project “EDULIA - Bringing down barriers to children’s healthy eating” that has received funding from the European Union’s Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement (No 764985).

The work was conducted at the University of Florence, SensoryLab, Italy from October 2018 to January 2022 under the main supervision of Prof. Erminio Monteleone (University of Florence, Italy) and the co-supervision of Dr. Sara Spinelli (University of Florence, Italy) and Dr. Valerie L. Almli (Nofima Ås, Norway). The thesis is submitted at the department of Agriculture, Food, Environment and Forestry (DAGRI) at the University of Florence (UNIFI) for the degree of Philosophiae Doctor (PhD).

The thesis was motivated by combined interests in children’s food choice and behavior, sensory and consumer science, method development and experimental psychology. The thesis integrates these interests aiming for a multidisciplinary approach.

This thesis consists of four parts: Part I is a general introduction to the topic, Part II focuses on the development of a self-report emoji measurement tool to measure emotions in response to food, Part III presents findings related to application of the tool and emotional responses to tasted food models, personality traits and sensory sensitivity. Finally, Part IV offers a general discussion about the research findings of the thesis.

Note, the last parts (Part III and Part IV) of the data collection were affected by the COVID-19 pandemic due to lockdowns and national restrictions to enter the schools to prevent the spread of the virus. For this reason, the data collection on the validation and application of the final questionnaire was conducted in Norway only.

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This dissertation has been dominant in my life during the last three years. It has been a privilege to be able to learn more about the role of emotions in children's food preferences, development of age-appropriate methods, personality traits, sensory responsiveness, and everything in-between every day. There have also been certain struggles, but I have benefited greatly from the help and support of others.

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The project was conducted as part of the project "EDULIA - Bringing down barriers to children's healthy eating" which has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement (No 764985). I am very grateful for this opportunity that enables young researchers so many opportunities like being involved in a multidisciplinary research project with an innumerable number of highly skilled experts in the field of children's eating behavior, participating in international conferences, enabling research stays abroad - just to name a few. Many thanks to the EDULIA team, I was very happy to be part of this very exciting and unique journey.

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My parents built the backbone that grew my interest in science and the important role of food in our daily life and its enjoyment. Thanks for broadening my horizon and supporting me in every step of my life with love and care. Finally, thanks to my sister Daniela, who is always there for me when times are difficult and when doubting myself - I do not know what I would have done without my family.

Florence, March 2022

*But **why** measure emotions in response to food?*

*Because food nourishes the **body and soul**.*

(King, 2016)

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List of abbreviations

12-PAC	12-point circumplex
2AFC	Two-alternative forced choice
ANOVA	Analysis of Variance
ANS	Autonomic nervous system
AHC	Agglomerative Hierarchical Cluster Analysis
BIS/BAS	Behavioral Inhibition System and Behavioral Activation System Scale
BSSS	Brief Sensation Seeking Scale
C1	Cluster 1
C2	Cluster 2
C3	Cluster 3
CA	Correspondence Analysis
CATA	Check-all-that-apply
CEQ	Valence x arousal circumplex-inspired emotion word questionnaire
DES-III	Differential Emotions Scale
e.g.	Exempli gratia (for example)
E3S	European Sensory Science Society
EEG	Electroencephalography
EUQ	Emoji Usage Questionnaire
fMRI	Magnetic resonance imaging
g	Grams
g/L	Grams per liter
GEOS	Geneva Emotion and Odor Scale
GF	Grapefruit juice
GDPR	General Data Protection Regulation
HMFA	Hierarchical Multiple Factor Analysis
IAT	Implicit Association Test
ICFNS	Italian Child Food Neophobia Scale
IMET	Image Measurement of Emotion and Texture
JE	Joyous exploration
LAM	Labeled Affective Magnitude Scale

LMS	Labeled Magnitude Scale
M	Mean
MAACL	Multiple Affect Adjective Checklist
mm	Millimeter
MFA	Multiple Factor Analysis
n	Number
PAD	Pleasure-Arousal-Dominance
PANAS	Positive and Negative Affect Schedule
PCA	Principle Component Analysis
POMS	Profile of Mood States
PrEmo®	Product Emotion Measurement Instrument
PROP	6-n-propylthiouracil
RATA	Rate-all-that-apply
REML	Restricted maximum likelihood
RGM	Repertory grid method
SAM	Self-Assessment Manikin
SC	Social curiosity
SD	Standard deviation
SO	Specific objective
TDE	Temporal Dominance of Emotions
VG	Vegetable broth
vs.	Versus

Abstract

Given the rise of food products targeted at children and the need of healthier products to combat the global rise of childhood obesity, children take an important role in nowadays' consumer testing. Although children between 4-11 years are already able to perform a range of consumer tests similar to adults, the assessment of children's food preferences requires engaging and age-appropriate methods. Emotions have been shown to give additional information about food products compared to hedonic measurements, however, they are understudied in children. Growing interest for emoji to measure consumer's product-elicited emotions emerged in the field of sensory and consumer science over the past years. However, previous studies often selected emoji without the consideration of how emoji are interpreted by preadolescents regarding their semantic and dimensional meanings. Moreover, research found associations between personality traits, taste responsiveness and food preferences, which constitutes another understudied topic in emotion research with children. Understanding this relationship could further help to understand factors influencing preadolescents' food preferences.

To tackle this problem, the aim of the PhD thesis was to develop an emoji-based self-report questionnaire, the Emoji Pair Questionnaire, for preadolescents consisting of a food-specific emoji list with identified emotional meaning and to validate and apply the tool to test its discriminant ability in response to food. A further aim was to investigate individual differences in emotional responses to foods by clustering children according to patterns of emotional responses and by testing the clusters for differences in personality traits, 6-n-propylthiouracil (PROP) status and sensory responsiveness to basic tastes.

A total of 711 children (9-13-y.o.) participated in seven studies, which attended primary and secondary school classes in schools based in Italy (n=454, Study 1-5) and Norway (n=257, Study 6 and 7). Study 1 identified 46 of 92 emoji as food-related and relevant for children to describe their emotions in response to food experiences. Study 2, that used projective mapping, showed that emoji were discriminated along three dimensions, that were interpreted as valence, power, and arousal. Results of Study 3 and 4, that used the Check-All-That-Apply method with emoji and emotion words respectively, were congruent in linking emoji and emotions words. Positive emoji were described by more words in general, which could be

explained by the context dependent use of emoji, which was clarified in Study 5 (qualitative interviews).

Emoji expressing similar semantic and dimensional meanings were grouped in pairs of two, based on the idea that the grouping of the two emoji with the most similar semantic and dimensional meaning allows to better identify the overall meaning of the emoji pair. Emoji with ambiguous meaning were excluded. Finally, the Emoji Pair Questionnaire contained a reduced list of 17 emoji pairs (n=34 emoji) varying in valence, power, and arousal dimension. Italian and Norwegian preadolescents were found to describe emoji with overlapping emotional meaning (Study 6), which allowed the validation and application of the Emoji Pair Questionnaire in Norway.

Findings of Study 7 showed that emoji pairs varied between food categories and were able to discriminate between familiar foods despite similar liking. Emoji also discriminated significantly among food products despite similar liking within the food categories of vegetables and desserts/juices, but not within the fruit category. The tasted samples (grapefruit juice spiked with sucrose) differed in liking and in associated emoji. Children were classified into three clusters according to their emotional patterns in Principal Component Analysis. The three clusters differed also in liking, surprise, sensitivity to reward, responsiveness to sweet, sour, and ability to discriminate between food samples.

The findings obtained in this PhD thesis illustrate that the newly developed Emoji Pair Questionnaire can be used to not only understand children's food behavior but also to develop novel products targeted at specific clusters of children considering their individual differences in emotions, personality traits and sensory responsiveness by providing target-specific products.

Keywords:

Emoji, Emotion Measurement, Preadolescents, Personality traits, Sensory Responsiveness.

Italian abstract

Dato l'aumento dei prodotti alimentari destinati ai bambini e la necessità di prodotti più salutari per combattere l'aumento globale dell'obesità infantile, i bambini ricoprono un ruolo importante nei test sui consumatori di oggi. Sebbene i bambini tra i 4 e gli 11 anni siano già in grado di eseguire una serie di test simili a quelli usati con gli adulti, la valutazione delle preferenze alimentari dei bambini richiede metodi coinvolgenti e adeguati all'età. È stato dimostrato che le emozioni forniscono informazioni aggiuntive sui prodotti alimentari rispetto alle misurazioni edoniche, tuttavia sono poco studiate nei bambini. Negli ultimi anni è emerso un crescente interesse per le emoji per misurare le emozioni suscitate dai prodotti nel campo delle scienze sensoriali e dei consumatori. Tuttavia, studi precedenti hanno spesso selezionato le emoji senza considerare come queste vengono interpretate dai preadolescenti per quanto riguarda il loro significato. Inoltre, la ricerca ha trovato associazioni tra tratti di personalità, sensibilità al gusto e preferenze alimentari, che costituisce un altro aspetto poco studiato nella ricerca sulle emozioni con i bambini. Comprendere meglio questa relazione potrebbe ulteriormente aiutare a comprendere i fattori che influenzano le preferenze alimentari dei preadolescenti.

Per affrontare questo problema, l'obiettivo della tesi di dottorato era sviluppare un questionario self-report basato su emoji, l'Emoji Pair Questionnaire, per preadolescenti costituito da una lista di emoji utilizzati per descrivere l'esperienza emozionale del cibo con un significato emotivo identificato, validare e applicare l'Emoji Pair Questionnaire per testare la sua capacità discriminante in risposta al cibo. Un ulteriore scopo era quello di indagare le differenze individuali nelle risposte emozionali agli alimenti raggruppando i bambini in base a pattern di risposte emozionali simili e testando i cluster per differenze nei tratti della personalità e nella sensibilità ai gusti (PROP status e risposta sensoriale ai gusti di base).

Un totale di 711 bambini (9-13 anni) hanno partecipato ai sette studi condotti, di cui 454, (Studio 1-5) frequentano le classi della scuola primaria e secondaria nelle scuole con sede in Italia e 257 in Norvegia (Studio 6 e 7). Lo studio 1 ha identificato 46 su 92 emoji come correlate al cibo e rilevanti per i bambini per descrivere le loro emozioni in risposta alle esperienze alimentari. Lo studio 2 (projective mapping) ha mostrato che le emoji sono state discriminate lungo tre dimensioni, che sono state interpretate come valenza, controllo e attivazione. I

risultati dello studio 3 e 4 (CATA) erano congruenti nel collegare le parole emoji ed emozioni. Le emoji positive sono state descritte da più parole in generale, il che potrebbe essere spiegato dall'uso dipendente dal contesto delle emoji, che è stato chiarito nello Studio 5 (interviste).

Le emoji che esprimono significati semantici e dimensionali simili sono state raggruppate in coppie, sulla base dell'idea che il raggruppamento delle due emoji con il significato semantico e dimensionale più simile consente di identificare meglio il significato complessivo di quelle emoji. Sono state escluse le emoji con significato ambiguo. Infine, l'Emoji Pair Questionnaire conteneva un elenco ridotto di 17 coppie di emoji (n=34 emoji) che variavano in valenza, controllo e nell'attivazione. È stato scoperto che i preadolescenti italiani e norvegesi descrivono emoji con significato emotivo simile (Studio 6), che ha consentito la validazione e l'applicazione dell'Emoji Pair Questionnaire in Norvegia.

I risultati dello studio 7 hanno mostrato che le coppie di emoji che descrivono l'esperienza emozionale al cibo variano tra le categorie di alimenti e sono in grado di discriminare tra gli alimenti familiari nonostante i prodotti non siano significativamente diversi per gradimento. Gli emoji ha anche discriminato in modo significativo tra i prodotti alimentari, nonostante un simile gradimento, all'interno delle categorie delle verdure e dei dessert/succhi, ma non all'interno della categoria frutta. I campioni assaggiati (succo di pompelmo addizionato di saccarosio) differivano per gradimento e per le emoji associate. I bambini sono stati classificati in tre gruppi in base ai loro pattern emozionali derivanti dall'analisi delle componenti principali. I tre cluster differivano anche per gradimento, sorpresa, sensibilità alla ricompensa, risposta al dolce, acido e capacità di discriminare tra i campioni di cibo.

Questi risultati ottenuti in questa tesi di dottorato illustrano non solo per comprendere il comportamento alimentare dei bambini, ma anche per sviluppare nuovi prodotti mirati a gruppi specifici di bambini, considerando le loro differenze individuali nelle emozioni, nei tratti della personalità e nella sensibilità ai gusti fornendo prodotti mirati.

List of publications

This thesis is based on the following papers:

I. Sick, J., Spinelli, S., Dinnella, C., & Monteleone, E. (2020). Children's selection of emoji to express food-elicited emotions in varied eating contexts. *Food Quality and Preference*, 85, 103953.

II. Sick, J., Monteleone, E., Pierguidi, L., Ares, G., & Spinelli, S. (2020). The Meaning of Emoji to Describe Food Experiences in Preadolescents. *Foods*, 9(9), 1307.

III. Sick, J., Monteleone, E., Dinnella, C., Pierguidi, L., & Spinelli, S. (2022). Development of an emoji-based self-report measurement tool to measure emotions elicited by foods in preadolescents. *Food Quality and Preference*, Pre-proof.

Other publications during the PhD:

IV. Olsen, A., Sick, J. C., Møller, P., & Hausner, H. (2019). No choice vs free choice: How serving situations influence pre-school children's vegetable intake. *Food Quality and Preference*, 72, 172–176.

V. Sick, J., Højer, R., & Olsen, A. (2019). Children's self-reported reasons for accepting and rejecting foods. *Nutrients*, 11(10), 2455.

VI. Ervina, E., Almli L., V., Berget, I., Spinelli, S., Sick, J., & Dinnella, C. (2021). Does responsiveness to basic tastes influence preadolescents' food liking? Investigating taste responsiveness clusters on bitter-sour-sweet and salty-umami model food samples. *Nutrients*, 13(8), 2721.

Part I Introduction

Chapter 1 Introduction, objectives, and outline of the thesis

1.1 General introduction

Investigating children's food preferences is important as they shape their eating behaviors, which can track into adulthood (De Cosmi, Scaglioni, & Agostoni, 2017; Harris, 2008; Ventura & Worobey, 2013). This underpins the importance of improving children's eating habits for health support and maintenance. Poor eating habits formed in childhood can lead to overweight and obesity and consequently lead to problematic health implications such as cardiovascular diseases, type 2 diabetes, musculoskeletal disorders and certain types of cancer (like endometrial, breast and colon) (WHO, 2020b). The worldwide prevalence of obesity nearly tripled between 1975 and 2016 (WHO, 2021). According to the World Health Organization (WHO, 2021), over 340 million children and adolescents (5-19-y.o.) were found to be overweight or obese in 2016. However, obesity and diseases associated with obesity are preventable (WHO, 2021). Adequate nutrition and healthy food choices are important for healthy human development (WHO, 2020a). With the increasing number of public health problems related to obesity in children, it is important to understand how to prevent unhealthy eating behavior and how healthy food choices can be promoted (WHO, 2020a). For the understanding of children's food choices, we need to dive deeper into the factors that influence children's eating behavior, especially how children choose between a series of similar alternative products. Consumer testing with children has mainly focused on hedonic measurements (acceptability of food products, Laureati, Pagliarini, et al., 2015). However, emotion measurements (how they feel about food products) have been shown to provide additional information beyond liking measurements that can help to better understand food experiences (King & Meiselman, 2010; Spinelli & Monteleone, 2018). This requires age-appropriate and engaging tools (Laureati, Pagliarini, et al., 2015), as children differ from adults in many aspects as for example in cognitive development (Mortimer & Shanahan, 2003).

The research described in this thesis is devoted to the development of an age-appropriate emotion measurement tool for preadolescents. Furthermore, this thesis investigates the role of emotions in children's food preferences considering foods varying in sensory properties (basic tastes) and individual differences in personality traits and sensitivity to bitterness.

This introduction commences with a brief overview of general determinants of food choice and food preferences and introduces the role of individual differences in food choice. The role of emotions in food choice will be elaborated followed by a summary of previously developed emotion measurement tools. Lastly, the objectives and research questions and thesis design are described.

1.2 Food choice and food preferences

Food choice is a complex activity with many dimensions and is multifaceted. Food choice refers to how people decide on whether, where, when, how long, how, why, with whom, for whom, and under what conditions eating occurs (Sobal, Bisogni, & Jastran, 2014). Some of the factors that influence food choice include biological (like hunger, appetite), economical (like cost, income), physical (like access, education, time), social (culture, family, meal patterns), psychological (like mood, stress) determinants and attitudes, beliefs, and knowledge about food (EUFIC, 2006; Sobal et al., 2014). Furthermore, food choices are developmental meaning that children learn and experience ways of eating and continue to accumulate and construct food choice competences and limitations as they grow older (Birch, 1999).

Children's food choices differ considerably to adults' due to several reasons. They are dominated by their parents and caregivers acting as "gatekeepers" and providing food environments and experiences with food for their children (Thomas, 1991). Conversely, children communicate their preferences to parents, thereby exerting great influence on what foods are available in the home and how they are prepared (Holsten, Deatrick, Kumanyika, Pinto-Martin, & Compher, 2012). As children start going to school, their social environment considerably influencing their food preference and choices, especially through exposure to peer influences (EUFIC, 2006; Ragelienė & Grønhøj, 2020; Thomas, 1991). Preadolescence (9-13-y.o.) is a critical period for the development of healthy eating habits as they gain more autonomy in making their own choices (ASTM, 2012). However, children may not always be aware what is good or bad for their health as they are driven by a range of factors including innate taste preferences, sensory cues, food familiarity, food availability (Birch, 1999), social norms, peer and sibling influences (Ragelienė & Grønhøj, 2020).

1.2.1 The role of emotions in food choice and liking

A great amount of research has been devoted to research focusing on the role of emotions in food choice and liking (Spinelli, Monteleone, Ares, & Jaeger, 2019). Food-evoked emotions and liking are closely related in the sense that positive emotions are related to liking, while negative emotions are related to dislike. In other words, emotions and liking fall partly into the same dimensions of valence (pleasure *vs.* displeasure).

In sensory and consumer science, a common procedure to measure food acceptance is the use of traditional hedonic liking (sensory pleasure) to understand and predict food choices and preferences (Laureati, Pagliarini, et al., 2015). In fact, products with higher liking scores are chosen more often compared to products with lower liking scores (De Graaf et al., 2005). Though, why a product is chosen goes beyond the sole measurement of product liking (Cardello et al., 2012; Jaeger & Hedderley, 2013; King, Meiselman, & Thomas Carr, 2013; Ng, Chaya, & Hort, 2013a) and there are different underlying reasons for that. For instance, besides sensory drivers (e.g., appearance, texture, smell of a product), affective drivers (like emotions) play an essential role in why a product is chosen (Jiang, King, & Prinyawiwatkul, 2014). Individuals attach emotions to foods that can be intrinsic (referring to sensory characteristics of a food product) or extrinsic (e.g., food packaging, advertisement), which can both elicit different emotions. Following, emotions can play a leading role in product experience by giving new information beyond liking and by discriminating food products more effectively by their emotional profiles (e.g., through the presence of different emotional dimensions like valence, arousal, power) in contrast to liking only (Cardello et al., 2012; Jaeger & Hedderley, 2013; King et al., 2013; Ng et al., 2013a).

However, there is a debate about what “emotions” really are and if some measurements used in sensory and consumer science are truly measuring emotions or emotional conceptualizations/associations/ feelings (Meiselman, 2016). Section 1.3.1 will discuss the definition and assessment of emotions more in depth that will help to better frame the understanding of emotions in this PhD thesis.

1.2.2 Individual differences in food choice and preferences

Individual differences constitute psychological, biological, and sociocultural factors that distinguish one person from another and thus contribute to characterize each person’s

individuality. Food preferences as well as food perception depend amongst others on (food) product characteristics, but also on individual differences related to the person itself (Köster, 2009; Pierguidi, Spinelli, Dinnella, Prescott, & Monteleone, 2019).

Individual differences in emotions have been investigated in marketing research and psychology (Haugtvedt, Herr, & Kardes, 2012) but are relatively unexplored in the field of sensory- and consumer science (Spinelli & Jaeger, 2019). However, as reviewed and emphasized by Spinelli & Jaeger (2019), investigating the role of individual differences in food-elicited emotions is important to better understand consumer's food choice. It was shown for example that individual differences in taste responsiveness and personality traits both affect sensory responses and liking (Laureati et al., 2018; Spinelli et al., 2018; Ullrich, Touger-Decker, O'sullivan-Maillet, & Tepper, 2004). Studying the role of individual differences in liking may help to clarify of whether there are sensory drivers of emotions across individuals differing in liking, or only across individuals that do not differ in liking (Spinelli & Jaeger, 2019). Jaeger & Hedderley (2013) found a relationship between psychological traits and emotional responses, where consumers who were higher in some personality trait scores (emotional intensity and private body consciousness) rated emotional words higher than those people with lower ratings of these personality trait scores. Currently, there is a research gap in studying individual differences in children's food preferences, which is however strongly encouraged when assessing emotions in children (Zeman, Klimes-Dougan, Cassano, & Adrian, 2007). The following sections will dive deeper into the role of sensory sensitivity and personality traits in food preferences.

1.2.2.1 The role of sensory properties and taste sensitivity in food preferences

Taste has been demonstrated to be one of the most important factors influencing children's food choice and acceptance (Koivisto & Sjödén, 1996; Sick, Højer, & Olsen, 2019) and is one of the drivers of children's food preferences and intake (Birch, 1999). Taste preferences were shown to vary among the five basic tastes; sweet, salty, and umami are tastes innately accepted, while bitter and sour are tastes that are innately rejected and are so-called acquired tastes. In nature, bitterness often occurs in plants that could potentially be toxic for human consumption, which serves as a natural protection to avoid eating something that could potentially harm us. However, not all bitter plants are toxic and especially with the presence of nowadays' supermarkets, the risk of eating something harmful is unlikely. Though, many

vegetables, especially green vegetables (like broccoli, peas, cauliflower) are bitter in taste (Dinnella et al., 2016) often representing a problem for individuals with high sensitivity for bitterness (Keller, Steinmann, Nurse, & Tepper, 2002; Tepper, 1998). Bitter taste is a well-known sensory barrier for liking and consumption of vegetables in adults (Drewnowski, 1997; Drewnowski & Gomez-Carneros, 2000) and children (Appleton et al., 2019; Mennella & Bobowski, 2015). Perceived intensity of bitter taste has been shown as a negative predictor of vegetable acceptance, while the opposite effect was shown on perceived intensity of sweet taste as a positive predictor on vegetable acceptance (Appleton et al., 2019; Dinehart, Hayes, Bartoshuk, Lanier, & Duffy, 2006; Mennella & Bobowski, 2015). A low intake of vegetables and fruits has been associated with increased risk for noncommunicable diseases such as obesity, cardio-vascular diseases, and cancer (Hartley et al., 2013).

Taste responsiveness, also known as taste intensity perception, varies across individuals and may influence food preferences in adults (Dinnella et al., 2018; Puputti, Aisala, Hoppu, & Sandell, 2019) and preadolescents (Ervina et al., 2021; Ervina, Berget, & Almli, 2020; Hartvig, Hausner, Wendin, & Bredie, 2014; Joseph, Reed, & Mennella, 2016). Taste sensitivity can be expressed as the ability to perceive a taste, such as sweet, sour, salty, and bitter (Lanfer et al., 2013). It can be measured by various methods such as detection and recognition thresholds, 6-n-propylthiouracil (PROP) bitterness intensity, and fungiform papillae density (Webb, Bolhuis, Cicerale, Hayes, & Keast, 2015). Individual differences in taste perception were linked with genetics (Diószegi, Llanaj, & Ádány, 2019). PROP has been associated with different chemosensory experiences (Keller et al., 2002; Tepper, 1998) and has been linked with lowered acceptance of some bitter foods, which however is less clear. For example, preadolescents with increased responsiveness to PROP have heightened responses to other basic tastes as well (Ervina, Berget, & Almli, 2020). Measures of taste responsiveness like sensitivity to bitterness (PROP status) were found to be related with perceived intensity of sensory properties and liking in adults (Dinnella et al., 2018; Prescott, Soo, Campbell, & Roberts, 2004; Shen, Kennedy, & Methven, 2016). A study by Bell & Tepper (2006) investigated the relationship between responsiveness to PROP and vegetable intake in 4-5-y.o. children and demonstrated that children with lower responsiveness to bitterness have a higher intake of broccoli, black olives, and cucumber in contrast to children with high responsiveness. Furthermore, children aged 9-11 who were high responsive for bitterness (quinine) showed a

decreased acceptance for grapefruit juice (Hartvig et al., 2014). Recently, an increasing number of studies have been devoted to the role of food-elicited emotions in sensory responsiveness. For instance, a study examining the link between PROP taste sensitivity and biologically relevant patterns of emotional responses showed that PROP supertasters reported more intense negative emotions (increased responses for anger, tension, and fear) compared to PROP non-tasters and medium tasters (Dubovski, Ert, & Niv, 2017; Macht & Mueller, 2007).

Moreover, sensory properties of basic taste stimuli (Dubovski et al., 2017) and foods (Jaeger, Spinelli, Ares, & Monteleone, 2018; Spinelli & Jaeger, 2019; Thomson, Crocker, & Marketo, 2010) were shown to evoke emotions. Bitter taste was demonstrated to elicit negative emotions, while sweet taste did not increase positive emotions (measured by the Positive and Negative Affect Schedule, PANAS) (Dubovski et al., 2017). The use of basic tastes in water solutions are common in food-related emotion research, but studies using real food and beverage products to measure this relationship is gaining increasing attention, especially in product development of food and beverage industries, and in optimization and changes in formulations (Spinelli & Jaeger, 2019). A relationship between sensory properties and emotional responses was found when comparing different product categories (Cardello et al., 2012; King & Meiselman, 2010) but also within specific product categories (Ng et al., 2013a; Thomson et al., 2010). A study by Thomson et al. (2010) revealed that specific sensory properties were associated with emotions in unbranded dark chocolate samples. “Cocoa” was linked with “powerful” and “energetic”, while “bitter” was linked with “confident, “adventurous” and “masculine”, and “creamy” and “sweet” with “fun”, “comforting” and “easy-going”. The study did not report liking measurements, which does not enable to identify the linkage between sensory properties and emotions moderated by liking.

Currently, there is a lack of research investigating the relationship between sensory responsiveness to basic tastes and emotional responses in preadolescent children. Investigating this relationship will help to better understand the factors behind food choice and food preferences to promote healthy eating.

1.2.2.2 Personality traits in food preferences

Food neophobia (the reluctance to try novel food) is a well-known trait in children affecting food preferences and was shown to lead to decreased intake of fruits and vegetables in 12-13-y.o. children (Guzek et al., 2018). This trait constitutes a problem as vegetables are part of a healthy and balanced diet. Humans consume an omnivorous diet, but in the past, it was advantageous to be cautious about what to eat as unfamiliar products could be poisonous. Consequently, a fear of unfamiliar items has served as a natural protection from an evolutionary point of view. Nowadays, food neophobia is considered as a maladaptive trait as it may lead to decreased dietary variety and poor diet quality (Kral, 2018). Though, nowadays where most foods are relatively safe to consume, food neophobia may be less adaptive resulting in a less varied diet that is low in vegetables and fruits in both children and adults. Consequently, it could be regarded as a predictor for decreased dietary variety. Furthermore, liking for vegetables with less appealing sensory properties was higher in adolescents with lower food neophobia, while liking for vegetables with more appealing sensory properties was higher in individuals with lower food neophobia (Appleton et al., 2019). PROP responsiveness ratings were negatively correlated with food neophobia scores in adults (Proserpio, Laureati, Invitti, & Pagliarini, 2018), but remains an understudied topic in children.

Sensation seeking is a further notable predictor for food choice among personality traits related to foods. In general, it is defined as an individual's increased willingness to take risks to seek new or intense stimuli (Alley & Potter, 2011). Individuals high in sensation seeking require a lot of stimulation to reach the appropriate level of arousal and they are more open to new food experiences, following they tend to be less food neophobic (Alley & Potter, 2011; Pliner & Melo, 1997). Pliner & Melo (1997) showed a relation between manipulated arousal (by having subjects play an exciting, neutral, or boring video game) and willingness to seek novel stimuli in the form of unfamiliar foods (Pliner & Melo, 1997). Moreover, sensation seeking was shown to be a positive predictor of the willingness to consume insects (Lammers, Ullmann, & Fiebelkorn, 2019) and was found to be correlated with liking of spicy food in adults (Byrnes & Hayes, 2016). In kindergarten and school-aged children, it was shown that the children's level of sensation seeking was related to their activities and their exposure to a variety of experiences, such as preference for complex puzzles and pictures (Kafry, 1982) to engagement in negative and rule-breaking behaviors and that children were more likely to

enjoy playing violent video games (Jensen, Weaver, Ivic, & Imboden, 2011). It may be hypothesized that children high in sensation seeking may also seek new or more extreme experiences related to food, but research exploring the role of sensation seeking in children's food preferences appears to be a neglected topic.

Curiosity can be generally defined as the recognition, pursuit, and desire to explore novel, uncertain, complex, and ambiguous events (Kashdan et al., 2018). There have only been a few studies that examined the role of curiosity in sensory science and consumer behavior, however, this trait was suggested to be a key predictor of willingness to try novel food (Stone, FitzGibbon, Millan, & Murayama, 2021). When adults from UK rated several food dishes (half of them contained insects) on different factors like curiosity and willingness to try the dish, it was found that curiosity predicted willingness to try dishes with and without insects above and beyond other predictors of willingness to try (e.g., attractiveness, familiarity, healthiness, and social influence). The authors concluded that curiosity is a powerful motivator of behavior, which can overcome negative emotions and motivate individuals to seek new experiences. A study on the willingness to try novel foods, of animal and nonanimal origin (familiar and unfamiliar), showed that both the interest evoked at the thought of consuming them and beliefs about disgusting properties were underlying factors of the acceptance/rejection of these foods (Martins & Pliner, 2005). Furthermore, a study investigating underlying stated reasons for food acceptance and rejection in 10-13-y.o. children found that curiosity was stated as the most important reason in girls and the second most important reason in boys (after taste) to accept unfamiliar foods (Sick, Højer, & Olsen, 2019).

It has recently been suggested that individual differences in **sensitivity to reward and punishment** influences how individuals respond to food (Byrnes & Hayes, 2013, 2015; De Cock et al., 2016, 2015; Vandeweghe, Verbeken, Moens, Vervoort, & Braet, 2016; Vandeweghe, Vervoort, Verbeken, Moens, & Braet, 2016). In adults' sensitivity to reward was positively associated with higher preference for sweet taste (Saliba, Wragg, & Richardson, 2009), higher frequency consumption and liking of spicy foods (Byrnes & Hayes, 2013, 2015; Spinelli et al., 2018). Interestingly, sensitivity to reward was not only associated with preference for sweet food, but also with increased intake of high energy products in adolescent children (De Cock et al., 2016, 2015). Especially, 14-16-y.o. girls with higher sensitivity to reward were found to have a higher daily intake of snacks and sugar sweetened beverages (De Cock et al., 2015).

Another study investigated the effect of sensitivity to reward and feeding strategies on willingness to taste disliked food items in preschool children via parent-report questionnaires (Vandeweghe, Verbeken, et al., 2016). It was shown that children high in sensitivity to reward were more likely to taste disliked vegetables immediately when rewarded, while children low in sensitivity to reward were more willing to taste when verbally encouraged, but with hesitation. Moreover, it was found that reward sensitivity was positively associated with food approach, whereas punishment sensitivity was positively associated with food avoidance in preschool children when using parental self-reports. However, there is a research gap exploring preadolescents' sensitivity to reward, especially sensitivity to punishment related to foods. Additionally, adolescent children were shown to be old enough to respond to questionnaires measuring sensitivity to reward and punishment when using age-appropriate questionnaires (De Cock et al., 2016, 2015), but previous research with younger children mainly relied on parental self-report questionnaires (Vandeweghe, Verbeken, et al., 2016). Exploring the role of sensitivity to reward and punishment in preadolescent's food preferences could help to gain important insights into the underlying factors of children's eating behavior.

1.3 Emotion measurement

1.3.1 Defining and assessing emotions

Research on emotion has gained increasing attention over the past years within various fields including psychology, neuroscience, sociology, philosophy, and economics (Coppin & Sander, 2016). Among psychologists, there is currently no scientific consensus on what an emotion exactly is (see the reviews in Frijda, 2008; Frijda & Scherer, 2009; Scherer, 2005). Yet, there is rather prevalent agreement that emotions are complex and are constituted of diverse elements including physiological arousal, motivation, expressive motor behavior, action tendencies and subjective feeling (Scherer, 2005). Emotions can be described as appraisal driven (the eliciting event and its consequences must be relevant to major concerns of the organism), by response synchronization (they prepare appropriate responses to an event that disrupts the flow of behavior), rapidity of change (they rapidly readjust to changing circumstances or evaluations), behavioral impact (they prepare adaptive action tendencies), high intensity and relatively short duration. These characteristics distinguish emotions from

other affective phenomena like moods, attitudes, preferences, affect dispositions and interpersonal stances (Scherer, 2005).

How an emotion is measured varies widely within but also across emotion theories, which led to the development of multitudinous methods to measure emotions in clinical and research settings. For instance, the theory of basic emotions (the classical approach) considers that an emotion is a "distinct" faculty and implies that each emotion is categorically different from every other emotion. Each emotion is caused by a different mechanism resulting in a distinct physical "fingerprint" (e.g., facial expression, increase in blood pressure) (see Figure 1.1a). In the classical approach, perceiver independent tools are used to measure indirect indicators of emotions like electrophysiological measurements of skin conductance, electroencephalography (EEG), magnetic resonance imaging (fMRI), pupil dilation and heart rate (Manning & Melchiori, 1974; Mauss & Robinson, 2009; Motte, 2009; Sequeira, Hot, Silvert, & Delplanque, 2009; Winton, Putnam, & Krauss, 1984). Further measurements include bodily, facial and vocal expressions (e.g., Bänzinger, Mortillaro, & Scherer, 2012; Ekman, Friesen, & Ellsworth, 1972). However, this theory has been criticized because the brain does not contain an intrinsic network which is specifically dedicated to any emotion (Barrett, 2016; Touroutoglou, Lindquist, Dickerson, & Barrett, 2015).

On the contrary, the theory of constructed emotions (the construction approach) does not define an emotion as a "distinct" faculty with its own distinct mechanism. Emotions do not have firm boundaries, instead an emotion is a category of instances of emotions and does not have an essence. It is suggested that through incoming sensory input (e.g., facial movements, vocalizations) the brain makes meaning of the body and the world (see Figure 1.1b). The construction approach requires multi-modal methods as the measurement of emotional responses at different levels is needed. This is dependent on changes in the brain and the state of the body, which are dynamic over time (Meiselman, 2016). However, such methods have the drawback to be high in complexity and costs. As emotions are commonly measured by self-report questionnaires, they can be influenced by contextual factors, emotional granularity of the individual, words and symbols in self-reports and culture differences. As stated by Barrett, it is suggested to include a measure of emotion concepts whenever measuring the experience of an emotion (Barrett, 2016) and that the best way is to ask individuals directly (e.g., through self-report questionnaires) (Barrett, 2006a, 2016).

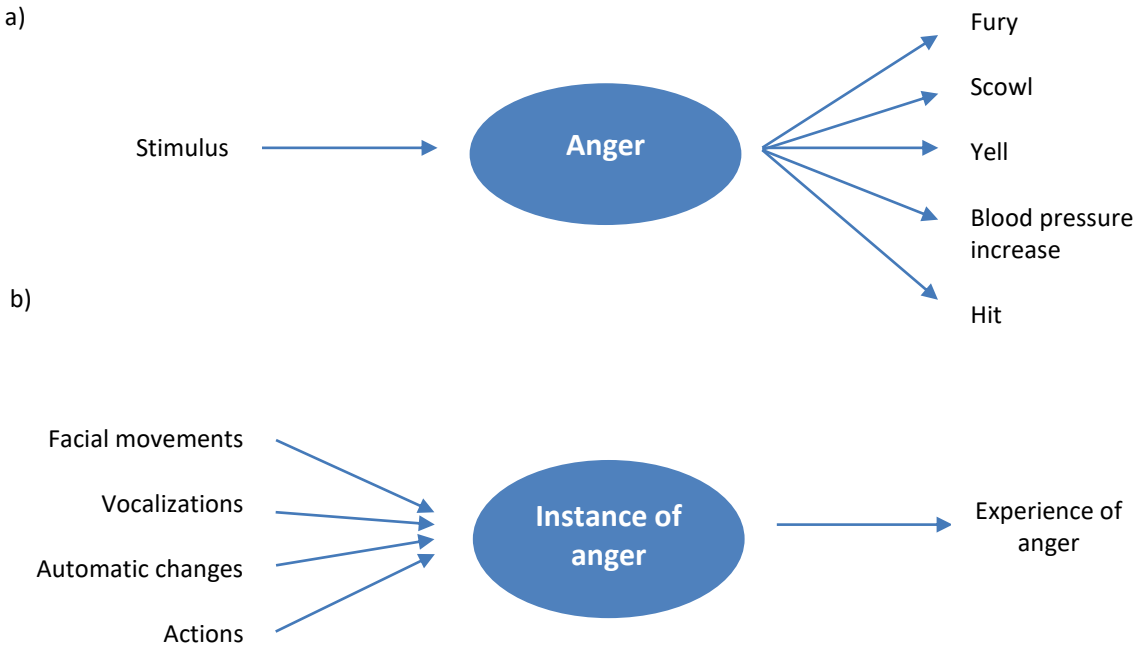


Figure 1.1 The measurement model for the theory of a) basic emotions and b) constructed emotion. Note: the figures display measurement models, but not a causal model of emotion. The figures are adopted from Barrett (2016).

Examples of earlier developed emotion and mood checklists are the **Multiple Affect Adjective Checklist** (MAACL) (Zuckerman & Lubin, 1965) and **MAACL-R** (Lubin et al., 1986; Zuckerman & Lubin, 1886), the **Positive and Negative Affect Schedule** (PANAS) (Watson, Clark, & Tellegen, 1988) and the **Profile of Mood States** (POMS) (McNair, Lorr, & Droppleman, 1971).

1.3.2 Dimensions of emotions

Dimensional models of emotion attempt to conceptualize human emotions by defining where they lie in two or three dimensions. Most dimensional models incorporate valence and arousal (and power) dimensions. Valence and arousal dimensions have been identified as two fundamental dimensions of meaning of core affect, and thus of emotions (Russell & Barrett, 1999). Valence refers to the differentiation between pleasant or unpleasant, while arousal refers to the level of physiological activation (high/low) (Russell & Barrett, 1999). Emotions are much more complex than valence and arousal, but emerge from the interaction of more basic mechanisms; valence and arousal are emergent properties of more basic processes (Barrett, 2016). Valence has been indicated as the *basic building block* that characterizes every emotion and that everybody is able to perceive (Barrett, 2006b), while the perception of

arousal depends on the emotional granularity of the person experiencing an emotion. In fact, people differ in their ability to discriminate emotions based on activation. For example, individuals with low emotional granularity use more global terms when expressing their feelings and may use the terms “sad” and “angry” interchangeably as a general expression of unpleasant feelings. In contrast, individuals with high emotional granularity make clearer distinctions between the terms that go beyond the description of an unpleasant feeling (Barrett, 2006b). Furthermore, research demonstrated the existence of a “power” dimension when studying the meaning of emotions (Fontaine & Scherer, 2013). The power dimension is defined by an opposition between control and lack of control on the situation, potency/strength *vs.* weakness and dominance *vs.* submissiveness: higher levels imply that the person has power over the situation and the people in the situation. For this reason, this dimension is different from arousal and can distinguish emotions characterized by similar arousal level, such as fear (low in power) and anger (high in power) that are both high in arousal (see Figure 1.2).

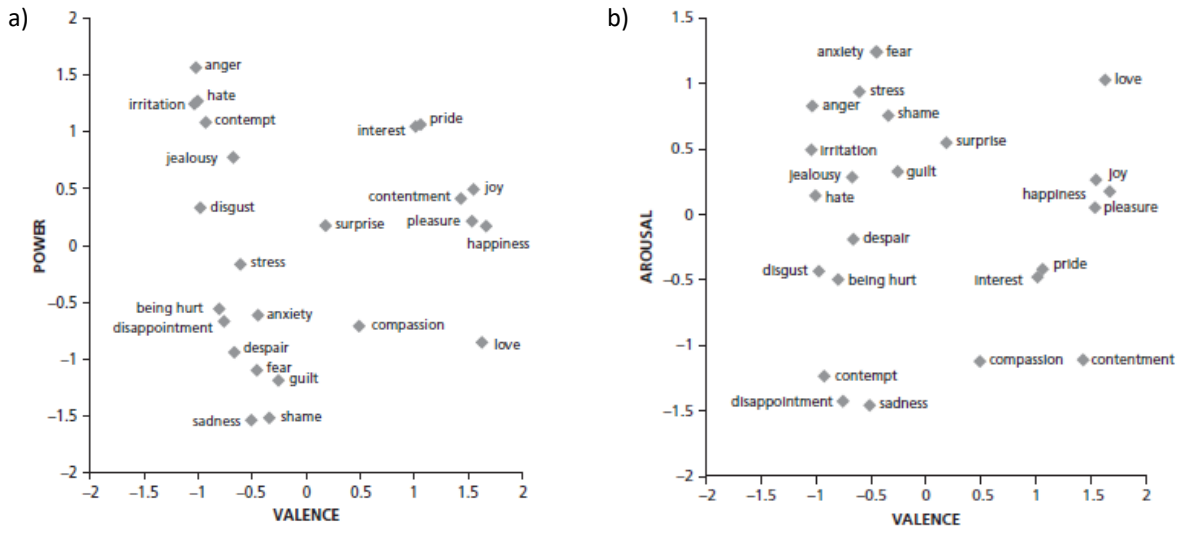


Figure 1.2 Comparison of plots displaying the valence *vs.* power dimension; a) and valence *vs.* arousal dimension b) of 24 emotion words (source: Fontaine & Scherer (2013))

Several dimensional models of emotion have been developed. One of the early models to classify emotions in different dimensions is the **Circumplex model of affect** by Russell (1980). In this model, emotions are mapped on a two-dimensional circular space along the valence (represented by the horizontal axis) and arousal (vertical axis) dimensions. Emotions can be represented at any level of valence and arousal along the circular space. Barrett & Russell

(1998) modified the circumplex model (Figure 1.3) and suggested that it is representative of core affect (the most elementary feelings). Emotions can be laid out on the circumplex along their levels of valence and arousal.

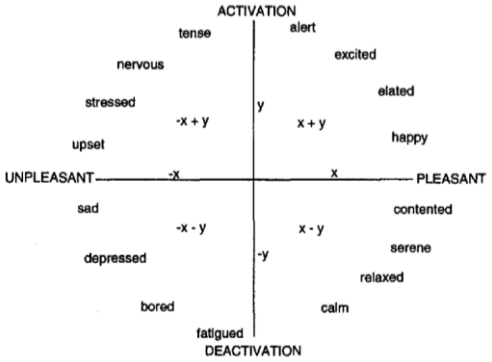


Figure 1.3 A modified semantic circumplex model as representative of core affect by Barrett & Russell (1998); the letters x and y represent semantic components: x = pleasantness and y = activation.

A further measurement tool is the **Pleasure-Arousal-Dominance (PAD) Emotional State Model** developed by Mehrabian & Russell (1974) to describe and measure emotional states. The model consists of the three numerical dimensions of pleasure, arousal, and dominance to represent all emotions. However, PAD scale does not intend to measure emotions per se, but rather it implies to measure the perceived pleasure, arousal, and dominance evoked by a set of environmental stimuli.

Based upon prior circumplex models, Yik, Russell, & Steiger (2011) aimed at developing a finer grained emotion circumplex of core affect by integrating previously dimensional models (e.g., Russell, 1980) and mood scales and semantic differential scales. The result was a **12-point circumplex (12-PAC) model of core affect** that incorporates a circumplex, dimensions, categories concurrently (see Figure 1.4).

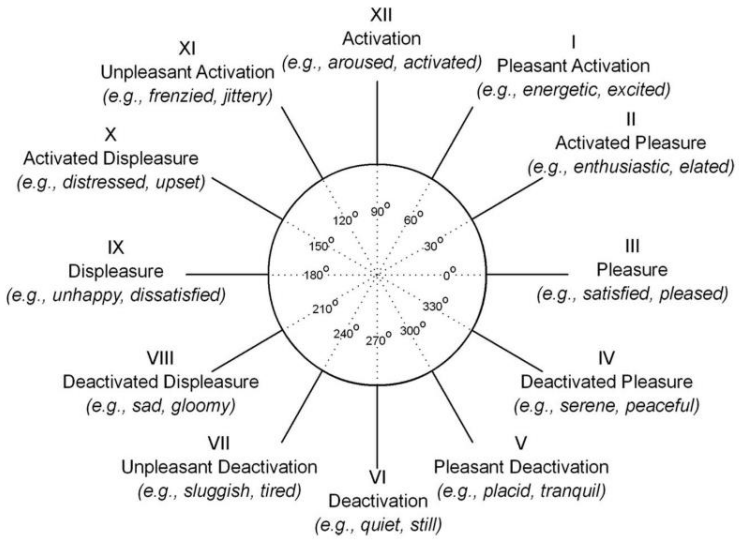


Figure 1.4 A 12-point circumplex (12-PAC) model of core affect (Yik et al., 2011). Horizontal axis (pleasure *vs.* displeasure) and vertical axis (activation *vs.* deactivation) and in-between segments with a combination of these dimensions.

Bradley & Lang (1994) developed the **Self-Assessment Mannikin (SAM)**, which is a picture-oriented tool to assess emotions (see Figure 1.5). SAM consists of 12 graphic characters representing three emotional dimensions of pleasure (spanning from displeasure to pleasure), arousal (spanning from high activation to low activation), and dominance (spanning from low dominance to high dominance). Each emotional dimension is represented as a sequence of 5 images, which are rated on a 9-point rating scale. SAM was used to measure emotions in different eating contexts with 6-14-y.o. children (van der Horst, Ferrage, & Rytz, 2014; van der Horst, Mathias, Prieto Patron, & Allirot, 2019). However, SAM requires extensive instructions in how to interpret the different emotional dimensions, which can be difficult to understand.

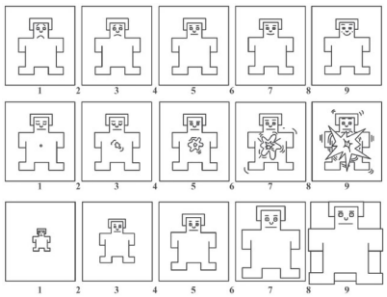


Figure 1.5 Self-Assessment Mannikin (SAM) showing the three emotional dimensions of pleasure (top), arousal (middle), and dominance (bottom) rated on a 9-point scale. Image derived from Soares et al. (2013).

1.3.3 Emotion questionnaires in sensory and consumer research

In applied sensory and consumer research, "emotions" are often used to describe brief emotional experiences in response to a product, yet a formal definition of emotions is missing. Some researchers rather use the terms "emotional conceptualizations" (Thomson et al., 2010), "emotional associations" (Piqueras-Fiszman & Jaeger, 2014b), or "feelings" to indicate an element of emotion described as a conscious phenomenon measured through self-report questionnaires (Delplanque et al., 2012; C. Porcherot, Delplanque, Ferdenzi, Gaudreau, & Cayeux, 2016). This emphasizes that not only emotions, but also other affective phenomena are of interest in sensory and consumer research. Furthermore, it enables to go beyond the difficulty of a scientific definition of what an emotion exactly is as product perception is not only affected by the emotion that is evoked by the product itself, but also by the preferences and the affective state of the individual, his/her moods and attitudes and by the concepts associated with the product in the mind of the individual consuming it (Spinelli, Masi, Dinnella, Zoboli, & Monteleone, 2014).

Moreover, despite the availability of numerous well-established emotion questionnaires developed in clinical psychology, there are several reasons why these questionnaires are unsuitable for measuring emotions in consumer research. First of all, these questionnaires are frequently focused on negative emotions, while consumers mostly use positive emotions to describe emotions in response to food products (Schifferstein & Desmet, 2010). Moreover, many emotion words included in psychological emotion questionnaires are not considered relevant by consumers to describe their emotions in response to products (Delplanque et al., 2012; King & Meiselman, 2010). This has led to the development of emotion questionnaires specifically aimed to be used in sensory and consumer studies (described more in detail in the

following sections 1.3.3.1 and 1.3.3.2). However, as indicated by a recent review on methods for evaluating emotions in response to food experiences, there is still no representative "golden standard" measure or combination of measures developed for the evaluation of food-evoked emotions (Kaneko, Toet, Brouwer, Kallen, & van Erp, 2018).

1.3.3.1 Word-based approaches in consumer emotions

Word-based approaches consist of emotion lexicons, which are lists of emotion words that have been specifically developed to measure emotions in response to a range of products including foods, beverages, other product classes, but also individual foods, or more specific sensory dimensions of products such as odor, appearance, taste etc. (Kaneko et al., 2018).

The **Consumption Emotion Set (CES)** was developed by Richins (1997) and was the first word list of specific emotions (47 emotions) suitable to measure food-related emotions, which represent a range of emotions consumers most frequently experience in consumption situations. Laros & Steenkamp (2005) further elaborated on the emotion list and extended the work on the content and structure of emotions in consumer behavior and suggested a **hierarchical model of consumer emotions** (see Table 1.1). The model is composed of the three levels: the "basic level" consists of four negative (anger, fear, sadness, and shame) and four positive (contentment, happiness, love, and pride) basic emotions. The "superordinate" level divides the basic emotions into negative and positive affect, while the "subordinate" level divides the basic emotions into 42 specific emotions based on Richins (1997); e.g., contentment is further divided into contented, fulfilled, and peaceful.

Table 1.1 Hierarchy of consumer emotions (Laros & Steenkamp, 2005); grey = superordinate level, light grey = basic level, white = subordinate level.

Negative affect				Positive affect			
Anger	Fear	Sadness	Shame	Contentment	Happiness	Love	Pride
Angry	Scared	Depressed	Embarrassed	Contented	Optimistic	Sexy	Pride
Frustrated	Afraid	Sad	Ashamed	Fulfilled	Encouraged	Romantic	
Irritated	Panicky	Miserable	Humiliated	Peaceful	Hopeful	Passionate	
Unfulfillment	Nervous	Helpless			Happy	Loving	
Discontented	Worried	Nostalgia			Pleased	Sentimental	
Envious	Tense	Guilty			Joyful	Warm-hearted	
Jealous					Relieved		
(Hostility)*					Thrilled		
					Enthusiastic		

The **Geneva Emotion Odor Scale (GEOS)** contains 36 emotion terms and was developed specifically to examine emotions in response to odors or fragranced products (Chrea et al., 2009; Christelle Porcherot et al., 2010). A new version of GEOS, the **ScentMove™** (Delplanque et al., 2012; Porcherot et al., 2012, 2010), was reduced to only six items of which each one is labelled with a phrase representing a dimension and clarified by three words (see Table 1.2).

Table 1.2 The emotion dimensions of the ScentMove™ (Christelle Porcherot et al., 2010)

Dimension	Group of emotion words
Pleasant feeling	Happiness – Well-being – Pleasantly surprised
Sensuality	Romantic – Desire – In love
Unpleasant feeling	Disgusted – Irritated – Unpleasantly surprised
Relaxation	Relaxed – Serene – Reassured
Sensory pleasure	Nostalgic – Amusement – Mouthwatering
Refreshment	Energetic – Invigorated – Clean

One of the most frequently used emotion word lists is the **EsSense Profile®** developed by King & Meiselman (2010). It has been developed to measure emotions in response to food products using a standardized questionnaire consisting of 39 emotion terms (35 positive and 4 negative terms) (see Table 1.3). The questionnaire has been validated and tested on several food products and has been compared with other emotion measurement methods. It has been validated in two formats: check-all-that-apply (CATA) and as a 5-point rating scale (1 = not at all to 5 = extremely). The EsSense Profile® was the starting point of a set of newly developed questionnaires in sensory and consumer science by adjusting the emotion word list to specific product categories through consumer input (Bhumiratana, Adhikari, & Chambers, 2014). A shortened version of the EsSense Profile®, named **EsSense25**, has been created by Nestrud, Meiselman, King, Lesher, & Cardello (2016). The list was reduced from 39 to 25 items by applying hierarchical clustering procedures and a sorting experiment.

Table 1.3 The EsSense Profile® showing 39 emotion words (King & Meiselman, 2010); items in bold indicate emotion words included in the EsSense25 (Nestrud et al., 2016).

Active	Glad	**Pleasant**
Adventurous	**Good**	Polite
Affectionate	**Good-natured**	Quiet
Aggressive	**Guilty**	**Satisfied**
Bored	**Happy**	**Secure**
Calm	**Interested**	Steady

Table 1.3 continued

Daring	**Joyful**	**Tame**
Disgusted	**Loving**	Tender
Eager	Merry	**Understanding**
Energetic	**Mild**	**Warm**
Enthusiastic	**Nostalgic**	Whole
Free	Peaceful	**Wild**
Friendly	Pleased	Worried

The **EmoSemio questionnaire protocol**, developed by Spinelli, Masi, Dinnella, Zoboli, & Monteleone (2014b), constitutes a procedure to develop product- and language/culture-specific questionnaires (see Table 1.4). Full sentences instead of emotion words were used to reduce ambiguity in describing food products. The authors compared EmoSemio to the EsSense Profile® (to describe chocolate and hazelnut spreads) and demonstrated that EmoSemio outperformed the emotion word list of the EsSense Profile® in its discriminant ability.

Table 1.4 EmoSemio questionnaire for chocolate and hazelnut spreads consisting of 32 items shown as full sentences and label for each sentences (Spinelli et al., 2014).

	EmoSemio questionnaire sentences	**EmoSemio questionnaire labels**
1	It is an anti-stress: it calms me, it soothes me, it reassures me	Anti-stress
2	It relaxes me and makes me feel carefree	Relaxed
3	I associate it with amusement and fun	Amused
4	It makes me feel full of energy and reinvigorated	Energetic
5	It makes me merry	Merry
6	It makes me happy	Happy
7	It satisfies me	Satisfied
8	It gratifies me, rewards me	Gratified
9	It makes me feel tender and affectionate	Tender
10	It makes me feel cuddled and loved	Cuddled
11	It communicates sensuality, it charms me	Sensual
12	It communicates security	Secure
13	I associate it to happy memories of childhood	Happy memory
14	It makes me feel good and generous	Generous
15	It surprises me	Surprised
16	It makes me curious	Curious
17	It makes me feel indifferent	Indifferent
18	It bores me	Bored
19	It makes me feel neglected, without any care of me	Neglected
20	It makes me feel sad	Sad
21	It disappoints me	Disappointed
22	It makes me feel guilty	Guilty
23	It annoys me, it makes me feel nervous	Annoyed

Many examples of consumer defined emotion lexicon specific for a product a category are present, e.g., for beer (Chaya et al., 2015), wine (Ferrarini et al., 2010) and commercial black currant sqaushes (Ng et al., 2013a). Schouteten, De Steur, Lagast, De Pelsmaeker, & Gellynck (2017) developed a **product-specific emotion list** (n=15) to evaluate traditional biscuits in 10-14-y.o. children (see Table 1.5). A pre-test was conducted with a group of preadolescents to select appropriate emotional terms based on a list of 59 emotional terms from previous research on adults (Desmet & Schifferstein, 2008; King & Meiselman, 2010). It was aimed for a balanced distribution of positive/negative terms, but other emotional dimensions were not considered.

Table 1.5 Emotional terms of a product-specific list to evaluate traditional biscuits in 10-14-y.o. children (Schouteten et al., 2017); [1] = positive, [2]= negative, [3]= unclassified emotion

Glad[1]	Unpleasant surprise[2]	Regret[2]
Loving[1]	Discontented[2]	Confused[2]
Happy[1]	Dissatisfied[2]	Merry[1]
Good[1]	Pleasant[1]	Disgust[2]
Nostalgic[3]	Boring[2]	Warm[1]

Some researchers developed methods integrating emotion words into a circular format. For example, Schouteten et al. (2015) developed the **EmoSensory® wheel**, a self-assessment tool of sensory attributes (example for burgers: brown color, homogenous, dry, granular, aftertaste, nutty flavor, off-flavor, juicy, meat aroma, meat taste, soft, salty) and emotion terms (example for burgers: pleasant surprise, worried, glad, energetic, happy, discontented, dissatisfied, pleasant, disappointed, contented, fear, merry, disgust, distrust) presented in a single wheel question format (see Figure 1.6). Sensory attributes and emotion terms are product specific and can vary in number of attributes/terms for each product. Respondents first need to click on the applicable emotion/sensory term and are then instructed to rate the intensity using a 5-point scale (RATA scaling approach). The EmoSensory® wheel can be rotated as preferred by the respondent. The tool was tested on crisps, chocolate, cola, and burgers.

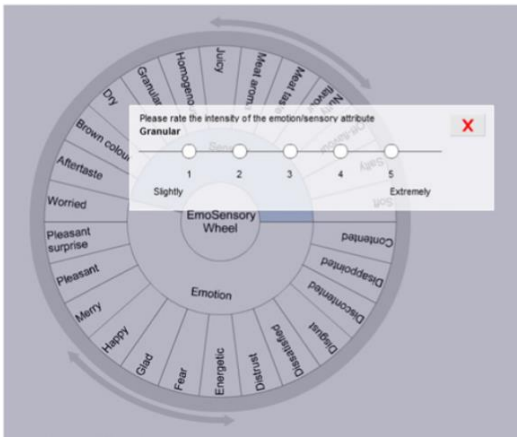


Figure 1.6 The EmoSensory® wheel used to evaluate burgers (Schouteten et al., 2015).

Inspired by the circumplex model of Yik et al. (2011), Jaeger et al. (2020) developed the **valence x arousal circumplex-inspired emotion word questionnaire (CEQ)** that spans the dimensions of pleasure and arousal, and their combinations. These are represented in a circular layout with 12 axes radiating from a central point of which each arm is represented by an emotion domain (of two emotion words) (Figure 1.7). The questionnaire was developed to measure product-related emotional associations (consumers are asked to select the word pair that best represents how they feel). The questionnaire's response characteristics (single response option *vs.* CATA) and layout (circumplex *vs.* conventional word list with 12 emotion word pairs), and the combination of these, were tested for differences in emotional responses. The authors concluded that all variants were appropriate, though greater sample discrimination and descriptive detail may be obtained with the CATA question format (Jaeger, Roigard, & Chheang, 2021).

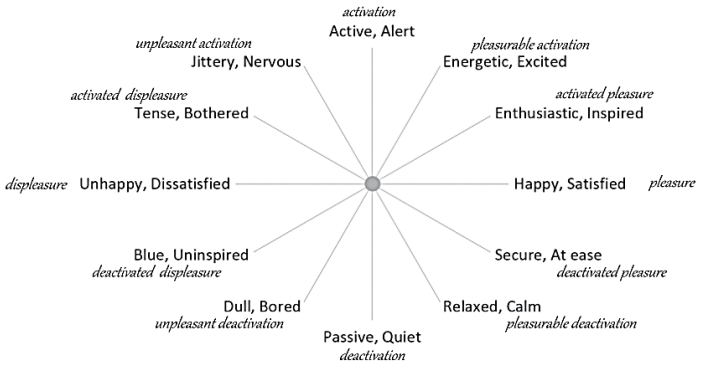


Figure 1.7 The valence x arousal circumplex inspired emotion word questionnaire (CEQ). Figure retrieved from Jaeger, Lee, Xia, Chheang, et al. (2019).

However using emotion words in emotion measurement questionnaires can have some shortcomings: Firstly, emotions are difficult to verbalize (Köster & Mojet, 2015). Secondly, they can pose a problem especially when using existing emotion word lists across different languages and cultures (Desmet, Hekkert, & Jacobs, 2000; Mesquita & Frijda, 1992; Spinelli et al., 2014), particularly when it comes to foods (Gutjar et al., 2015). It was suggested that attention should be paid when using emotion word lists developed in other languages and when conducting cross-cultural studies. Emotion words can have different semantic meanings in different countries but so far it is unclear how emotion words can be translated correctly or how to find an "equivalent" translation (Spinelli et al., 2014). Thirdly, verbalizing emotions can influence the food experience itself (Kaneko et al., 2018) and lastly, some children may have difficulties to express their feelings using words (Gallo, Swaney-Stueve, & Chambers, 2017a).

1.3.3.2 Image-based approaches in consumer emotions

Even though most emotion measurement questionnaires are word-based, some researchers discovered the advantage in developing image-based approaches to study consumer emotions. While they can seem somewhat more complex to develop, these tools offer an interesting approach as they do not require the verbalization of emotions that must be interpreted and do not rely on a person's ability to articulate his/her emotions with words. By using visual approaches, the risk of translation problems between languages/ cultures can be reduced and consequently it offers more multilingual applications as the approach does not rely on words. Facial and body expressions are supposed to be more common across languages/ cultures (Meiselman, 2016). In fact, there is fair evidence that humans can attribute emotions to facial and body expressions and that these have stability across cultures

to some degree (Ekman, 1992b; Elfenbein & Ambady, 2002). This makes graphical self-report instruments particularly appealing especially when used to compare emotional responses across cultures or even when used with children with difficulties to express their feelings with words (Gallo, Swaney-Stueve, et al., 2017a).

The **Image Measurement of Emotion and Texture (IMET)** was developed by Collinsworth et al. (2014) to measure differences in emotion and texture in response to food products through human facial expressions (see Figure 1.8). IMET was tested on products like orange soda, dairy type beverages, and convenience cheeses.

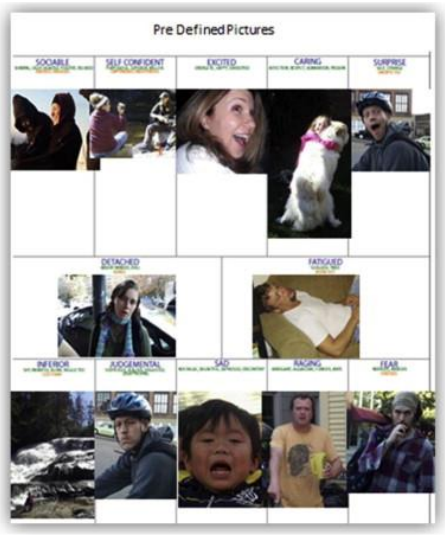


Figure 1.8 Image Measurement of Emotion and Texture (IMET)

Other approaches focused on emotion measurement through pictures instead of photos. For instance, the **Product Emotion Measurement Instrument (PrEmo®)** developed by Desmet et al. (2000) is a pictorial self-report tool to measure product emotions. The animated cartoon characters express different emotions through facial and body expressions. PrEmo® is a cross-cultural validated tool that has been further developed, known as the **PrEmo2®** (Laurans & Desmet, 2012), by adjusting the cartoon characters and represented emotional expressions (see Figure 1.9). It includes seven positive (joy, hope, pride, admiration, satisfaction, fascination, and attraction) and seven negative emotions (sadness, fear, shame, contempt, dissatisfaction, boredom, and disgust).

Figure 1.9 PrEmo2® self-report instrument showing 14 cartoon characters; top row, from left to right (positive emotions): joy, hope, pride, admiration, satisfaction, fascination, and attraction; bottom row (negative emotions): sadness, fear, shame, contempt, dissatisfaction, boredom, and disgust (Laurans & Desmet, 2012).

1.3.4 The importance of measuring affective responses to foods in children with appropriate tools

Given the rise of food products targeted at children and the need of healthier food products (European Commission - EU Science Hub, 2020) to combat the global rise of childhood obesity (Wang & Lobstein, 2006), children take an important role in consumer testing today (Laureati, Pagliarini, et al., 2015). Emotions have been shown to play an essential role in children's food preference assessment as they can help to better discriminate between food products compared to the sole use of liking measurements and to better predict product performance (Schouteten, Verwaeren, Lagast, Gellynck, & De Steur, 2018). In addition, investigating children's emotional responses to foods is important because emotional profiles can help to understand drivers of food choice in order to promote healthier and tastier foods (Jiang et al., 2014; Macht, 2008). But until now, measuring children's emotional responses to foods is underrepresented in sensory and consumer studies (Laureati, Pagliarini, et al., 2015).

Although children between 4-11 years are already able to perform a range of consumer tests (like projective mapping, memory and emotion evaluation) similar to adults, the assessment of children's food preferences requires engaging and age-appropriate methods (Laureati, Pagliarini, et al., 2015). In psychology, children's emotions have been measured through a range of assessment methods including reports (e.g., self-reports, parental, teacher, or peer reports) and observational methodologies (e.g., facial expression, words, tone of voice, and body gestures) (Zeman et al., 2007), however, these methods may not always be appropriate or sufficient to capture emotions related to foods in the context of sensory and consumer research with children.

Research on children's food preferences recognized the importance of measuring food-elicited emotions as they were shown to be a better indicator of food choice compared to liking (Laureati, Pagliarini, et al., 2015). Yet our understanding of affective responses in children's food choice and behavior is still limited and so far, there is no standard procedure in how to assess food-elicited emotions in children. Self-reported questionnaires using words have been the most common method for the evaluation of emotional responses to food products (see Meiselman, 2016; Spinelli & Monteleone, 2018) with promising results to be used with children (Gallo, Swaney-Stueve, & Chambers, 2017b; Jervis, Jervis, Guthrie, & Drake, 2014; Pelsmaeker, Schouteten, & Gellynck, 2013). When assessing emotions through self-report measures, it is inevitable to consider the children's age as the developmental status affects the way children respond to self-report measures (Zeman et al., 2007). In contrast to younger children (5-6-y.o.), older children (8-12-y.o.) have already a more developed ability to conceive that multiple emotions can be experienced concurrently (Larsen, To, & Fireman, 2007). Preadolescents (9-13-y.o.) develop an increased drive for autonomy (Eccles, 1999) and an enhanced developmental ability to express themselves appropriately when responding to self-reported questionnaires (see Laureati & Pagliarini, 2018). Pelsmaeker, Schouteten, & Gellynck (2013) evaluated emotional responses to flavored milk samples in 8-13-y.o. children (CATA approach with 20 emotion terms) and found that children were able to discriminate between samples. Furthermore, the use of pictorial self-report methods were suggested (Desmet et al., 2000) as a measurement tool for emotionally responding to products. These methods are used in a variety of demographic populations, including children or populations of different languages. Kuenzel & Martin (2012) used SAM and the differential emotions scale (DES-III) in 8-10-y.o. children to investigate if emotion scales available in the psychological literature can measure emotions evoked by different beverages. They concluded that children were able to use these questionnaires and that they were able to discriminate products in valence and arousal. However, methods like SAM require familiarization with the unfamiliar images and one drawback is that children have to be trained in using the three affective dimensions (valence, arousal, and power) before they can use the approach. A further risk is that unfamiliar images - as e.g., with SAM - could be misinterpreted when filling out a survey response, thus misdirecting the data interpretation.

Recently, an increasing interest in using emoji to measure children's emotional responses emerged and emoji were found appropriate, especially to be used with preadolescent children to discriminate between food products (Gallo, Swaney-Stueve, et al., 2017a, 2017b; Schouteten, Verwaeren, Gellynck, & Almli, 2019; Schouteten et al., 2018). The use of emoji to measure food-elicited emotions in preadolescents represents an understudied topic yet deserving to gain more attention.

1.4 Emoji as a tool to measure emotions to describe food experiences

1.4.1 What are emoji? A definition

Emoji are small icons used in digital communication to express emotions/feelings (Kaye, Malone, & Wall, 2017; Wikipedia, 2019) that are commonly used on various social media platforms and smartphones worldwide (Lu et al., 2016). The use of social media and digital communication is attaining more and more popularity among young adults and children (Commonsensemedia, 2016), which makes emoji a medium that is already familiar to them. The name "emoji" originates from Japanese and is a synergy of the words *e* ("picture") and *moji* ("character"). Emoticons (from "emotional icon") are earlier versions of emoji and differ in the way that emoticons are created by punctuation marks, letters, and numbers to visualize pictorial icons that generally display an emotion or sentiment, e.g., the *smiling face* :-) or the *frowning face* :-(. One of the functions of emoji is to fill in emotional cues that otherwise would be typed as text (e.g., via emotion words). A variety of different types of emoji emerged over the last years spanning from facial expressions (e.g., 😊, 😍), hand gestures (e.g., 👋, 🤞), people (e.g., 👰, 👮), common objects (e.g., 🎁, ☎️) places and travel (like 🏝️, 🚗) as well as animals and nature (e.g., 🐟, 🦓, ☀️) (Emojipedia, 2021). Emoji are available in a variety of operating systems (like Apple, Facebook, Twitter), which define their operating system's specific presentation like color, shapes etc. For example, the emoji *face with tongue* is visualized in the Apple version as 😛 (iOS version 14.6) and in the Twitter version as 😛 (Twemoji version 13.1) (Emojipedia, 2021). In total there are 3633 emoji in the Unicode Standard as of September 2021 (Emojipedia, 2021). The emoji *face with tears of joy* 😂 was named the word of the year by Oxford Dictionaries in 2015 (Yena Oh, 2015) highlighting the popularity of emoji around the world.

1.4.2 Emoji used in sensory- and consumer science

A growing interest for emoji to measure consumer's product-elicited emotions emerged in the field of sensory and consumer science over the past years. Emoji serve as a measurement of explicit emotions, with consumers that describe how a product makes them feel using self-reported questionnaires (Meiselman, 2016). In fact, emoji are supposed to simulate facial expressions that convey specific emotions or other situational meanings (Bai, Dan, Mu, & Yang, 2019). They are language-independent indicators of emotions (Kralj Novak, Smailović, Sluban, & Mozetič, 2015) and can help to elicit spontaneous expressions of emotional experiences elicited by foods (Vidal, Ares, & Jaeger, 2016). Recently, a range of studies showed that emoji can help to discriminate between food products, which was particularly effective when liking was not a strong discriminator between them (Ares & Jaeger, 2017; Da Cruz et al., 2021; Gallo, Swaney-Stueve, et al., 2017b; Jaeger, Lee, Kim, et al., 2018; Jaeger, Roigard, & Ares, 2018; Schouteten et al., 2019). They were shown to discriminate between food products both in adults (Jaeger, Lee, et al., 2017; Jaeger, Lee, Kim, et al., 2018; Jaeger, Roigard, & Ares, 2018; Jaeger, Vidal, Kam, & Ares, 2017) and children (Gallo, Swaney-Stueve, et al., 2017b; Schouteten et al., 2019, 2018; Swaney-Stueve, Jepsen, & Deubler, 2018). In adults, emoji were shown to discriminate between different samples of muesli bars and popcorn as tasted stimuli and milk, water, red wine and chocolate as written stimuli (Jaeger, Roigard, & Ares, 2018; Jaeger, Vidal, et al., 2017).

Several researchers discovered the advantage of emoji to measure preadolescents' emotions towards food products (Gallo, Swaney-Stueve, et al., 2017b; Lima, de Alcantara, Martins, Ares, & Deliza, 2019; Schouteten et al., 2019, 2018). Most preadolescents are already familiar with emoji and think they are fun to use when describing their food experiences, which is a significant prerequisite when developing novel tools where emoji are implemented because this motivates children to be more actively engaged in sensory and consumer studies. In a focus group conducted by Gallo, Swaney-Stueve, & Chambers (2017) preadolescents stated their preference using emoji over words when describing food-related emotions. Studies using emoji to measure food-elicited emotions already tested a variety of food products such as baby carrots, cheddar cheese, chocolate graham snacks, fresh spinach, lychee gummy candy, orange juice, white bread, white grapes (Gallo, Swaney-Stueve, et al., 2017b), biscuits (Schouteten et al., 2018) and probiotic fermented milk products (Da Cruz et al., 2021).

However, people may not always agree that specific emoji indicate specific emotions, especially in the absence of contextual cues and instructions on how they should be interpreted, regardless of any external similarities to human facial expressions of emotion (Franco & Fugate, 2020). Thus, a the person's conceptual knowledge and context may play an important role in the development of specific emoji-emotion associations (Franco & Fugate, 2020).

1.4.3 Existing emoji measurement tools/questionnaires/scales/methods

Recently a range of self-report tools using emoji to measure food-related emotions have been developed and tested in adults and children, e.g., **Check-All-That-Apply** (CATA) with emoji (adults: Ares & Jaeger, 2017, using different response formats, see Figure 1.10; children: Gallo, Delores, et al., 2017 (see Figure 1.11), Schouteten et al., 2019 and 2018), **Rate-All-That-Apply** (RATA) with emoji (adults: Ares & Jaeger, 2017), **EmojiGrid** (adults: Toet et al., 2018, see Figure 1.12) , **K-state emoji scale** (children: Deubler, Swaney-Stueve, Jepsen, & Su-Fern, 2020 (Figure 1.13), adults: Deubler & Swaney-Stueve, 2020), and the **Valence x arousal circumplex-inspired emotion questionnaire (CEQ)** with emoji (adults: Schouteten, Llobell, Roigard, Jin, & Jaeger, 2022, see Figure 1.14). Some of these methods were developed specifically for or adjusted for preadolescents (Deubler et al., 2020; Gallo, Swaney-Stueve, et al., 2017b; Schouteten et al., 2019, 2018; Sick, Monteleone, Pierguidi, Ares, & Spinelli, 2020; Sick, Spinelli, Dinnella, & Monteleone, 2020).

Figure 1.10 Examples of 4 different emoji questionnaire formats to describe how consumers would feel eating a focal sample using: a) Check-All-That-Apply (CATA) question on single page with direct emoji selection; b) CATA question on single page (with scroll bar) with adjacent box to click; c) yes/no forced-choice question on single page (with scroll bar); d) Rate-All-That-Apply (RATA) questionnaire on single page (with scroll bar) by clicking an adjacent box to indicate that it applied to the food and then providing a “low”, “medium” or “high” response. The study used a fifth questionnaire format similar to a) but without asking “How would you feel?”.

Source:Ares & Jaeger (2017)

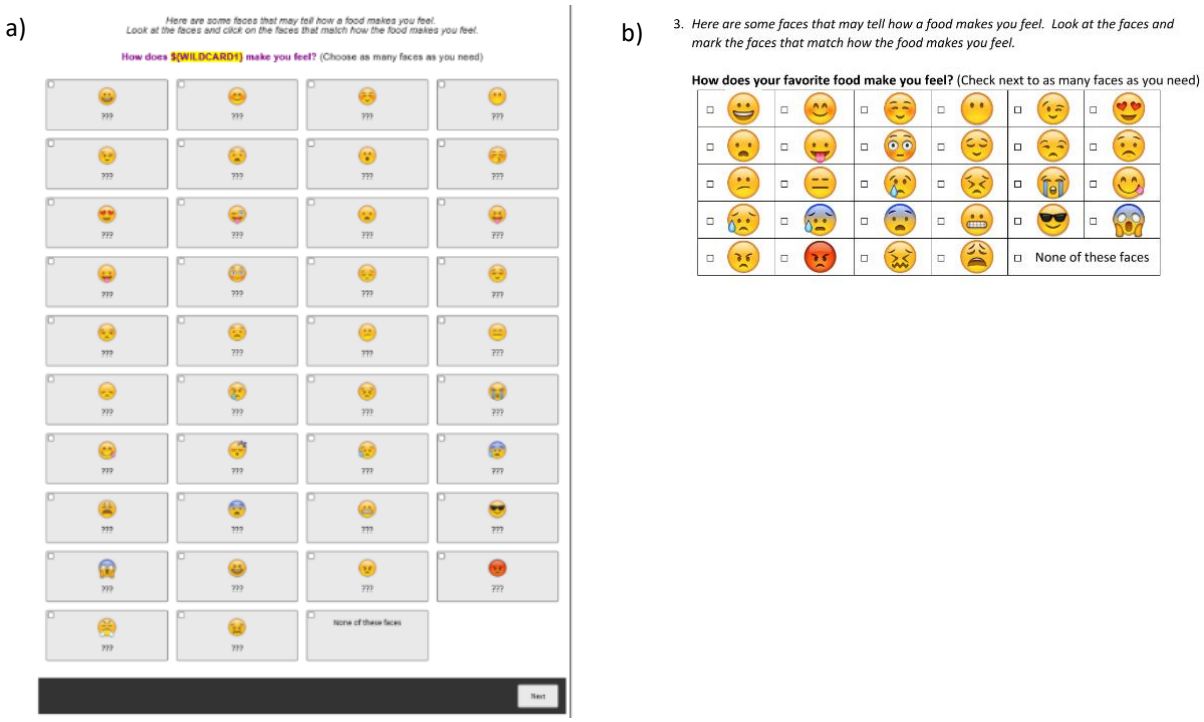


Figure 1.11 Check-All-That-Apply (CATA) questionnaires using emoji to measure emotional responses to food products; a) online questionnaire (Compusense, Inc.) used for children from the United States of America and b) paper ballot for testing used for children from Ghana. Source: Gallo (2016).

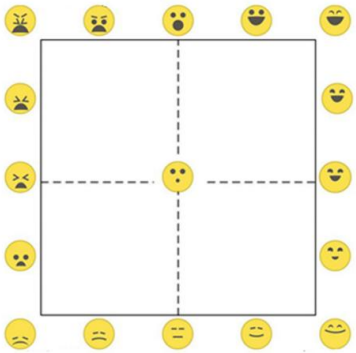


Figure 1.12 The EmojiGrid by Toet et al., 2018

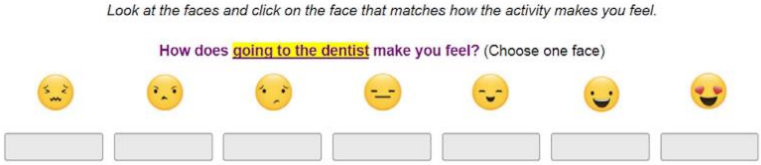


Figure 1.13 The K-state emoji scale (Deubler et al., 2020).

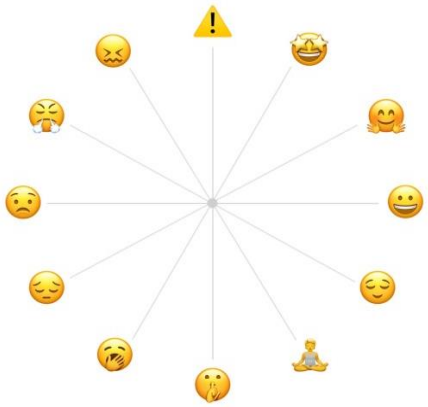


Figure 1.14 The Valence x arousal circumplex-inspired emotion questionnaire (CEQ) with emoji developed by (Schouteten et al., 2022)

The most common method used is the CATA approach. Here, participants are presented a food stimulus and asked to state how this makes them feel by selecting all emoji that apply. This method has the advantage of being intuitive, easy to understand and quick to use. The integration of emoji in a CATA approach was used with preadolescents to measure food-elicited emotions, with a large variety of emoji that were shown to discriminate between food products (Da Cruz et al., 2021; Gallo et al., 2017b; Schouteten et al., 2019, 2018). The number of emoji included varies widely among studies ranging between 7 and 38 emoji (Da Cruz et al., 2021; Gallo, Swaney-Stueve, et al., 2017b; Schouteten et al., 2019, 2018; Swaney-Stueve et al., 2018), while not all the emoji were shown to have a discriminant ability between food products (Da Cruz et al., 2021; Gallo, Swaney-Stueve, et al., 2017b; Schouteten et al., 2019). One of the reasons for this fact could be that most previous studies started with very heterogenous emoji lists resulting in a large set of emoji that were either not appropriate to describe emotional food experience or not relevant to use for preadolescents. Product-specific emoji lists usually contain less emoji compared to general emoji lists (Schouteten et al., 2019). However, their specificity is restricted to a specific set of food products, which limits their application to a wider range of food categories. This is comparable to general emotion word lexicons (like the EsSense Profile®) and product-category specific emotion questionnaires using words (e.g., a lexicon developed for black currant squashes by Ng, Chaya, & Hort, 2013b) or sentences (e.g., the EmoSemio questionnaire, Spinelli et al., 2014) to capture emotional profiles in response to food products. Emoji have often been selected based on emoji lists developed for adults (e.g., Lima et al., 2019) but the use and interpretation

of emoji can vary between different age groups (Brants, Sharif, & Serebrenik, 2019; Herring & Dainas, 2020) - especially among preadolescents.

Moreover, rating scales (e.g., RATA format) were shown to provide more information and to have higher sensitivity compared to CATA questionnaires in adults. This could further improve the discriminant ability of emoji, especially if food products were very similar in sensory characteristics (Ares & Jaeger, 2017). By using rating scales, it can also be measured how intense emotions are felt towards food products, which can give further insights into product discrimination using emoji. Ares & Jaeger (2017) compared four different emoji questionnaire formats to describe how consumers would feel eating different seafood products using (see Figure 1.10): a) Check-All-That-Apply (CATA) question on single page with direct emoji selection; b) CATA question on single page (with scroll bar) with adjacent box to click; c) yes/no forced-choice question on single page (with scroll bar); d) Rate-All-That-Apply (RATA) questionnaire on single page (with scroll bar) by clicking an adjacent box to indicate that it applied to the food and then providing a “low”, “medium” or “high” response. The study used a fifth questionnaire format similar to a) but without asking “How would you feel?”. The authors concluded that while either of the tested methodological variants can be used to lead to similar overall findings, the RATA showed superior performance in terms of frequency of emoji use and sample discrimination. Forced yes/no questions were participants' least favorite methodological variant. Despite leading to a high frequency of emoji use, sample discrimination was a stable relative to CATA questions. To our knowledge, the approach to use a rating scale with emoji to measure children’s emotional responses to food products has not been used before but might be beneficial when differences between products are small and difficult to quantify.

Recently, the Valence x arousal circumplex-inspired emotion questionnaire (CEQ) was introduced with emoji (Schouteten et al., 2022, see Figure 1.14), which is a further development of its word-based variant developed by (Jaeger, Roigard, et al., 2021, see Figure 1.7). Consumers are asked to associate a food product with the emoji that describes how they feel towards the product (single-item CEQ response). The CEQ has been tested with adults but could also provide an alternative approach to CATA questionnaires when used with children.

1.4.4 Why is it important to develop a new emoji scale for children?

The development of emoji-based questionnaires is strongly encouraged (Jaeger, Vidal, & Ares, 2021). Supporting reasons for using questionnaires with emoji compared to emotion words are children's familiarity and shared meanings between cultures through the use of emoji. This is advantageous, especially when there are language barriers in cross-cultural research and where the translation of words is problematic (Jaeger, Vidal, et al., 2021; Schouteten & Meiselman, 2021). Emoji could have the advantage to offer a non-verbal way of conveying meanings that otherwise cannot be expressed with words or that would be expressed differently. This can also be an advantage for younger children with reduced verbal skills and limited vocabulary, but also for shy children that struggle to communicate information about their feelings. The use of emoji implies a game-like situation and seems to be an easy-to-use and intuitive tool to measure emotions/feelings in children (see Laureati & Pagliarini, 2018).

Previous studies often selected emoji without the consideration of how emoji are interpreted by preadolescents regarding their semantic meanings, degree of valence, arousal, and power. Interpretations of some emoji were shown to differ between individuals (Franco & Fugate, 2020; Miller et al., 2016) and therefore a thorough preselection of an age-appropriate emoji list is required. For example, the interpretation of the *face screaming fear* 😱 has a tendency to shift from "surprise" to "fear" from younger to older adult groups (Brants et al., 2019). By more carefully selecting appropriate emoji used in emotion measurement tools, the discriminative ability of the tool between products could be enhanced, and thus helping to better understand preadolescent's food preferences and affective responses to foods. Furthermore, it is unclear if some emoji are redundant, e.g., express some similar meanings, or are ambiguous, e.g., express different contrasting meanings.

1.4.5 The need to develop emoji lists to measure emotions to describe food experiences in preadolescents

Due to the high number and diversity of available emoji, researchers followed different procedures to develop emoji lists and scales and to select the appropriate number of emoji to be tested in a reliable tool for food-related emotion measurement. The selection of emoji ranged from conducting focus groups with 8-11-y.o. children (Gallo, Swaney-Stueve, et al., 2017a) to relying on predefined emoji lists of former studies based on adults (Schouteten et

al., 2018) and on pretests of a predefined list based on both responses of adults and 8-11-y.o. children (Schouteten et al., 2019). Gallo et al. (2017a) developed an emoji list originating from focus groups with a total of 17 children aged 8-11, who were asked how they felt about their favorite, least favorite and "just okay" food in different eating contexts. The facial emoji used in the study were obtained from an internet data base and preselected by a researcher to limit emoji that might not be relevant when evaluating food. Based on children's use of emoji through discussion and activities, a list of 38 emoji was considered appropriate for further emotion testing with children aged 8-11, while other lists comprised of 28 (Gallo, Swaney-Stueve, et al., 2017b) or even 20 emoji (Schouteten et al., 2019) in the case of a product-specific list. Schouteten et al. (2018) pointed out that it is still unclear how to use emoji to describe food products with preadolescents, especially how they should be selected, and which number of emoji is appropriate to use.

Some emoji lists were based on predefined lists developed with and for adults (Lima et al., 2019; Schouteten et al., 2018). However, as children differ from adults in many developmental aspects, emoji lists have to be age-appropriate, hence, they need to be specifically developed or adjusted for children. Additionally, preadolescents start to become more familiar with social media and digital communication, with increasing familiarity with age; 23% of children aged 8-12 have a social media account, in contrast to 80% of children aged 13-18 (Commonsensemedia, 2016; Howard, 2018). This steep rise of social media usage in the transition from early to late preadolescence and adolescence could affect how familiar emoji are to children and the way in which they use them.

The papers described above have the merit of pointing out the need of specifically developing an emoji list that can be used to measure food-related emotions with an age-specific group of children. However, given that there is a growing number of newly developed facial emoji, it is important to consider the wide spectrum of emoji available that have the potential to measure food-elicited emotions in children. This means that it is difficult to rely on pre-existing lists when an emoji-based tool measuring food-related emotions has to be developed for a specific age group of children. In addition, cross-cultural differences could be expected between children of different countries as it was shown that emoji usage, preferences and their meanings can differ across countries (Barbieri, Kruszewski, Ronzano, & Saggion, 2016; Lu et al., 2016).

Another point that needs to be considered is which and how food items should be presented to children to select food-related emoji. As emotions are much influenced by interactions between the person and the environment, it is important to consider contextual aspects in emotion research with children (Zeman et al., 2007). Foods evoke associated memories of previous eating occasions and are thus linked to emotions experienced on these occasions (Köster & Mojet, 2015), which highlights the importance of including situational factors when evoking food-related emotions.

In addition to the general aspects presented above, a more specific research question in selecting food-related emoji for consumer testing with children is: Is there a difference in the use of food-related emoji in children of similar age? This question is particularly relevant in studies conducted with preadolescents, since even within a limited age interval (9-13-y.o.) subjects may have profound changes in their social interaction (Eccles, 1999). For example, during preadolescence, children make a transition from primary to secondary school, which means a change of their social environment leading to important developmental advances such as gaining more self-esteem and individuality (Eccles, 1999). Differences in emotion expression have been previously found across childhood from toddler/preschool age into adolescence (Chaplin & Aldao, 2013).

Furthermore, attention has to be paid to differences in emotion expression and non-verbal communication between genders (Kring & Gordon, 1998). A meta-analytic review on emotion expression in children demonstrated that boys and girls differed in emotion expression. Girls expressed more positive emotions, which became even more evident with increasing age into adolescence compared to boys. Girls also showed more internalizing emotions (e.g. sadness and fear), whereas boys expressed more externalizing emotions (e.g. anger) (Chaplin & Aldao, 2013). Similar findings were shown in adults (Fischer, Rodriguez Mosquera, Van Vianen, & Manstead, 2004). Women tend to use more emoji in their digital communication than men (Chen et al., 2018), which could be explained by their increased emotion expression. However, no gender differences were found in a study investigating if emoji questionnaires can be used equally across gender and age groups in adults when characterizing stimuli with emoji with Chinese and New Zealander participants (Jaeger, Xia, Lee, et al., 2018). However, more research is needed to clarify if there are gender differences in emoji questionnaires in preadolescents.

1.4.6 The need to evaluate the meaning of emoji to describe food experiences in preadolescents

1.4.6.1 Age and gender differences in emoji usage

Although emoji were found to be able to discriminate between food products in children (Gallo, Swaney-Stueve, et al., 2017b; Schouteten et al., 2019), little is known about how children interpret emoji in terms of their emotional meaning in the context of food. Research conducted with adults show a limited shared agreement in the meaning of emoji (Franco & Fugate, 2020). Intensive research by Jaeger, Ares and colleagues (Jaeger & Ares, 2017; Jaeger, Roigard, Jin, Vidal, & Ares, 2019) on the meaning of 33 facial emoji found that there are emoji strongly associated with one emotion word, emoji that are associated with several but related emotions/moods and emoji that are associated with different moods and emotions, indicating multiple and unrelated meanings. Brants et al. (2019) found a high agreement in the meaning for some emoji, such as *pouting face* 😡, *crying face* 😢, *face with open mouth* 😮, *neutral face* 😐 and *face with tears of joy* 😂 that were associated with a unique emotional meaning indicating respectively “anger,” “sadness,” “surprise,” “neutral” and “joy.” Interpretations of other emoji were found to depend on age or gender.

Research conducted with adults indicated that emoji differ in their affective meaning, spanning broad ranges in core valence and arousal (Jaeger, Roigard, et al., 2019; Rodrigues, Prada, Gaspar, Garrido, & Lopes, 2018). The ability to discriminate among emotions increases gradually with age, meaning that children’s emotion categories are quite broad and become more distinct during preschool years (Widen & Russell, 2008). Age differences have been demonstrated in valence- and arousal ratings of emotion words in French children aged 7-13 years, where younger children (aged 7-9) gave higher mean valence- and arousal ratings compared to older children; moreover, the tendency to judge words positively (i.e., positive bias) decreased with age (Monnier & Syssau, 2017). As we know that emotion vocabulary gradually becomes more stable and differentiated during middle childhood (Bahn, Vesker, García Alanis, Schwarzer, & Kauschke, 2017) and it is likely that some children are more limited in making fine distinctions between emotions, simplified questionnaires using emoji were suggested for evaluating emotions elicited by food products in this age group (Spinelli & Jaeger, 2019).

Furthermore, emotion expression can differ by gender in adults (Kring & Gordon, 1998), but also in children (Chaplin & Aldao, 2013). Females have been shown to be more accurate than males in judging the emotional meaning of facial expressions (Hall & Matsumoto, 2004) and to give higher valence and arousal ratings (Proverbio, 2017). Gender differences were also found in studies investigating the interpretation of emoji (Brants et al., 2019) and in the selection of specific food-related emoji in preadolescents (Sick, Spinelli, et al., 2020). Women evaluated emoji as clearer and more meaningful and familiar (Rodrigues et al., 2018) and gave higher overall positive ratings when assessing the valence of emoji (Jones, Wurm, Norville, & Mullins, 2020). They were also shown to be more familiar with emoji and to use them more frequently compared to men (Chen et al., 2018; Jones et al., 2020; Rodrigues et al., 2018). However, other studies did not report gender differences in the interpretation of emoji when using emoji questionnaires (Jaeger, Xia, Lee, et al., 2018). Hence, age- and gender differences in the meaning of emoji (including valence- and arousal dimensions) need to be further investigated as previous research shows controversial findings, leading to a further research question: Do gender and age influence how emoji are interpreted by preadolescents?

1.4.6.2 Using projective mapping to explore the dimensional meaning of emoji

In projective mapping, stimuli with different characteristics are mapped according to their similarities and differences. A set of stimuli is presented simultaneously and the respondent is asked to evaluate the stimulus and then position all stimuli on a two-dimensional space according to the similarities and differences between the stimuli (Valentin, Chollet, Lelièvre, & Abdi, 2012). This technique was widely used to describe food products (Valentin et al., 2012; Varela & Ares, 2012) and could also be helpful when exploring similarities and differences of emoji because the respondent does not have to think about specific emotion words to describe each emoji. Additionally, it could give insights about their valence- and arousal dimensions or even other informative dimensions to uncover the meaning of emoji. Projective mapping has been previously used with children between 4 and 11 years to evaluate different food products and found to be appropriate for this age group because of its intuitive nature and suitability with untrained subjects (Laureati, Pagliarini, et al., 2015; Mitterer Daltoé et al., 2017; Varela & Salvador, 2014). This technique has never been applied before to determine similarities and differences of meanings of emoji in preadolescents or in adults. The CATA approach, instead, was successfully used with adults to investigate the dominant meaning of

emoji (Jaeger & Ares, 2017; Jaeger, Roigard, et al., 2019). With preadolescents it has been used previously with emoji to evaluate emotional experiences of food products (Gallo, Swaney-Stueve, et al., 2017b; Schouteten et al., 2019, 2018), but not yet to understand their meaning.

1.5 Research objectives and aims of the thesis

The overall objective for this PhD thesis was to develop an emoji-based self-report questionnaire for preadolescents consisting of a food-specific emoji list with identified emotional meaning and to validate and apply the tool to test its discriminant ability in response to food. A further main objective was to investigate individual differences in emotional responses to foods by clustering children according to patterns of emotional responses and by testing the clusters for differences in personality traits and sensory responsiveness.

In accordance with the literature discussed above in the introduction, two main research objectives are distinguished. These research objectives correspond to the two main parts of this PhD thesis. Based on these two general research objectives, six specific research objectives (SO) are formulated, which will be explicated more in detail in this section.

Part II The development of the emoji-based self-report questionnaire

Research objective 1: Developing an emoji-based self-report measurement tool to measure food-related emotions in preadolescents

Five research chapters (Chapter 2-6) of this PhD thesis focus on the development of the emoji-based self-report questionnaire and its validation. This new method is described in Part II.

Measuring emotions in response to foods has been shown to be a better indicator for food choice compared to hedonic measurements (Gutjar et al., 2015). Self-report questionnaires using emoji emerged as a promising tool to be used in children (Deubler et al., 2020; Gallo, Swaney-Stueve, et al., 2017a, 2017b; Lima et al., 2019; Schouteten et al., 2019, 2018) to

measure food-elicited emotions. However, there is a need to develop a **specific age-appropriate emoji list** to measure food-elicited emotions in preadolescents, which could improve its discriminant power. Furthermore, **age- and gender differences** in preadolescents have never been investigated when selecting relevant emoji to describe food experiences, which could affect children's use of such emoji lists. Accordingly, the first specific research objective is:

> *SO 1: To **select a list of emoji** that is **appropriate for preadolescents** to describe their emotions elicited by foods recalled in relation to different evoked eating contexts and to explore related **age- and gender differences** in how emoji are selected for each evoked eating context.*

Although emoji were found to be able to discriminate between food products in children (Gallo, Swaney-Stueve, et al., 2017b; Schouteten et al., 2019), little is known about how children **interpret emoji in terms of their emotional meaning** in the context of food. An in-depth exploration of the meaning of emoji can contribute to understanding what is measured - if emotions or broader dimensions of product experience are measured, and if children agree in how they interpret the meaning of emoji. Semantic theories highlighted two perspectives on meaning: a differential dimension of meaning (intra-semiotic), defined by the inter-relationship of an object with other similar objects, and a cognitive dimension of meaning, which refers to the relationship with concepts (Violi, 2001). Additionally, **age- and gender differences** have been found in emotion expression and how emoji are interpreted. Based on this, the second and third specific research objective of this doctoral thesis are as follows:

> *SO 2: To **explore the meaning of emoji** by applying a) a similarity-based method (Study 2: projective mapping) to detect the meaning defined in the interrelationship between emoji (differential dimension meaning), b) descriptive methods (Study 3: CATA with emoji described by emotion words and Study 4: CATA with emotion words described by emoji) to investigate the association of emoji with words (cognitive/conceptual dimension of meaning), and c) a qualitative descriptive method (one-on-one interviews using a modified version of the Repertory Grid Method) to investigate emoji more in-depth. A*

*further specific research objective was to measure **age- and gender differences** in the emotional meaning of food-related emoji.*

*SO 3: To **develop the emoji-based self-report questionnaire** based on Studies 1-5 by reducing the number of emoji and grouping emoji of similar emotional meaning to be used to evaluate emotional responses to foods in preadolescents.*

Emoji are supposed to simulate facial expressions that convey specific emotions or other situational meanings (Bai et al., 2019) that are language-independent indicators of emotions (Novak et al., 2015) with shared meaning between different cultures (Jaeger, Vidal, et al., 2021). However, some research demonstrated that meanings can differ across countries in adults (Barbieri et al., 2016; Lu et al., 2016), but little is known about preadolescents. **Cross-cultural shared meanings of emoji** are a crucial prerequisite for the application of the developed emoji-based self-report questionnaire in other countries/cultures. In this PhD research, preadolescents from Italy and Norway were recruited to explore the semantic meaning of food-related emoji between countries. The following research specific research objective is formulated:

*SO 4: To compare the emotional meaning of emoji for Italian and Norwegian pre-adolescents through a **cross-cultural study** by repeating Study 3 (CATA emoji described by emotion words) with Norwegian preadolescents (Study 6).*

When introducing a new method, it is necessary to **assess its performance and discriminant ability** compared to more traditional methods (such as liking measurements). The developed emoji-based self-report questionnaire (available in two response formats: CATA and rating scale) was tested on a list of food names using the CATA Emoji Pair Questionnaire and tasted food models (with variations in sensory properties) using the Emoji Pair Rating Scale. Consequently, the research specific research objective is specified:

*SO 5: To **validate and apply the emoji-based self-report questionnaire** with Norwegian preadolescents to **assess its emotional profiles and discriminant ability** in response to food (food names and tasted food models).*

Part III Individual differences in children's food preferences

Research objective 2: Applying the emoji-based self-report questionnaire to cluster preadolescents according to emotional patterns and testing the clusters for differences in personality traits and sensory responsiveness

While the second part has a methodological angle (development and validation of the emoji-based self-report questionnaire), the third part of this thesis deals with the role of emotions, personality traits and sensory sensitivity in preadolescents' food preferences. Moreover, research found **associations between personality traits, taste responsiveness and food preferences** (De Toffoli et al., 2019; Laureati et al., 2018; Spinelli et al., 2018), which constitutes another understudied topic research with children. For example, **food neophobia** (the reluctance to try novel food) is a well-known trait in children affecting food preferences and was shown to lead to decreased intake of vegetables in children (Guzek et al., 2018). **Curiosity** was shown to be an important stated reason in preadolescents' food acceptance (Sick, Højer, & Olsen, 2019). **Sensation seeking** was shown to be a positive predictor of the willingness to consume novel food (Lammers et al., 2019) and to be correlated with liking of spicy foods in adults (Byrnes & Hayes, 2016). The traits **sensitivity to reward and punishment** were shown to influence how individuals respond to food both in adults and children (Byrnes & Hayes, 2013, 2015; De Cock et al., 2016, 2015; Vandeweghe, Verbeken, et al., 2016; Vandeweghe, Vervoort, et al., 2016). In children, sensitivity to reward was not only associated with preference for sweet food, but also with increased intake of high energy products in adolescent children (De Cock et al., 2016, 2015). Yet, both sensation seeking and sensitivity to reward and punishment represent an understudied topic children's food choice and more research is needed to understand the role of these traits in children's food preferences and its association with emotional responses.

Furthermore, taste responsiveness varies across individuals and may influence food preferences in adults (Dinnella et al., 2018; Puputti et al., 2019) and preadolescents (Ervina et al., 2021; Ervina, Berget, & Almli, 2020; Hartvig et al., 2014; Joseph et al., 2016). **PROP status** was associated with reported emotional responses to foods in adults (Macht & Mueller, 2007),

and **sensory properties** of basic taste stimuli (Dubovski et al., 2017) and foods (Spinelli et al., 2014; Thomson et al., 2010) were shown to evoke emotions. The relationships between taste responsiveness, sensory properties, emotions, and personality traits remain an understudied topic in children but could help to understand factors influencing preadolescents' food preferences. Based upon this, the sixth specific objective of this doctoral thesis is framed:

> *SO 6: To **investigate individual differences by clustering children according to patterns of emotional responses** and by testing the clusters for differences in **personality traits** (food neophobia, sensation seeking, sensitivity to reward and punishment, curiosity trait), and **sensory responsiveness** (responsiveness to basic tastes and PROP status).*

1.6 Structure of the doctoral thesis

This PhD dissertation presents original research conducted from 2018 to 2021 within the EU funded EDULIA project. Part of this research has been presented in international scientific conferences and published in peer-review journals in the field of sensory and consumer science. A graphical summarization of the structure of the doctoral thesis is provided in Figure 1.15.

Part I provided a **general introduction** to the doctoral thesis. It included an introduction to the research topic and the relevant theoretical background about food choice and preferences, emotion measurement and individual differences of personality traits and sensory responsiveness. Also, this part discussed the relevance of this doctoral research on a scientific and a practical level. Finally, an overview about the research design was presented.

Part II focuses on the **development of a self-report emoji-based questionnaire** to measure emotions in response to food in preadolescents. Chapter 2 deals with the selection of emoji to describe food experiences and gender differences. Chapter 3 explores the meaning of emoji used to describe food experiences by applying four different methods (projective mapping, CATA with emoji described by words and CATA with emotion words described by emoji, and one-on-one interviews) to explore the dimensional and the semantic meaning of emoji. Chapter 4 specifically focuses on the development of the questionnaire by combining the studies on the selection and exploration of the meaning of emoji resulting in the final emoji-based self-report measurement tool, the Emoji Pair Questionnaire. Further, Chapter 5

investigates the semantic meaning of emoji in a cross-cultural context (Italy *vs.* Norway) by repeating one study on the semantic meaning (CATA with emoji described by emotions words) with Norwegian children to validate and apply the tool with preadolescents from a different culture. Lastly, Chapter 6 concentrates on the validation of the self-report emoji-based questionnaire by applying two different questionnaire formats on food names (CATA Emoji Pair Questionnaire) and tasted food models (Emoji Pair Rating Scale).

Part III examines the **role of emotions, personality traits, and sensory sensitivity** in children's food preferences. This part investigates individual differences by clustering children according to emotional patterns to test differences in personality traits, PROP status, and sensory responsiveness to basic tastes of tasted food models.

Finally, the last **Part IV** covers a more **general discussion** about the research findings and provides an overview of the overall conclusions. Moreover, some perspectives for future research are formulated.

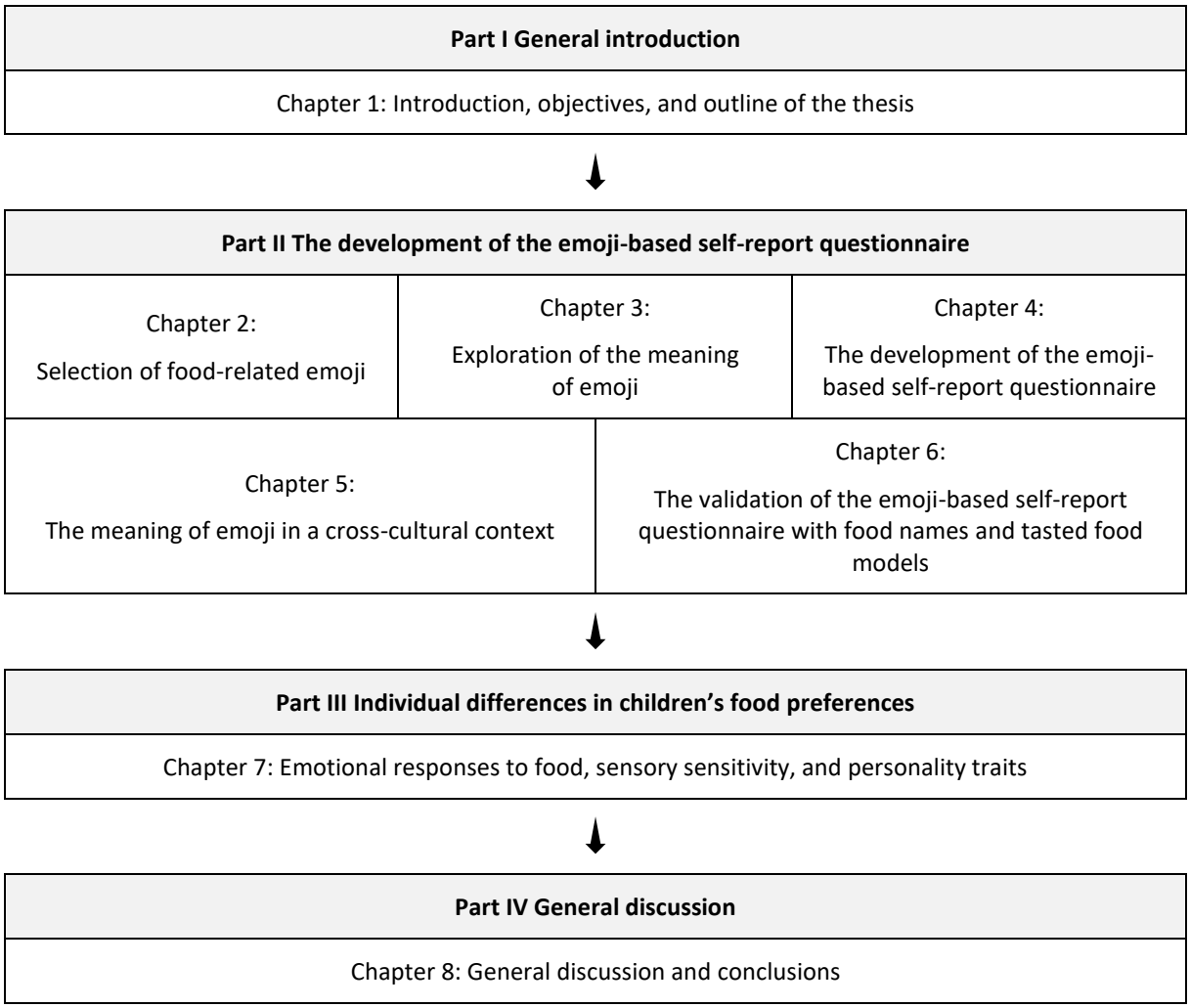


Figure 1.15 Graphical summarization of the structure of the doctoral thesis.

1.7 Overview of research design and studies

Data required to meet the research objectives are collected through quantitative and qualitative research procedures. Data are collected through primary resources. A total of 711 children (9-13-y.o.) participated in seven studies, which attended primary and secondary school classes in Italy and Norway. For the quantitative Studies 1-7 (except Study 5) it was aimed to include around 80-100 children to reach an adequate level for analyzing the data based on indications for CATA and projective mapping tests (Valentin et al., 2012), while for the qualitative one-on-one interviews (Study 5) it was aimed to include around 20-25 interviews as suggested by Spinelli & Monteleone (2018). Furthermore, for the interviews only secondary school children (12-13-y.o.) were included due to their increased developmental ability to express emotions with words compared to younger children. Table 1.6 provides an overview of the studies conducted during the PhD research presented in this thesis.

Table 1.6 Overview of Studies 1-7 including type of study, country of data collection, number of children (n), age range and school level.

Study	Type	Country	Children n	Age range	School level
Study 1	Emoji selection	Italy	96	9-13-y.o.	primary and secondary
Study 2	Projective mapping	Italy	162	9-13-y.o.	primary and secondary
Study 3	CATA emoji	Italy	92	11-13-y.o.	secondary
Study 4	CATA words	Italy	85	9-13-y.o.	primary and secondary
Study 5	One-on-one interviews	Italy	19	12-13-y.o.	secondary
Study 6	CATA emoji	Norway	109	11-13-y.o.	secondary
Study 7	Sensory tests	Norway	148	11-13-y.o.	secondary

Part II The development of the emoji-based self-report questionnaire

Chapter 2 The selection of emoji relevant to describe children's food experiences

This chapter is based on:

Sick, J., Spinelli, S., Dinnella, C., & Monteleone, E. (2020). Children's selection of emoji to express food-elicited emotions in varied eating contexts. Food Quality and Preference, 85, 103953.

Abstract

Emoji were suggested for children to be used to measure food-elicited emotions. The present study was aimed to explore the appropriateness of emoji to describe predolescents' emotions elicited by foods recalled in relation to different evoked eating contexts and to explore related age- and gender differences. Fifty-five boys and forty-one girls aged 9-13 participated to the study. First, subjects were asked to recall, by means of an open-ended question, the foods they had in specific eating contexts: "Most liked food" and "Most disliked food", "Breakfast", "Dinner", "Snack", "Birthday" and "Novel food". Then, they were asked to select the emoji appropriate to describe their feelings for the context-related foods by selecting from a list of 92 facial emoji (CATA method). Emoji selected by more than 20% of children in at least one eating context qualified as food-related. In total, 46 emoji resulted as appropriate to describe emotions in different eating contexts. Preadolescents used mainly positive emoji, except for the context "Most disliked food", where mainly negative emoji were used. Most food-related emoji resulted from "Most liked food" and "Most disliked food", but the context "Birthday" also added some context-specific emoji. The number of selected emoji varied across evoked eating contexts eliciting different foods. Age and gender significantly affected emoji selection across and within foods elicited by varied eating contexts, with girls and 9-11-y.o. children selecting some emoji more frequently across all contexts, but also within contexts. The approach used in the present study has the potential to be used for the development of a food-related emotion measurement tool for preadolescents. Future research aimed at interpreting the meaning of facial emoji is needed and should consider age- and gender differences.

2.1 Study 1: The selection of emoji relevant to describe children's food experiences

2.1.1 Material and methods

2.1.1.1 Participants

Ninety-six children (43% girls) aged 9-13 (M=11, SD=1.5, in both gender groups) were recruited in primary and secondary schools in the Florence area, Italy. Children were grouped into two age groups of 9-11-y.o. (24 girls and 31 boys) attending primary school and 12-13-y.o. children (17 girls and 24 boys) attending secondary school. Only children who returned a signed consent form from their parents and who agreed to voluntarily participate in the study by signing their own consent form were allowed to participate. There were no other exclusion criteria set as no child should feel excluded from the study. Recruitment criteria and data treatment were planned in accordance with the principles of the Declaration of Helsinki. The study was approved by the Ethical Committee of the University of Florence, Italy.

2.1.1.2 Data collection

Testing took place in the regular classrooms of the schools by collecting data in one school class at a time. The testing lasted approximately one hour and was conducted in the morning. Children sat in their general seating order either in rows or in groups of 2-6 children. They were asked to place their tablets flat on the table to prevent any peers from seeing and thereby copying any responses. Additionally, questionnaires were randomized for each child. During each testing session, one instructor and 3-4 assistants were present to ensure the protocol-based procedure and helped distribute the tablets. The teacher was present during the session to ensure the children were less distracted and felt more at ease. The risk that the teacher impacted the results was eliminated as the teacher was strongly advised not to help children with the questionnaire and was not involved in the activity of the study. Before each session, the instructor explained the questionnaire and made sure all children were confident how to use the tablets. Children were allowed to ask for assistance in case they had difficulties in how to use the tablets. Data were collected on tablets (Acer Iconia One 10, Android 7.0) using the software Compusense Cloud (Compusense, Inc., Guelph, Ontario, Canada).

2.1.1.3 Preselection of emoji

Emoji were obtained from Apple iOS 12.2 (Apple, inc, Cupertino, CA) accessed through Emojipedia on the 4th of April 2019 (Emojipedia, 2019). A researcher preselected from a total of 2776 emoji available at that time point all facial emoji (in this doctoral thesis defined as round and usually yellow facial emoji varying in facial expressions e.g., 😀) and emoji displaying people, animals, objects, food etc. (n=2684) were excluded. This approach was adopted due to the explorative nature of the study to let only preadolescents select food-related emoji that they considered appropriate, contrary to studies with preadolescents that conducted a preselection of emoji by adults (Gallo, Swaney-Stueve, et al., 2017a, 2017b; Schouteten et al., 2019; Swaney-Stueve et al., 2018). Consequently, 92 facial emoji were considered for the study. The first school class (n=23 children, 78% boys, M=10.3 and SD=0.5) acted as a pilot class to pretest, if children had any difficulties with the length of the emoji list and if boredom effects occurred. This was assessed based on the test evaluation questions (see section 2.1.1.4) and verbal feedback by the children. Children did not express any problems with the emoji list and found the test easy to do, therefore the children from the pretest were included for further data analysis. Emoji are depicted in Table 2.1 with their names retrieved from Emojipedia (Emojipedia, 2019). The names were not displayed to the children. The order of emoji was randomized for each child and for every food context.

Table 2.1 Full 92-item emoji list included in the CATA questionnaire with frequencies (%) of children (n=96) that selected emoji to describe the foods recalled by each eating context; ● = selected food-related emoji * = emoji selected by ≤20% of children, but still included as food-related emoji for further analysis.

	Emoji		Breakfast	Dinner	Snack	Most liked food	Most disliked food	Birthday	Novel food
●	😀	*grinning face*	18	29	33	35	0	45	20
●	😃	*grinning face with big eyes*	30	32	34	38	0	45	23
●	😄	*grinning face with smiling eyes*	23	23	31	41	0	44	18
●	😁	*beaming face with smiling eyes*	21	22	34	36	0	46	21
●	😆	*grinning squinting face*	8	7	14	26	0	28	16
	😅	*grinning face with sweat*	3	6	11	8	0	20	13
	🤣	*rolling on the floor laughing*	4	6	11	10	0	20	9

	😂	*face with tears of joy*	6	7	13	14	1	20	9
•	🙂	*slightly smiling face*	19	17	21	24	0	31	27
	🙃	*upside-down face*	7	7	11	10	1	20	8
•	😉	*winking face*	13	8	14	21	0	23	16
•	😊	*smiling face with smiling eyes*	16	9	25	27	0	29	16
•	😇	*smiling face with halo*	8	11	13	20	1	29	16
•	🥰	*smiling face with hearts*	23	19	31	46	1	43	24
•	😍	*smiling face with heart-eyes*	18	20	32	49	1	45	29
•	🤩	*star-struck*	28	34	44	55	1	58	30
•	😘	*face blowing a kiss*	9	3	14	25	0	24	20
	😗	*kissing face*	3	3	6	8	0	14	9
•	☺️	*smiling face*	15	9	15	22	0	26	17
	😚	*kissing face with closed eyes*	5	4	7	14	0	18	13
	😙	*kissing face with smiling eyes*	7	5	4	13	0	15	10
•	😋	*face savoring food*	39	31	30	50	0	44	28
•	😛	*face with tongue*	13	10	11	27	0	28	22
•	😜	*winking face with tongue*	13	6	13	33	0	27	22
•	🤪	*zany face*	11	6	13	35	0	22	16
•	😝	*squinting face with tongue*	6	7	7	19	1	21	19
•	🤑	*money-mouth face*	7	8	14	21	1	23	13
•	🤗	*hugging face*	17	8	15	23	0	19	16
	🤭	*face with hand over mouth*	5	1	2	1	11	1	5
	🤫	*shushing face*	1	3	3	4	1	3	4
	🤔	*thinking face*	5	9	3	1	2	0	9
	🤐	*zipper-mouth face*	2	3	3	2	13	1	2
	🤨	*face with raised eyebrow*	1	4	2	1	7	0	5
*	😐	*neutral face*	5	6	3	0	14	1	8
	😑	*expressionless face*	4	7	4	1	10	2	2
	😶	*face without mouth*	4	6	2	1	8	2	5
	😏	*smirking face*	7	6	6	10	1	4	5
	😒	*unamused face*	1	4	1	0	14	1	2
	🙄	*face with rolling eyes*	1	5	1	0	7	1	4
	😬	*grimacing face*	1	3	1	0	9	0	1
	🤥	*lying face*	2	3	0	0	2	0	1

•		*relieved face*	10	6	8	23	1	11	9
		*pensive face*	2	2	1	0	9	0	1
		*sleepy face*	2	3	0	0	9	0	0
•		*drooling face*	22	17	20	30	1	19	8
		*sleeping face*	8	5	3	1	1	0	0
		*face with medical mask*	1	1	0	0	20	0	3
		*face with thermometer*	1	1	0	1	13	0	2
		*face with head-bandage*	1	2	0	0	14	0	1
•		*nauseated face*	3	4	4	0	77	1	17
•		*face vomiting*	3	6	3	1	85	1	15
		*sneezing face*	1	1	0	0	11	0	4
•		*hot face*	2	3	2	0	28	1	10
		*cold face*	5	5	4	2	13	1	9
		*woozy face*	5	3	3	9	6	4	2
•		*dizzy face*	1	3	2	1	28	1	1
•		*exploding face*	6	4	3	8	26	4	6
		*cowboy hat face*	8	1	5	13	2	17	9
•		*partying face*	16	9	16	35	2	34	11
•		*smiling face with sunglasses*	13	7	14	29	1	17	10
		*nerd face*	2	3	5	5	0	3	1
		*face with monocle*	1	5	0	2	2	1	1
		*confused face*	1	3	0	0	16	2	2
		*worried face*	1	1	0	1	18	1	1
		*slightly frowning face*	2	4	2	0	20	0	2
•		*frowning face*	1	4	1	0	25	0	1
*		*face with open mouth*	6	3	4	4	7	1	3
		*hushed face*	3	1	2	1	6	2	3
		*astonished face*	2	5	3	7	6	0	2
		*flushed face*	2	1	0	1	8	2	2
		*pleading face*	4	4	6	6	17	5	5
		*frowning face with open mouth*	1	1	0	1	11	0	1
		*anguished face*	1	2	1	1	10	1	0
•		*fearful face*	1	2	1	2	24	0	5

•	*anxious face with sweat*	1	2	1	0	28	0	6
	sad but relieved face	1	1	0	0	17	1	4
•	*crying face*	1	1	1	1	21	0	0
•	*loudly crying face*	2	4	2	2	30	0	3
•	*face screaming fear*	2	3	1	1	28	0	7
•	*confounded face*	1	2	0	0	24	0	3
•	*perserving face*	1	1	1	0	21	0	3
	disappointed face	1	6	1	0	19	0	1
	downcast face with sweat	1	1	0	0	15	0	1
	weary face	1	4	0	1	15	1	1
•	*tired face*	1	1	0	1	25	2	2
	yawning face	9	3	2	1	11	0	1
•	*face with steam from nose*	2	4	2	0	21	1	1
•	*pouting face*	3	4	3	1	30	1	3
•	*angry face*	1	3	2	0	21	1	0
•	*face with symbols on mouth*	1	3	1	0	34	1	4
	smiling face with horns	5	6	3	5	16	5	3
•	*angry face with horns*	3	2	2	1	32	1	5

2.1.1.4 Procedure

The test was individual. Children were asked to recall foods associated to seven eating contexts by using an open-ended response option (written response to an evoked context). The eating contexts included “Breakfast” (breakfast of the morning before coming to school), “Dinner” (yesterday’s dinner), “Snack” (yesterday’s snack consumed in the morning or in the afternoon), “Birthday” (a typical food consumed during their last birthday party), a “Novel food” (the children were asked to recall a situation in which they were invited to taste a food they never tasted before, e.g. at a friend’s or relative’s place) and “most liked/most disliked foods”. After describing foods related to the first evoked eating context children were presented with the 92 facial emoji and asked to check those that apply (Check-All-That-Apply format) to describe how they feel in response to the self-selected foods (see Figure 2.1). The same two-step procedure was repeated for all the considered eating contexts. As soon as a child finished the first part of emoji selection, they were asked to solve a riddle until the last

child finished the emoji selection task. Then, children were asked about demographics (gender and age) and to fill in a questionnaire (Supplementary materials Table S 1) about emoji usage and asked to evaluate the test. Several domains of emoji usage were considered: Familiarity; Frequency of usage; Social use; Motivation; Valence of emoji and Enjoyment in using emoji. Two more questions were asked to the children to know how difficult the test was (very difficult/a bit difficult/neither difficult nor easy/ easy/very easy) and how much they enjoyed it (by no means/a bit/so and so/fairly/a lot).

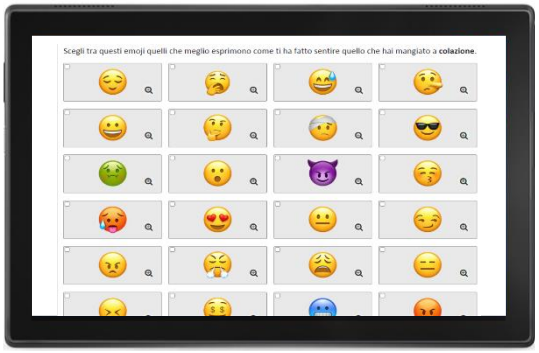


Figure 2.1 Experimental setup of Study 1 (Selection of emoji to describe food experiences); images are derived from screenshots of the original test created through the software Compusense Inc.

2.1.1.5 Data analysis

Data from the questionnaire on emoji usage were analyzed by computing frequencies (%) of children that responded to each question. Gender- and age effects on familiarity, frequency of usage of emoji and enjoyment were tested by using Kruskal–Wallis One–Way Analysis of Variance by ranks. Chi-square test was applied to test differences between genders and age groups in each item of the other domains. For each eating context, the frequency of each emoji across subjects was determined. Emoji selected by >20% of participants in at least one eating context qualified as food-related emoji. Emoji ≤20% were not considered for further analysis as they did not qualify as food-related emoji, with some exception of emoji that were assumed to be potentially relevant but not sufficiently aroused by our stimuli (eating contexts). Average emoji selection across eating contexts was calculated for gender and age groups separately. Age- and gender differences in the frequency of selection of each emoji were tested by using a Chi-square test for each eating context. The level of significance for all the analysis was set at $p \leq 0.05$. Statistical analyses were performed using XLSTAT (Version XLSTAT 2018.7, Excel 14.0.6024, Windows 10, Build 54971, XLSTAT-Sensory). For each evoked

eating context, the frequency of recalled foods was analyzed using the text-analysis software T-LAB 2020.1 (Plus version 5.1.0.4; T-LAB di Lancia Franco, Italy). First, words not relevant for analysis (stop words such as “and”, “the”, “a” and “an”) were removed. Secondly, foods that were very similar were grouped (e.g., Italian “focaccia” and “panino” were grouped into “sandwich”); when a food in a food category was frequently mentioned it was not grouped under the category label but, instead, it was considered as a separate food item (e.g., broccoli, spinach and other frequently mentioned vegetables in the context “Most disliked foods” were counted separately, while all other vegetables were grouped under the vegetable label). Frequency of foods (foods occurring only once were excluded) were visualized as a word cloud using XLSTAT. Foods stated more frequently were displayed in bigger letters and foods stated less frequently were displayed in smaller letters.

2.1.2 Results

2.1.2.1 Emoji Usage Questionnaire (EUQ) and test evaluation questions

Most children found that the test was very easy (63%) or easy (22%) to do and enjoyed participating in it a lot (76%) or fairly (18%) regardless of gender and age. No significant gender differences were found for neither of the domains of the EUQ (see Supplementary materials Table S 1). In contrast, a significant age effect was found for “familiarity with” and “frequency of use” of emoji and for specific items of the domains “social use” and “valence of emoji”. Emoji were shown to be very familiar across subjects. Overall, children reported to use them regularly (68%) or occasionally (26%), but older children were more familiar with emoji than younger children ($p=0.006$). In general, children used emoji a few times a week (42%) or every day (24%), whereof 12-13-y.o. children showed higher frequency of usage ($p=0.007$). Social use of emoji was shown to be mostly popular among friends (75%), with relatives (57%) and with parents (55%). Older children significantly differed from the younger ones for a higher frequency of the items “send emoji to friends” ($p<0.0001$), “to parents” ($p=0.026$) and “to teachers” ($p=0.017$). Seventy % of children reported emoji being fun to use, which was the highest consensus among children compared to the other items within the domain “motivation”. Lower percentages of children reported that emoji can be used to express something that normally cannot be described in words (45%), that they make text messages more understandable (45%) and that they can be used instead of words (42%). Age did not

affect responses for any item of the motivation domain. Children reported to use mostly positive emoji (72%) and enjoy using emoji a lot (65%) or fairly (25%).

2.1.2.2 Foods recalled by each evoked context

Children reported foods that were consumed in seven eating contexts in response to an open-ended question (see Figure 2.2a-g). The types of food were found to be specific for each eating context. For the "Most liked food" the most occurring foods were pizza (40%) and pasta (28%); for the "Most disliked food" it was broccoli (17%) and spinach (16%); for "Breakfast" it was milk (55%) and biscuits (50%); for "Dinner" it was pasta (32%) and several other foods like chicken, salad, vegetables and fish (14-16%); for "Snack" it was bread (31%) and Nutella, sandwich and ham (13-15%); for "Birthday" it was cake (51%) followed by pizza, chips and chocolate (14-21%). For the context "Novel food" foods were more specific for each child resulting in a wider variety of foods e.g., vegetables (13%), specific combinations of pasta with sauce (11%), other non-Italian recipes (10%), oriental recipes (7%) and fish (6%).

a) Most liked food

b) Most disliked food

Figure 2.2 Self-reported foods recalled by each evoked context; a) Most liked food b) Most disliked food c) Breakfast d) Dinner e) Snack f) Birthday g) Novel food.

2.1.2.3 Food-related emoji

In total, 44 emoji were associated with a frequency of >20% to foods recalled by each evoked eating contexts and thus were qualified as "food-related" (Table 2.1). *Neutral face* (😐) and

face with open mouth (😮) were selected less than 20%, but still considered for further analysis because they were assumed to be potentially relevant for the association with the emotions of "surprise" and "indifference". They were also included in previous studies with 8-11-y.o. preadolescents (Schouteten et al., 2019). Consequently, the complete food-related emoji list comprised of 46 emoji.

During data analysis, significant age- and gender differences were detected, which are described more in detail in the following sections.

2.1.2.4 Emoji associated to foods recalled by varied evoked eating contexts

It was shown that the number of emoji associated to recalled foods varied across eating contexts (Table 2.2). The highest number of emoji associated to foods recalled by the evoked context resulted for "Most liked food" (23 emoji), followed by "Birthday" (21 emoji), "Most disliked food" (19 emoji), "Snack" (10 emoji), "Novel food" (9 emoji), "Breakfast" (7 emoji) and "Dinner" (6 emoji).

Table 2.2 Food-related emoji (selected by >20% of children) divided by evoked eating contexts 1) Most liked food 2) Birthday 3) Most disliked food 4) Snack 5) Novel food 6) Breakfast 7) Dinner; the highest number of selected emoji across contexts are shown from top to bottom and most frequently selected emoji within each context are shown from left to right.

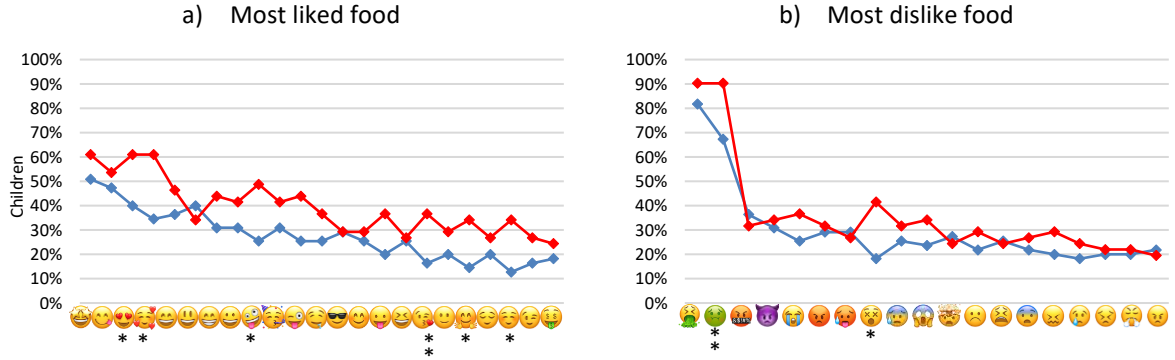
1	🤩	😋	😍	🥰	😄	😃	😁	😀	🤪	🥳	😜	🤤	😎	😊	😛	😆	😘	🙂	🤗	😌	☺️	😉	🤑
%	55	50	49	46	41	38	36	35	35	35	33	30	29	27	27	26	25	24	23	23	22	21	21
2	🤩	😄	😀	😃	😍	😁	😋	🥰	🥳	🙂	😊	😇	😆	😛	😜	☺️	😘	😉	🤑	🤪	😝		
%	58	46	45	45	45	44	44	43	34	31	29	29	28	28	27	26	24	23	23	22	21		
3	🤮	🤢	🤬	😈	😭	😡	🥵	😵	😟	😱	🤯	☹️	😫	😰	😖	😢	😣	😤	😠				
%	85	77	34	32	30	30	28	28	28	28	26	25	25	24	24	21	21	21	21				
4	🤩	😃	😄	😀	😍	😁	🥰	😋	😊	🙂													
%	44	34	34	33	32	31	31	30	25	21													
5	🤩	😍	😋	🙂	🥰	😃	😛	😜	😁														
%	30	29	28	27	24	23	22	22	21														
6	😋	😃	🤩	😁	🥰	☺️	😄																
%	39	30	28	23	23	22	21																
7	🤩	😃	😋	😀	😄	😁																	
%	34	32	31	29	23	22																	

Emoji associated to foods recalled by the contexts "Birthday", "Snack", "Novel food", "Breakfast" and "Dinner" were mostly positive. They were also associated to foods of the context "Most liked food". However, emoji selected to describe foods for "Birthday" included two specific ones that did not appear in "Most liked food" such as *smiling face with halo* (😇)

and *squinting face with tongue* (😝). Frequencies of the most selected emoji in response to foods recalled by these "positive" eating contexts varied from 30 ("Novel food") to 58% ("Birthday"). As expected, children associated mostly negative emoji with their "most disliked food". Within this context, children also had the highest agreement for the use of the *emoji face vomiting* (🤮), with 85% of respondents that defined this emoji as appropriate to describe their experience of the foods recalled by this context.

2.1.2.5 Gender differences in emoji selection

In general, females selected food-related emoji more frequently than males (Figure 2.3a-g). Girls selected an average of 8.8 emoji across all evoked eating contexts in contrast to boys that selected on average 7.3 emoji. Significant gender differences were also found in emoji frequencies describing foods evoked by each eating context except for "Novel food". Especially, emoji with hearts were selected more often by girls in general and in some specific, eating contexts. Frequencies of the *smiling face with heart-eyes* (😍) were significantly higher ($p<0.05$) in females than in males for the foods recalled by the contexts "Most liked food, "Breakfast, and "Snack". The same significant ($p<0.05$) gender effect was found for the *face blowing a kiss* (😘) in relation to the evoked contexts "Most liked food" and "Birthday", and the *smiling face with hearts* (🥰) for the context "Most liked food" ($p=0.010$). For "Most liked food", girls selected significantly ($p<0.05$) more than boys also the emoji *zany face* (🤪), *hugging face* (🤗)and *smiling face* (☺️). For foods evoked by the context "Dinner", females selected *star-struck* (🤩) significantly ($p=0.033$) more often than males. Finally, girls associated the emoji *nauseated face* (🤢) ($p=0.008$) and *dizzy face* (😵) ($p=0.012$) more frequently to foods recalled by the context "Most disliked food" than boys.



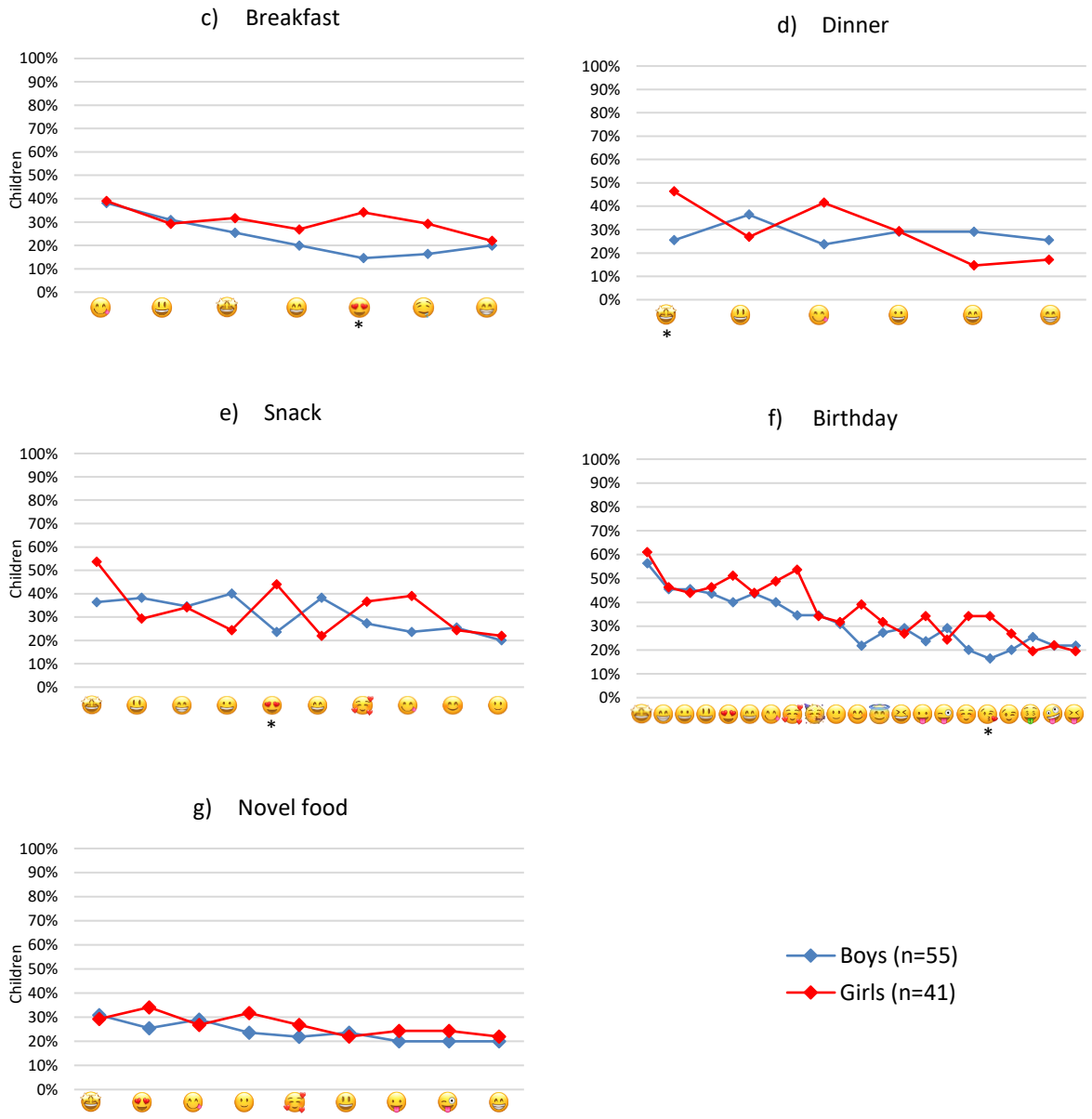
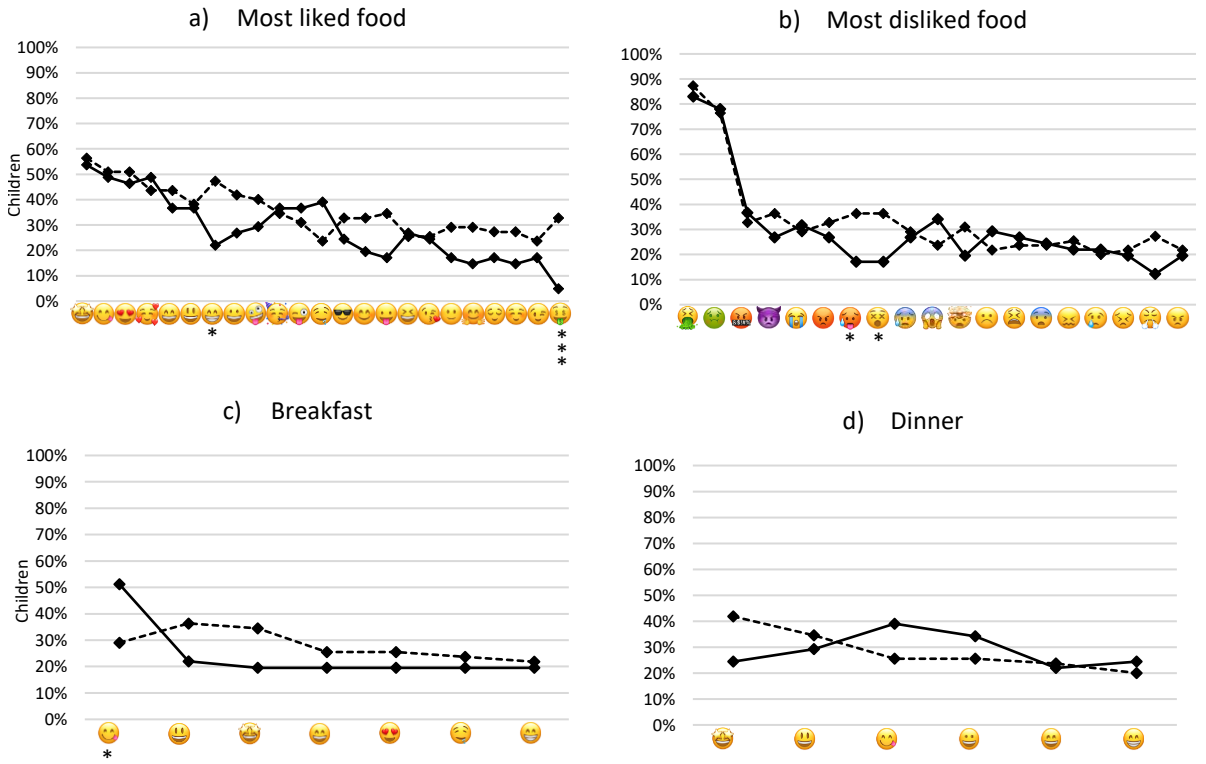


Figure 2.3 Food-related emoji shown for each context with significant differences between genders; a) Most liked food, b) Most disliked food c) Breakfast, d) Dinner, e) Snack, f) Birthday, g) Novel food; most selected emoji in each context are shown from left to right; n=number of children; *=p≤0.05, **=p≤0.01, ***=p≤0.001.

2.1.2.6 Age differences in emoji selection

In general, 9-11-y.o. children tended to use emoji more frequently than 12-13-y.o. children (Figure 2.4 Food-related emoji shown for each context with significant differences between age; a) Most liked food, b) Most disliked food c) Breakfast, d) Dinner, e) Snack, f) Birthday, g) Novel food; most selected emojis in each context are shown from left to right; n=number of children; *=p≤0.05, **=p≤0.01, ***=p≤0.001.

a-g). Younger children selected an average of 6.9 emoji across all contexts in contrast to older children with 4.4 emoji. Age differences were mainly related to the foods evoked by the eating contexts “Birthday” and “Novel food”, where younger children selected laughing/smiling emoji (e.g., *grinning face with big eyes* 😃) and emoji showing their tongue (e.g., *face with tongue* 😛) significantly ($p<0.05$) more frequently than older children. The emoji *star-struck* (🤩) was stated more frequently among 9-11-y.o. children in response to foods of the evoked contexts “Snack”, “Birthday” and “Novel food” ($p<0.05$) and the *money-mouth face* (🤑) was stated more frequently in the evoked contexts “Birthday” and “Most liked food” ($p<0.01$). The *smiling face with halo* (😇) was stated more frequently by younger children for foods of the context “Birthday” ($p=0.024$). For foods evoked by the context “Most disliked food”, the *emoji hot face* (🥵) and *dizzy face* (😵) were stated more frequently by younger children ($p<0.05$). Only one emoji, the *face savoring food* (😋), was stated more frequently by 12-13-y.o. children for foods recalled by the context “Breakfast” ($p=0.028$).



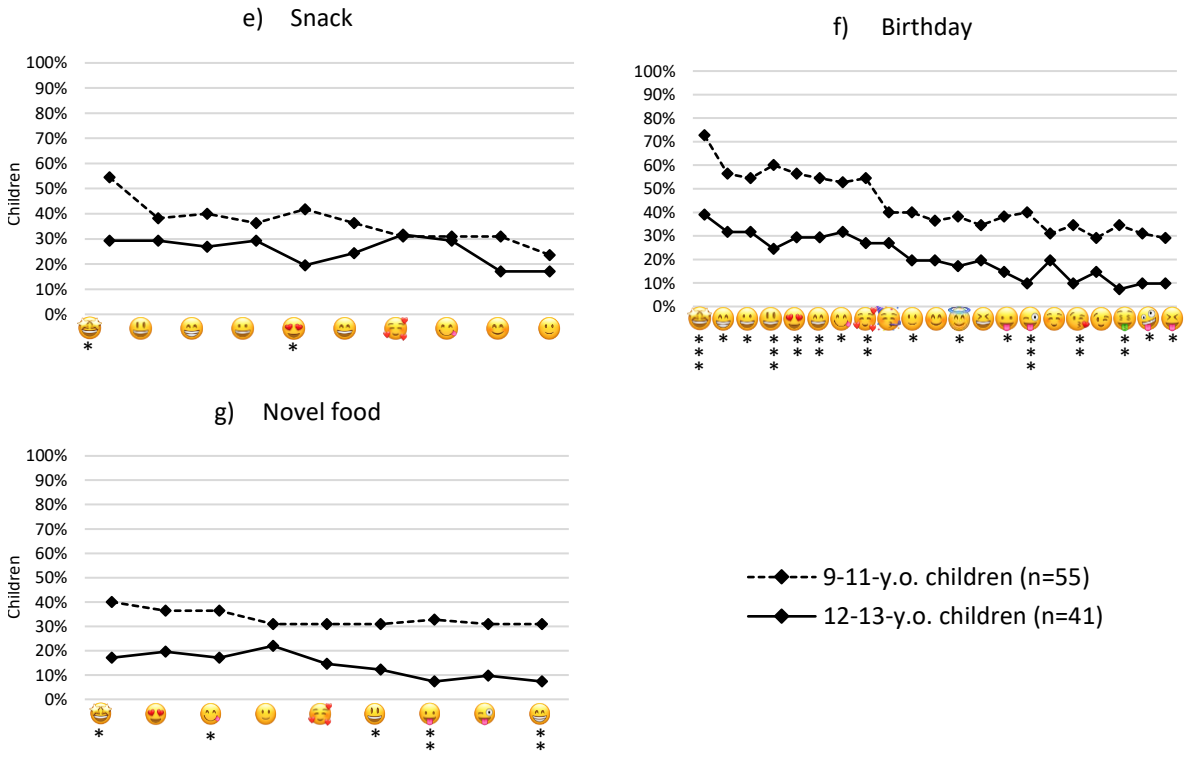


Figure 2.4 Food-related emoji shown for each context with significant differences between age; a) Most liked food, b) Most disliked food c) Breakfast, d) Dinner, e) Snack, f) Birthday, g) Novel food; most selected emojis in each context are shown from left to right; n=number of children; *=p≤0.05, **=p≤0.01, ***=p≤0.001.

2.2 Discussion

The present study explored the appropriateness of emoji to describe preadolescent's emotions elicited by foods recalled in relation to different evoked eating contexts and to explore related age- and gender differences. Forty-six emoji resulted as appropriate to describe emotions in different eating contexts. The number of selected emoji varied across evoked eating contexts eliciting different foods. As expected, age and gender significantly affected emoji selection across and within foods elicited by varied eating contexts.

2.2.1 Emoji usage questionnaire (EUQ) and test evaluation questions

Children found the test easy to do, enjoyed participating in it and enjoyed using emoji to a great extent. This is a very important information as it implies that children's involvement and attention in the test was high, and they were motivated to participate in the test. The fact that the test was conducted on tablets engaged and motivated the children, turning the questionnaire into a gamification task (Simões, Redondo, & Vilas, 2013). Verbal emotion lists can result in boredom and fatigue (Jaeger, Cardello, & Schutz, 2013), whereas emoji might

help to increase the attention span. Children were able to fill out the questionnaire independently, which is encouraged when conducting consumer tests with children (see Laureati & Pagliarini, 2018).

All children, but especially older children, were already familiar with emoji and used them frequently before the study, which was also observed previously among this age group (Gallo, Swaney-Stueve, et al., 2017a). Consistent with previous findings (Commonsensemedia, 2016; Howard, 2018), it was found that 12-13-y.o. children have a more intense and structured social media usage of emoji than 9-11-y.o. children. In fact, it was shown that especially older children send emoji to friends, parents, and teachers, which implies that they already have an increased social network and that they communicate more digitally with these people compared to younger children.

Overall, these findings confirm the opportunity of testing the age effect among preadolescents due to a varied familiarity with and a frequency of emoji usage. However, relevant age differences in the valence domain of the EUQ did not emerge. Similarly, age did not affect responses for any item of the motivation domain. This means that children aged 9-13 use emoji for similar reasons, whereof the most important reason why emoji are used was that they “are fun to use”. Children reported to use mostly positive emoji, which could be one of the explanations why they used so many positive emoji when describing how they felt about their foods recalled by various eating contexts. Future research may extend the focus to further dimensions investigated in adults, such as meaningfulness, visual complexity, and arousal (Rodrigues et al., 2018).

2.2.2 Foods recalled by each evoked context

Preadolescents were able to recall foods for each evoked eating context. Each eating context resulted in a unique collection of foods, of which some foods were stated very frequently and specific for each context. For example, in the context “Most liked food” pizza and pasta, but also several meat products were among the most frequently stated foods, which aligns with Beyer & Morris (1974). Various vegetables (especially spinach and broccoli) and vegetables in general were stated as the most disliked foods, which is in accordance with previous research showing that vegetables were among children’s most disliked foods (De Moura, 2007). The foods of the eating contexts “Breakfast”, “Dinner” and “Lunch” represented foods that were

commonly consumed for these occasions (Monteleone & Dinnella, 2009). “Novel foods” resulted in a wide variety of foods and showed only minor overlappings between children. This could be explained by the fact that each child has a different idea of what food is most novel to them, hence, resulting in very individual food choices.

2.2.3 Food-related emoji

Only facial images were used for the selection of food-related emoji. A similar approach was adopted by Gallo et al. (2017a), but in contrast, we did not exclude any facial emoji previously given the explorative nature of the study. Children did not show any difficulties in recalling their previously consumed foods and expressing how they felt about them. In total, 46 emoji qualified as food-related after children’s selection. This number is slightly higher than the number of emoji included in emoji lists used in previous studies on children (Gallo et al. 2017; Schouteten et al., 2019, 2018). More interestingly, similarities and differences with previously used lists were found. There were some similarities in specific emoji used to describe emotions elicited by foods in children (Gallo, Swaney-Stueve, et al., 2017a; Schouteten et al., 2019), but also in adults (Jaeger, Vidal, et al., 2017). Although, the studies cannot directly be compared due to differences in methodological approaches on how food-related emoji were selected (e.g., focus groups or emoji lists based on adults), some emoji seem to be very popular to describe emotions towards foods. For example, Gallo et al. (2017a) found 38 emoji to be appropriate to describe foods, of which 25 overlap with our findings. Differently from this study the following emoji were not found to be food-related in our study with a selection of ≤20%: *face without mouth* 😶, *anguished face* 😧, *kissing face with closed eyes* 😚, *frowning face with open mouth* 😦, *flushed face* 😳, *pensive face* 😔, *unamused face* 😒, *worried face* 😟, *confused face* 😕, *expressionless face* 😑, *disappointed face* 😞, *sleeping face* 😴 and *grimacing face* 😬.

Schouteten et al. (2019) showed (using the standardized emoji list of Gallo et al. (2017a) the *face savoring food* 😋, *winking face with tongue* 😜, *grinning face* 😀 and *smiling face with sunglasses* 😎 were among the most frequently selected emoji to describe food samples with a mean usage frequency >20%, which was also confirmed in our study (see Table 2.2). The *face with tears of joy* 😂 and *smirking face* 😏 were not demonstrated to be useful to describe the experience of food products, which is in line with Schouteten et al. (2018). On the other

hand, *weary face* 😩 included in the product-specific list was found to be discriminative among speculoos biscuits by Schouteten et al. (2019), but was selected by ≤20% of children as food-appropriate in our study. All emoji of the product-specific list (Schouteten et al., 2019) with exception of the *weary face* 😩 and the non-facial emoji were also part in our food-related emoji list.

These congruencies indirectly indicate that the proposed approach allowed us to select relevant emoji assumed to describe emotions elicited by foods in preadolescents. In addition, all available emoji at the time of data collection increased the list of existing food-related emoji through newly developed or updated emoji. The findings showed that some of these novel images were used quite frequently when children described how they felt about their foods recalled by various eating contexts. One of the most popular emoji was *star-struck* 🤩, which was the most frequently stated emoji in five out of seven eating contexts. Other examples of new food-related emoji relevant to describe emotions elicited by foods included *exploding face* 🤯, *partying face* 🥳, *money-mouth face* 🤑, *smiling face with halo* 😇, *drooling face* 🤤, *nauseated face* 🤢, *face vomiting* 🤮, *angry face with horns* 😈 and *face with symbols on mouth* 🤬. Consequently, these novel emoji could have the potential to be used in an emotion measurement tool to discriminate between real food products.

2.2.4 Emoji associated to foods recalled by varied evoked eating contexts

Regarding context-specific differences it was demonstrated that the number of food-related emoji differed between eating contexts. Foods recalled by the contexts “Most liked food”, “Birthday” and “Most disliked food” elicited the highest frequencies of emoji (respectively 23, 21 and 19 emoji). This result was somehow expected and could be explained by the fact that the foods eaten in these contexts evoked more emotions in preadolescents. The foods eaten in the “Breakfast”, “Lunch” and “Dinner” contexts might resemble more general consumed foods that only elicit a limited number and variety of emotions. In addition, the eating context of “Birthday” activates more positive emotions than everyday meals. Interestingly, the foods recalled by the eating context “Novel food” elicited mostly positive emoji. This was not expected as novel foods are often rejected by preadolescents and usually lead to more negative attitudes towards them (Damsbo-Svendsen, Frøst, & Olsen, 2017). An explanation could be that preadolescents recalled primarily novel foods that they actually liked, thus, they

associated these foods with a positive context. Novelty has been proposed as a dimension, which structures emotion meaning in addition to valence, arousal and control, and which is explicated by surprise (Fontaine & Veirman, 2013). Additionally, preadolescents that like to taste novel foods could be triggered by their curiosity to taste them (Sick et al., 2019). Also, curiosity has been previously described as a positive emotion (Kashdan & Silvia, 2009), which might have triggered more positive emotions in general. The two contexts of "Most liked food" and "Most disliked food" elicited the majority of all food-related emoji and contributed to a rather balanced distribution of positive and negative emoji. An equal balance of positively and negatively associated emoji (38 emoji in total) was also obtained in other research (Gallo, Swaney-Stueve, et al., 2017a). However, we could not identify any "neutral" emoji in our study in contrast to Gallo et al. (2017a), who found that the *relieved face* 😌 was regarded as neutral; in our study this emoji was frequently elicited by foods recalled by the context "Most liked food".

2.2.5 Gender differences in emoji selection

In this study, girls tended to select more emoji than boys. Similar findings were observed previously, where girls mentioned emoji in their discussion about food-provoked emotions more often than boys (Gallo, Swaney-Stueve, et al., 2017a) and females used emoji in their text messages more frequently (Chen et al., 2018). An explanation for this could be that females use more non-verbal communication than males (Hall & Gunnery, 2013) and that females were found to have a higher emotional expressivity (Diener, Sandvik, & Larsen, 1985; Kring & Gordon, 1998), even if the findings about gender differences in the food emotion research are controversial (Cardello & Jaeger, 2016). Although gender differences were minor, it was demonstrated that girls and boys mostly differed in their selection of emoji with hearts. For girls, emoji with hearts seemed to be more relevant to describe positive emotions elicited by foods of recalled contexts. Girls might be able to perceive or express more "lovable" and "endearing" emotions when describing their feelings towards foods, which could be explained by findings showing that women were more probable to communicate love in real life (Wilkins & Gareis, 2006). Boys might exhibit restrictive emotionality for some particular emotions (Jansz, 2000) or they think that emoji with hearts are something for females. These findings may be explained by the role of culture in shaping gender identity and confirm how much gender stereotypes are rooted since childhood (Martinez, Osornio, Halim, & Zosuls, 2020).

For other food-related emoji (e.g., *nauseated face* and *dizzy face*) it was less clear why they were selected more frequently by girls. Literature on gender differences in emoji selection is very scarce, hence, future research should investigate differences between genders.

2.2.6 Age differences in emoji selection

On average, 9-11-y.o. children selected a higher number of emoji and used them more frequently to describe their feelings towards foods recalled in various contexts compared to older children. An opposite trend would have been expected since older children are more familiar with, and more frequent users of emoji as shown in the EUQ. Especially, for foods recalled by the contexts "Birthday" and "Novel food", younger children significantly selected specific emoji more often than older children. A previously conducted study by Pagliarini, Gabbiadini, & Ratti (2005) found age-related differences in respect to liking scores, where younger children generally gave higher liking ratings compared to older children. The results were explained by the assumption that older children already have an increased self-confidence in their preferences, and thus making more critical and selective choices with growing age. In the current study it might be speculated that older children are also more selective towards emotional responses, which might explain the results. In respect to some specific emoji, younger children preferred laughing/smiling emoji and emoji showing their tongue to describe their emotions towards foods that were recalled in several eating contexts. A study showed that younger children tended to use more positive emotions to describe their food-related emotions (Gallo et al., 2017a). Younger children were also shown to differ in their emotion expression (Chaplin & Aldao, 2013), which could lead to differences in how children feel about foods recalled by various contexts. The findings suggest that attention should be paid to the children's age and gender when using emoji-based approaches, but more research is needed to better understand differences related to gender and age. In fact, the number of children in each age or gender group in this study was relatively small (between 41 and 55 children per group), thus studies with bigger sample sizes would be beneficial to generalize these findings.

2.2.7 Conclusions

An approach based on recalled foods evoked by varied eating contexts was applied to select emoji used by preadolescents to represent how they feel in response to food. The CATA method using emoji was shown easy to apply and allowed to define a large list of food-related emoji including facial emoji that were never used in previous studies in this respect. However, as the current list of food-related emoji might contain emoji with very similar meanings, a deep investigation of their meaning should be considered. Significant age- and gender differences were found in the selection of food-related emoji and therefore, future research should investigate if there are differences in the interpretation of food-related emoji.

Chapter 3 The exploration of the meaning of emoji used to describe food experiences

This chapter is based on:

Sick, J., Monteleone, E., Pierguidi, L., Ares, G., & Spinelli, S. (2020). The Meaning of Emoji to Describe Food Experiences in Preadolescents. *Foods*, 9(9), 1307.

Sick, J., Monteleone, E., Dinnella, C., Pierguidi, L., & Spinelli, S. (2022). Development of an emoji-based self-report measurement tool elicited by foods in preadolescents. *Food Quality and Preference*, Pre-proof.

Abstract

Ongoing research has shown that emoji can be used by children to discriminate food products, but it is unclear if they express emotions and how they are linked to emotional words. Little is known about how children interpret emoji in terms of their emotional meaning in the context of food. This study aimed at investigating the emotional meaning of emoji used to describe food experiences in 9-13-y.o. preadolescents and to measure related age- and gender differences. The meaning of 46 emoji used to describe food experience was explored by: mapping emoji according to similarities and differences in their emotional meaning using the projective mapping technique, using two check-all-that-apply (CATA) formats (emoji described by emotion words and vice versa) and using one-on one interviews. The four tasks gave consistent results and showed that emoji were discriminated along the valence (positive *vs.* negative) and power (dominant *vs.* submissive) dimension, and to a lower extent along the arousal dimension (high *vs.* low activation). In general, negative emoji had more distinct meanings than positive emoji in both studies, but differences in nuances of meaning were found also among positive emoji. In the projective mapping task, girls and older preadolescents (12-13-y.o.) discriminated positive emoji slightly better than boys and younger preadolescents (9-11-y.o.). This suggests that girls and older preadolescents may be higher in emotional granularity (the ability to experience and discriminate emotions), particularly of positive emotions. The results of the present work can be used for the development of an emoji-based tool to measure emotions elicited by foods in preadolescents.

3.1 Study 2: The dimensional meaning of emoji using projective mapping

3.1.1 Material and methods

3.1.1.1 Participants

A total of 162 children (54% girls) aged 9-13 (M=11, SD=1.7, in both gender groups) were recruited from three schools attending primary and secondary classes in the Florence area, Italy. Only children who returned a signed consent form from their parents and who agreed to voluntarily participate in the study by signing their own consent form were allowed to participate. There were no other exclusion criteria as no child should feel excluded from the study. Recruitment criteria and data treatment were planned in accordance with the General Data Protection Regulation (GDPR) 2016/679 and the principles of the Declaration of Helsinki. The protocol of the study was approved by the Ethical Committee of the University of Florence, Italy.

3.1.1.2 Data collection

Testing took place in the regular classrooms of the schools. The tests lasted approximately one hour and were conducted during school time between 8 AM and 3 PM. The children sat in their normal seating order, either in rows or in groups of 2-6 seats. Children were given a tablet (Acer Iconia One 10, Android 7.0, Taiwan, China) and asked to fill in the questionnaire individually using the software Compusense Cloud (version 20.0.7557.33837, Compusense Inc., Guelph, ON, Canada). During each testing session, one researcher led the test with the help of 2-3 assistants. The teacher was also present during the session to ensure the children were less distracted and felt at ease. Before each session, the researcher explained the questionnaire and made sure all children were confident about how to use the tablets. Children were invited to ask for assistance in case they had difficulties or questions.

3.1.1.3 Selection of emoji

Emoji appropriate for 9-13-y.o. children to describe their emotional experiences of foods resulting from Study 1 were used to explore their emotional meaning. Table 3.1 displays the list of the selected 46 food-related emoji that were used in the projective mapping task (Study 2).

Table 3.1 Emoji list of 46 emoji appropriate to describe food experiences in preadolescents resulting from Study 1 with emoji names from Emojipedia (Emojipedia, 2019).

😀	*grinning face*	🤤	*drooling face*
😃	*grinning face with big eyes*	🤢	*nauseated face*
😄	*grinning face with smiling eyes*	🤮	*face vomiting*
😁	*beaming face with smiling eyes*	🥵	*hot face*
😆	*grinning squinting face*	😵	*dizzy face*
🙂	*slightly smiling face*	🤯	*exploding face*
😉	*winking face*	🥳	*partying face*
😊	*smiling face with smiling eyes*	😎	*smiling face with sunglasses*
😇	*smiling face with halo*	☹️	*frowning face*
🥰	*smiling face with hearts*	😮	*face with open mouth*
😍	*smiling face with heart-eyes*	😨	*fearful face*
🤩	*star-struck*	😰	*anxious face with sweat*
😘	*face blowing a kiss*	😢	*crying face*
☺️	*smiling face*	😭	*loudly crying face*
😋	*face savoring food*	😱	*face screaming fear*
😛	*face with tongue*	😖	*confounded face*
😜	*winking face with tongue*	😣	*persevering face*
🤪	*zany face*	😫	*tired face*
😝	*squinting face with tongue*	😤	*face with steam from nose*
🤑	*money-mouth face*	😡	*pouting face*
🤗	*hugging face*	😠	*angry face*
😐	*neutral face*	🤬	*face with symbols on mouth*
😌	*relieved face*	😈	*angry face with horns*

3.1.1.4 Study procedure

Children were asked to map the 46 emoji according to similarities and differences in their emotion meaning on a rectangular mapping area (dimensions: 140 x 90 mm) of the tablets. The instructions were: "*These emoji were selected by other children as appropriate to describe food experiences. We are interested in knowing your opinion of how similar or different these emoji are in terms of meaning. Think about using these emoji to describe food experiences. Do not just think about the food you eat, because you also feel emotions for the foods you don't eat (e.g., new foods that you have never tasted, hated foods etc.). You will see a white space on the screen on which to place the emoji. Arrange the emoji on the white space - the closer they are, the more similar their meaning is. It is also allowed to overlay emoji if they have a very similar meaning. The further away you place emoji, the more different their meaning is. Try to use all the space you have available. Pay attention to the meaning and not to how they look graphically. The exact position of each emoji is indicated by the blue pin. If you have any*

questions during the test, raise your hand and we will come to you." Emoji were presented in a random order for each child. Children were able to freely choose in which order they wanted to map emoji and to rearrange emoji on the mapping area as much and as many times they wanted (Figure 3.1). An example was provided before the test with selected cartoons (PrEmo® from Laurans and Desmet (2017)) expressing various emotions. The cartoons were printed in paper and the classroom's blackboard was used by the lead researcher to explain to the children the basic concepts of a mapping task based on the same criteria of the study (similarities in meaning). The cartoons were used as an example instead of emoji to not introduce any bias in the study.

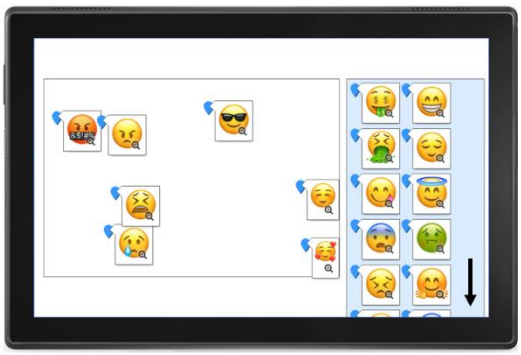


Figure 3.1 Experimental setup of Study 2 (projective mapping); images are derived from screenshots of the original test created through the software Compusense Inc.

3.1.1.5 Emoji Usage Questionnaire (EUQ) and test evaluation

Children were asked about demographics (gender and age) and to fill in a questionnaire including emoji usage questions (EUQ) and questions about the test they completed. Several domains of emoji usage were considered: Familiarity; Frequency of usage; Social use; Motivation; Valence; Enjoyment in using emoji. Two additional questions were asked to know how easy or difficult the test was (very difficult/a bit difficult/neither difficult nor easy/ easy/very easy) and how much they enjoyed it (by no means/a bit/so and so/fairly/a lot).

3.1.1.6 Data analysis

Data of the EUQ were analyzed by calculating frequencies (%) of the total sample and separated by gender (boys *vs.* girls) and school level (elementary *vs.* secondary level). Gender and school level effects on Familiarity, Frequency of usage, Valence and Enjoyment were tested by using Kruskal-Wallis One-Way Analysis of Variance by ranks. Chi-square test was

applied to test differences in the distributions of the responses by gender and school level for each item of the other domains.

Projective mapping was analyzed using a multi-configuration data analysis (STATIS) (Abdi, Williams, Valentin, & Bennani-Dosse, 2012; Lavit, Escoufier, Sabatier, & Traissac, 1994; Lavit, 1988; Valentin, Chollet, Nestrud, & Abdi, 2017). Age- and gender differences were analyzed by considering each subgroup (two age groups: 9-11-y.o. and 12-13-y.o. children; two gender groups: girls and boys) as a separate table.

3.1.2 Results

3.1.2.1 The dimensions of emoji: valence, power, and arousal

Figure 3.2a) shows results of the projective mapping task in which children mapped 46 food-related emoji according to their similarities and differences in their emotional meaning in the food context. The first two dimensions accounted for 38.95% of the variance. Visual inspection of the maps indicates that emoji were mainly separated on the first dimension which explained the 32.03% of the variance. Emoji were discriminated along the first dimension which can be interpreted as valence, with emoji commonly assumed having a positive meaning on the right of Figure 3.2a) and emoji commonly expressing a negative meaning on the left side of Figure 3.2a). Emoji *neutral face* 😐 and *face with open mouth* 😮, usually recognized as indicating "indifference" and "surprise" which are respectively low and high in arousal (Brants et al., 2019; Jaeger, Roigard, et al., 2019) but both neutral in the valence and power dimension (Fontaine & Scherer, 2013), had an intermediate position in Figure 3.2a) even if they were perceived as more similar to the negative emoji group (left side of Figure 3.2a).

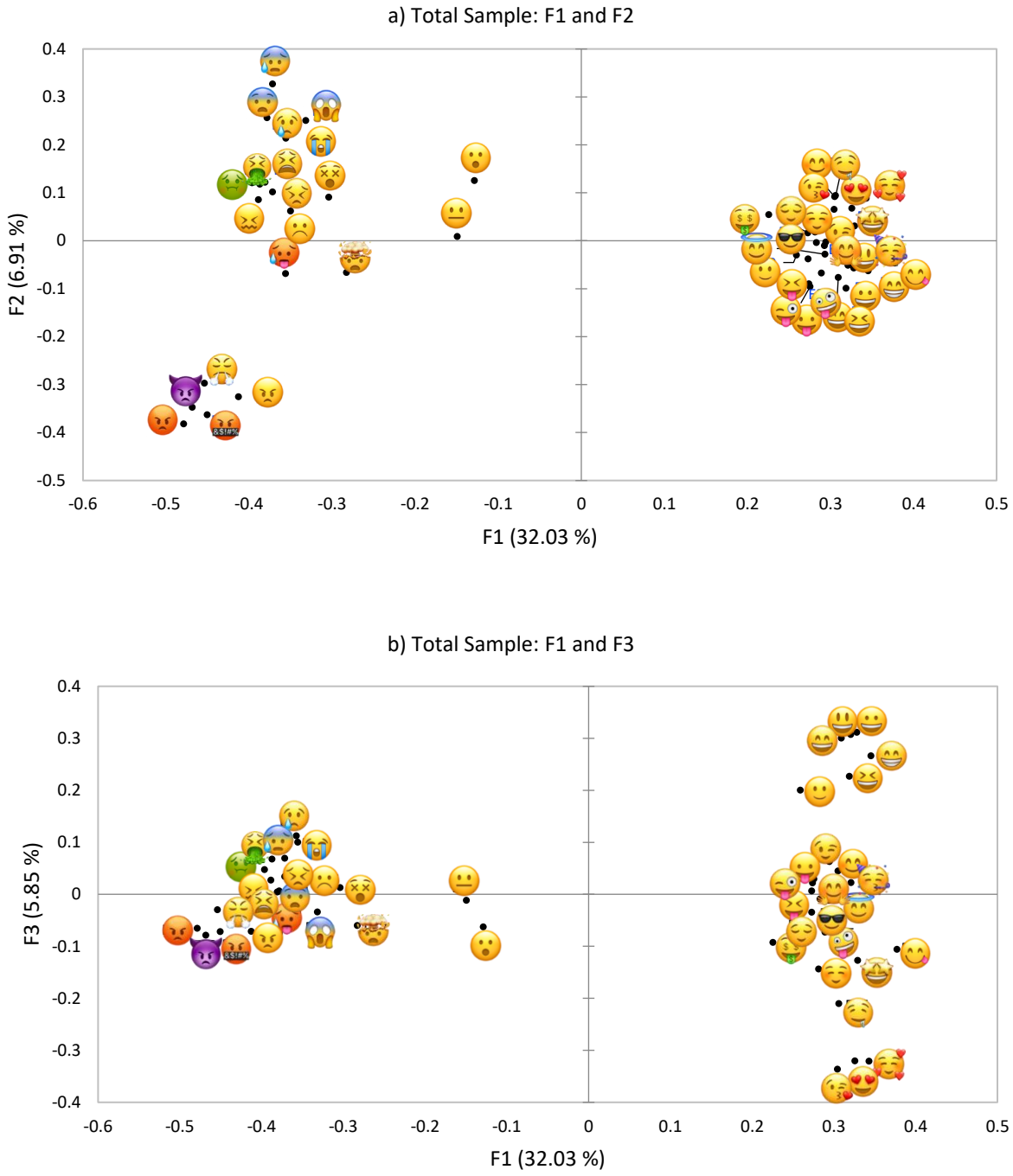


Figure 3.2 a) Representation of emoji in the first and second dimension of the projective mapping task (Study 2) of 46 food-related emoji evaluated by all preadolescents. b) Representation of emoji in the first and third dimension of the projective mapping task (Study 2) of 46 food-related emoji evaluated by all preadolescents.

Discrimination was also observed along the second dimension, which explained an additional 6.91% of the variance. However, the interpretation of the second dimension is less straightforward. Within emoji on the left side of the map of Figure 3.2a) it is possible to identify on the bottom a group of emoji (😡, 😈, 😤, 🤬 and 😠) described in the literature

as expressing “anger,” characterized by negative valence and high arousal (Brants et al., 2019; Jaeger, Roigard, et al., 2019). The emotion “anger” is also high in the power dimension (Fontaine & Scherer, 2013). This group is opposed along the second dimension to a group of emoji (including 😰, 😨, 😱, 😢 and 😭), that were described in previous studies on adults (Brants et al., 2019; Jaeger & Ares, 2017; Jaeger, Roigard, et al., 2019) as indicating high to low arousal states and expressing different negative emotions which included “fear” and “sadness.” These emotions, while differing in arousal are both characterized by a low power (Fontaine & Scherer, 2013).

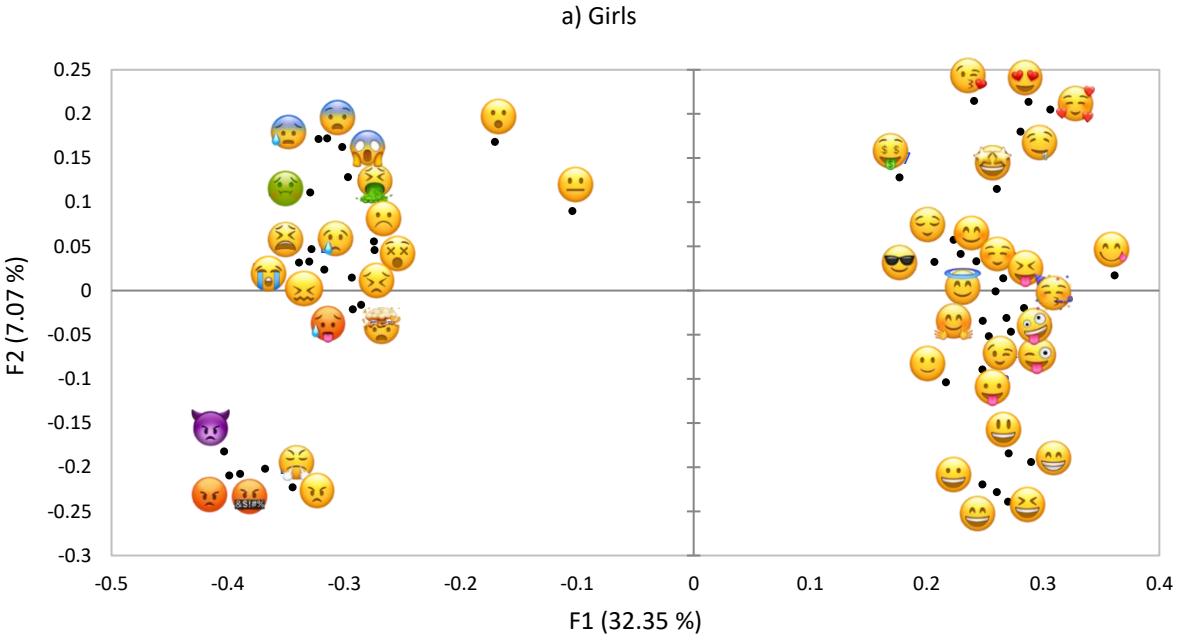
Emoji on the right side of Figure 3.2a) appear very close to each other, indicating a larger overlapping in terms of meaning compared to the group on the left side of Figure 3.2a). Within this group of emoji usually recognized as conveying a positive meaning it was possible to distinguish some emoji on the bottom right side of Figure 3.2a) (e.g., 😝, 😛, 😄 and 😆) that previous studies on adults indicated as expressing “naughty/playful/goofy/mischievous” and “happy,” from other emoji on the top right side of Figure 3.2a) (e.g., 😍, 🥰) which were found to express “love” (Jaeger & Ares, 2017; Jaeger, Roigard, et al., 2019). These two groups of emoji were all high in arousal, while they differed in power, being the former higher and the latter lower in power (Fontaine & Scherer, 2013).

The third dimension explained an additional 5.85% of the variance Figure 3.2b). This dimension differentiated mostly among the emoji conveying a positive meaning the ones commonly found expressing “happiness” (😀, 😄, 😃) and the ones expressing “love” (😘, 😍, 🥰) based on previous study with adults (Jaeger & Ares, 2017; Jaeger, Roigard, et al., 2019), which are respectively characterized by lower and higher arousal. On the bottom left side of Figure 3.2b), in addition emoji indicating “anger” and “fear,” both higher in arousal but different in power, are now close to each other. These results taken together suggest that the second dimension can be interpreted as power, while the third dimension could be interpreted as arousal.

Results of the Emoji Usage Questionnaire are reported in the Supplementary Materials Table S 2 and further described in Chapter 4.

3.1.2.2 Gender- and age differences in emoji dimensions

Configuration of emoji in segments divided by age- and gender Figure 3.3 and Figure 3.4 were similar to Figure 3.2a) (all children). Explained variance of the first two dimensions ranged between 37.84% and 41.36% considering children separated by gender (boys and girls) and age group (9-11-y.o. and 12-13-y.o.), with the first dimension explaining 31.42-32.55% of the variance. The maps were compared by gender and age calculating the RV coefficient and through visual inspection. RV coefficients were very high in both cases (0.94 for gender and 0.92 for age). Visual inspection of the map indicated that gender- and age differences were mainly observed on the second dimension, that we interpreted as power. Girls and older preadolescents (12-13-y.o.) were able to discriminate between positive emoji much better showing some emoji indicating "love" (Jaeger & Ares, 2017) that were low in power (e.g., 😘, 😍, 🥰, 😚) and some emoji indicating "happy" and thus that were higher in power (e.g., 😆, 😄, 😀, 😁, 😃). For boys and younger preadolescents (9-11-y.o.) this discrimination among positive emoji could not be observed. The emoji *face with open mouth* 😮 was interpreted as quite neutral by boys, while it was perceived as more similar to negative emoji by girls. On the other hand, the emoji *neutral face* 😐 had a more negative meaning for boys as demonstrated by the fact that the emoji was closer (= more similar) to the negative emoji in boys than in girls.



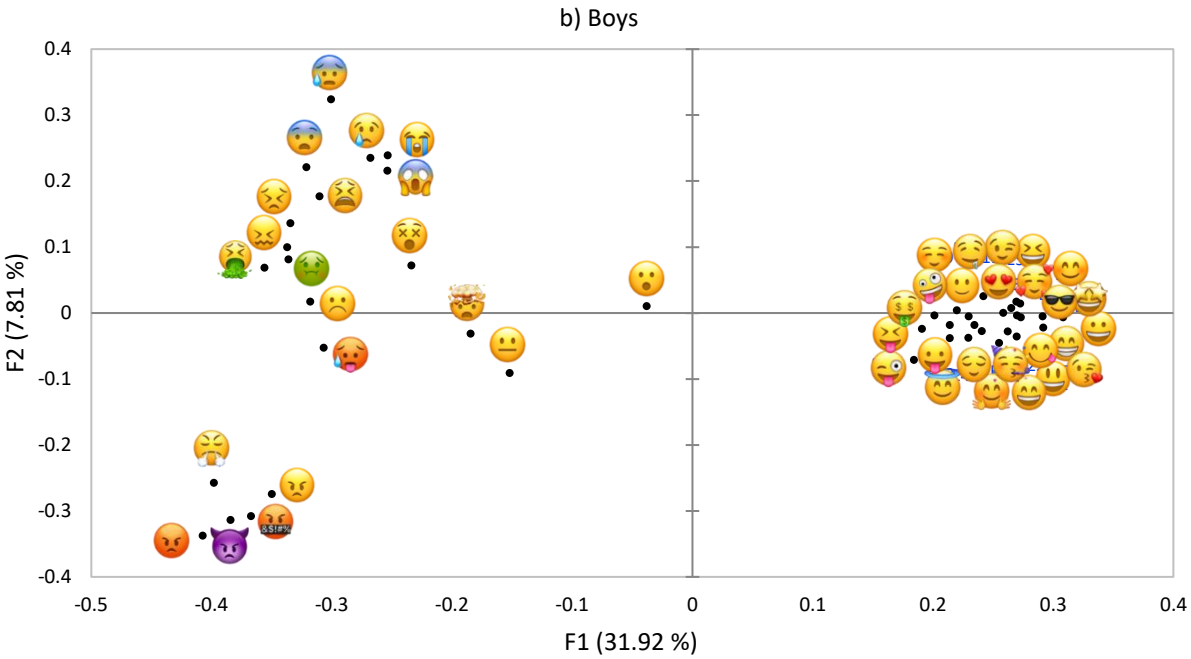
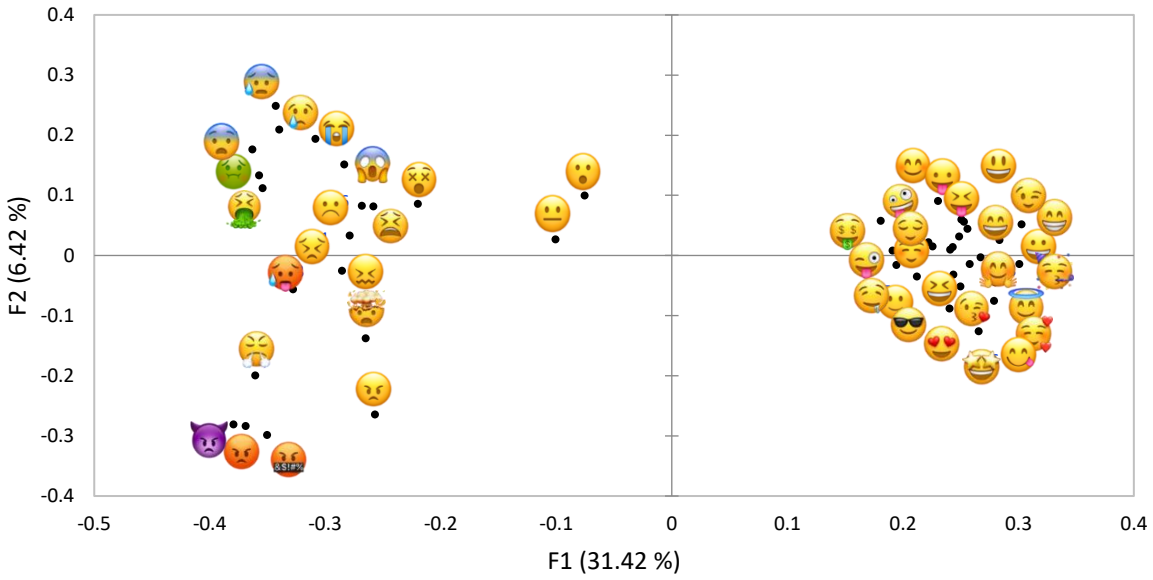


Figure 3.3 a) Representation of emoji in the first and second dimension of the projective mapping task (Study 2) of 46 food-related emoji evaluated by girls (n=87); b) Representation of emoji in the first and second dimension of the projective mapping task (Study 2) of 46 food-related emoji evaluated by boys (n=75).

a) 9-11-y.o. children



b) 12-13-y.o. children

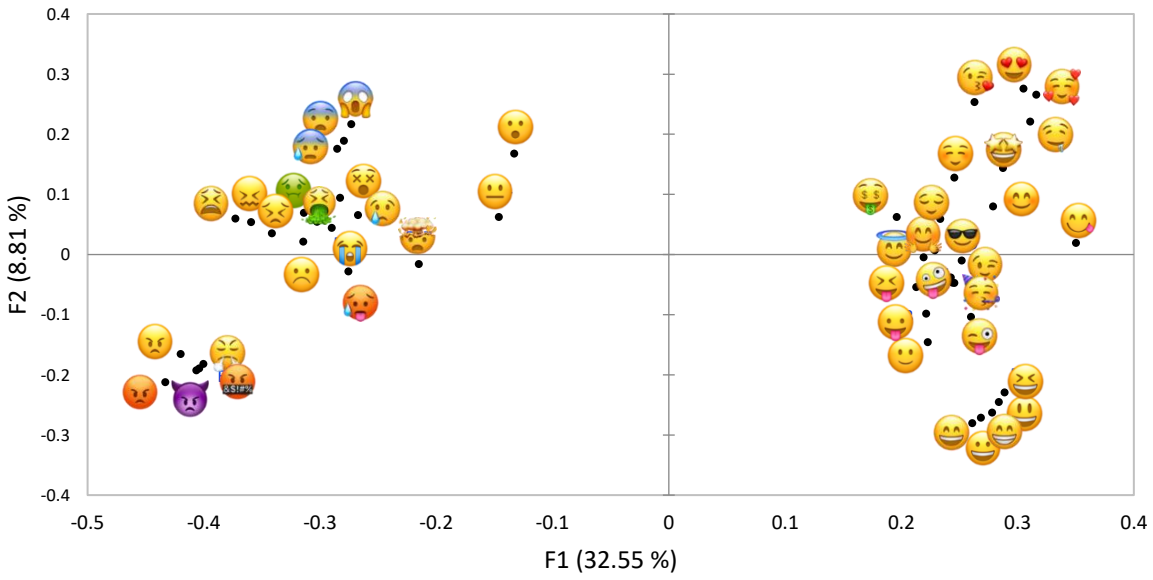


Figure 3.4 a) Representation of emoji in the first and second dimension of the projective mapping task (Study 2) of 46 food-related emoji evaluated by 9-11-y.o. children (n=75); b) Representation of emoji in the first and second dimension of the projective mapping task (Study 2) of 46 food-related emoji evaluated by 12-13-y.o. children (n=87).

3.2 Study 3 and 4: The semantic meaning of emoji using the CATA format

3.2.1 Material and methods

3.2.1.1 Participants

For Study 3, 92 children (57% girls) aged 11-13 (M=12, SD=0.3, in both gender groups) and for Study 4, 85 children (54% girls) aged 9-13 (M=11, SD=0.9, in both gender groups) were recruited from two schools attending primary and secondary classes in the Florence area, Italy. Only children who returned a signed consent form from their parents and who agreed to voluntarily participate in the study by signing their own consent form were allowed to participate. There were no other exclusion criteria as no child should feel excluded from the study. Recruitment criteria and data treatment were planned in accordance with the General Data Protection Regulation (GDPR) 2016/679 and the principles of the Declaration of Helsinki. The protocol of the study was approved by the Ethical Committee of the University of Florence, Italy.

3.2.1.2 Data collection

For both Study 3 and 4, testing took place in the regular classrooms of the schools. The tests lasted approximately one hour and were conducted during school time between 8 AM and 3 PM. The children sat in their normal seating order, either in rows or in groups of 2-6 seats. Children were given a tablet (Acer Iconia One 10, Android 7.0, Taiwan, China) and asked to fill in the questionnaire individually using the software Compusense Cloud (version 20.0.7557.33837, Compusense Inc., Guelph, ON, Canada). During each testing session, one researcher led the test with the help of 2-3 assistants. The teacher was also present during the session to ensure the children were less distracted and felt at ease. Before each session, the researcher explained the questionnaire and made sure all children were confident about how to use the tablets. Children were invited to ask for assistance in case they had difficulties or questions.

3.2.1.3 Selection of emoji and emotion words

Emoji (n=46) resulting from Study 1 (see Table 3.1) were used to explore their semantic meaning in Study 3 and 4. Emotion words were selected by reviewing literature on emotions elicited by foods (Jaeger, Lee, et al., 2019; Spinelli et al., 2014) and general literature on

emotions (Yik et al., 2011). The selection intended to cover a wide range of emotion words differing in the valence- and arousal dimension (Table 3.2). Translation between languages was checked (Scherer, Wallbott, & Summerfield, 1986). The final list resulted in 30 emotion words used in Study 3 and 4.

Table 3.2 Selection of emotion words following the 12-point circumplex structure of core affect (Yik et al., 2011).

Dimensions	Emotion Words		
	References	**Study 3+4 (English)**	**Study 3+4 (Italian)**
I Pleasant Activation	energetic [1, 2, 3], excited [1, 2], sensual[3]	energetic	pieno di energia
II Activated Pleasure	enthusiastic [1, 2], elated[1], inspired [2], amused [3], cheerful [3]	enthusiastic, amused, cheerful	entusiasta, allegro/a, divertito/a
III Pleasure	pleased [1], satisfied [1, 2, 3], happy [2, 3], happy memory [3], merry, cuddled [3], gratified [3]	happy, satisfied, cuddled, gratified	felice, soddisfatto/a, coccolato/a,gratificato/a
IV Deactivated Pleasure	serene [1], peaceful [1], secure [2, 3], at ease [2], generous [3], tender [3], anti-stress [3] (calming, shooting, reassuring)	confident, at ease, reassured	sicuro/a, a mio agio, rassicurato/a
V Pleasant Deactivation	placid [1], tranquil [1], relaxed [2, 3]/carefree [3], calm [2]	relaxed, calm, serene, carefree	rilassato/a, calmo/a, sereno/a, spensierato/a
VI Deactivation	quiet [1, 2], still [1], passive [2], indifferent [3]	indifferent, quiet	indifferente, tranquillo/a
VII Unpleasant Deactivation	sluggish [1], tired [1], dulled [2], bored [2,3]	bored	annoiato/a
VIII Deactivated Displeasure	sad [1, 3], gloomy [1], blue [2], uninspired [2]	sad, melancholic	triste, malinconico/a
IX Displeasure	unhappy [1, 2], dissatisfied [1, 2], neglected [3], disappointed [3]	unhappy, dissatisfied, disappointed	infelice, insoddifatto/a, deluso/a
X Activated Displeasure	distressed [1], upset [1], tense [2], bothered [2], guilty [3]	guilty	in colpa
XI Unpleasant Activation	frenzied [1], jittery [1, 2], nervous [2], annoyed [3]	annoyed, disgusted, angry, worried	infastidito/a, disgustato/a, arrabbiato/a, preoccupato/a
XII Activation	aroused [1], activated [1], active [2], alert [2], surprised [3], curious [3]	surprised, curious	sorpreso/a, incuriosito/a

[1] Yik et al. (2011); [2] Jaeger, Spinelli, Ares, & Monteleone (2018); [3] Spinelli et al. (2014b).

3.2.1.4 Study procedures

Study 3 (CATA with emoji described by emotion words): Children were asked to select all emotion words they found appropriate to express the meaning of each of the emoji. The 46 emoji were presented one at a time in two blocks of emoji (2x23 emoji). Emoji were randomized within each block and the presentation order of the two blocks was balanced across children. In between the two blocks children were given a refreshing break and they were asked to solve a riddle to decrease boredom effects. Emotion words were presented in a balanced order for each emoji. In case children could not find a fitting emotion word to describe the presented emoji or they felt that some words were missing, they had the possibility to specify their own emotion word in an open-ended response format. The instructions also emphasized that there were no right or wrong answers and that responses should be quick and spontaneous. Before the test started, the instructor went through the meaning of each emotion word for everyone in the classroom and poster with a child-friendly description of each emotion word was provided in the classroom. In case children expressed problems understanding a specific emotion word they could check the meaning on the poster and/or ask for questions to the researchers. These instructions appeared on the screen: "*We are interested in the meaning of several emoji used to describe food experiences. You will be asked to evaluate 46 emoji in total but split into two sessions, so you will have a short break in between the two sessions. First, you will see on your screen an emoji and a list of 30 words. You will be asked to select all the words that seem suitable for you to describe the meaning of that emoji. You have to choose at least one word for each emoji, which best represents its meaning. You can also choose several words if you think they suit. If there is a word that is not included in the list but came to your mind, you can specify your own word on the next page. There are no right or wrong answers. If you have any questions during the test, raise your hand and we will come to you.*"

Study 4 (CATA with emotion words described by emoji): Similar to Study 3, the aim was to explore the semantic emotional meaning of the selected 46 emoji from Study 1. The study procedure was organized similar to Study 3, but instead of describing emoji using emotion words, children were asked to describe emotion words using emoji. This inverted procedure was used to recheck the linkage between emoji and emotion words from Study 3. Children did not have the possibility to add other emoji than the ones already presented in the list. Emotion

words (n=30) were presented one at a time in two blocks of emotion words (2x15), presented in a balanced order across children. A refreshment break was given between the two blocks, where children were asked to solve a fun riddle. The following instructions appeared on the screen: "*We are interested in the meaning of several emoji used to describe food experiences. You will be asked to evaluate 30 emotion words in total but split into two sessions, so you will have a short break in between the two sessions. First, you will see on your screen an emotion word and a list of 46 emoji. You will be asked to select all the emoji that seem suitable for you to describe the given emotion word. You have to choose at least one emoji for each emotion word, which best represents its meaning. You can also choose several emoji if you think they suit. There are no right or wrong answers. If you have any questions during the test, raise your hand and we will come to you.*". Figure 3.5 shows the setup of the questionnaires of a) Study 3 and b) Study 4.

a) b)

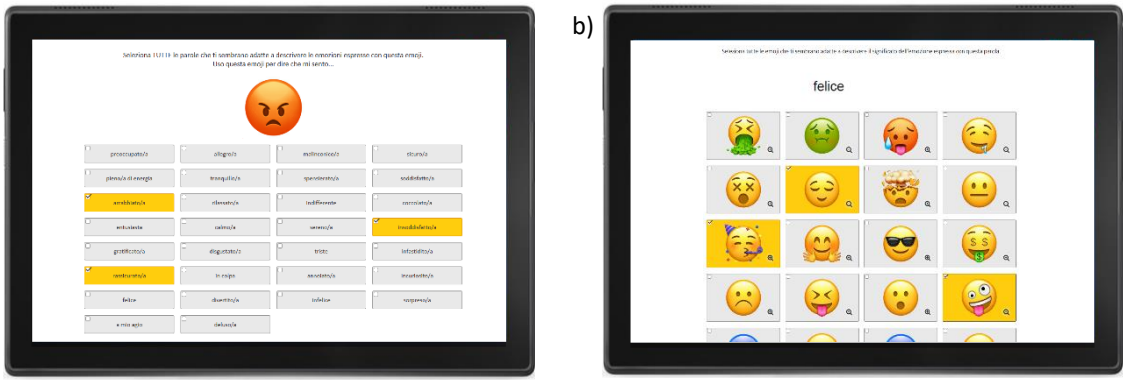


Figure 3.5 Experimental setup of a) Study 3 (CATA with emoji described by emotion words) and b) Study 4 (CATA with emotion words described by emoji); images are derived from screenshots of the original test created through the software Compusense Inc.

3.2.1.5 Data analysis

For both studies, data were analyzed using Cochran's Q test with Sheskin as a post-hoc test to identify the semantic meaning of emoji/words described by emotion words/emoji. Frequency tables (emoji as columns x emotion word as rows or the opposite, depending on the study) were generated and Correspondence Analysis (CA) was applied. CA was applied on the total samples and on boys and girls of Study 3 separately to evaluate gender differences (within-gender approach). Emotion words selected by ≥40% of children for each emoji were considered as important emotion words to describe a specific emoji. For the open-ended

responses in Study 3, additional words were grouped based on their meaning and all emotion words ≥10% were considered as a further emotional meaning for a specific emoji.
RV coefficients were calculated to compare the plots by methods. The interpretation of RV coefficients was accompanied by the visual inspection of the scatter plots of scores of the CAs conducted on each block of data, as recommended by Tomic, Berget, & Næs (2015).

3.2.2 Results

3.2.2.1 Study 3: CATA with emoji described by emotion words

Each emoji was described by 11.7 words on average, with *hot face* 🥵 and *face vomiting* 🤮 that were described by the lowest number of words (5.5 and 5.5, respectively) and the emoji *smiling face with halo* 😇 and *beaming face with smiling eyes* 😁 that were described by the highest number of words (17.2 and 17.8, respectively). Furthermore, on average the number of emotion words selected was higher for positive emoji than for negative emoji (14.3 and 8.7, respectively).

All emotion words discriminated significantly among emoji ($p<0.0001$). The contingency table (%) can be found in the Supplementary Materials Table S 7. The configuration of emoji based on CATA with words (Figure 3.6) was very similar to the one of Study 2 using projective mapping (Figure 3.2a), but the explained variance of the two first dimensions was higher. The first two dimensions accounted for 65.74% of variance. Emoji were mainly divided along the first dimension (accounting for 50.34% of variance) between positive and negative (valence), but negative emoji were also discriminated along the second dimension (accounting for 15.39% of variance). Similar to the projective mapping task the second dimension seemed to be described more by power than arousal and discriminated mainly among the negative emoji (on the left side of Figure 3.6). Positive emoji appeared as overlapped on the map. No major differences by gender were found neither by inspecting the maps nor through RV coefficient (=0.93).

The "angry" emoji group was shown to have by far the most shared emotional meaning (😡, 😈, 😤, 🤬 and 😠), where 74-95% of preadolescents agreed on the emotion word "angry," and for the last three also on the emotion word "annoyed." The *nauseated face* 🤢 (87% of respondents) and the *face vomiting* 🤮 (84% of respondents) were mostly associated with

"disgusted." The *face vomiting* 🤮 was also described by its physical appearances such as "vomiting" and by a "sick" feeling (12% respondents of open-ended response, respectively).

A group of negative emoji (😢, 😭, ☹️, 😣, 😫, 😖) was shown to have multiple meanings. All express "unhappy" (49-66%) and "disappointed" (39-47%) while the first two indicated also with large agreement "sad" (75% and 86%, respectively). The last two expressed also "guilty" (40% and 47% respectively). The *face screaming fear* 😱 was mainly described by "surprised" (58%) and "worried" (48%) but an additional 22% of preadolescents described the emoji as "scared/frightened" in the open comments ("fear" was not included in the emotion list). The *fearful face* 😨 was described as "worried" (56%) and "surprised" (42%).

The *neutral face* 😐 was mainly associated with "indifferent" (58% of respondents) and the *face with open mouth* 😮 with "surprised" (73% of respondents). The *dizzy face* 😵 was associated both with surprised (40%) and with worried (40%), suggesting a more negative meaning.

The emoji 😰, 🤯, 😛 and 😌 were not clearly associated with any emotion word (each emotion word was checked by less than 40% of the participants). All other emoji were associated with "happy" (33-78%) and many of them also with "cheerful" with large agreement. The emoji 😎 expressed in addition "confident" and "at ease" (50 and 44%, respectively). The emoji 😇, 😊, 😌 were also associated with "calm" (44-47%) and "serene" (47-60%). The emoji 😀, 😃, 😄, 😁, 🥰, 🤗 were associated with "serene" (44-55%) and "cheerful" (42-71%), while the emoji 🙂 and 😉 were associated mostly with serene (49 and 36%, respectively). The emoji 🥳 and 😅 expressed a combination of "happy" (70 and 64%), "cheerful" (70 and 49%), "enthusiastic" (49 and 48%), "energetic" (52 and 54%), "amused" (49-42%). The emoji 😜, 🤪, 😝 expressed a combination of "happy" (59-63%), "amused" (51-53%), "cheerful" (57-59%) and "energetic" (41-57%). Emoji 😍, 🥰 and 😘 were used also to express "in love" based on the further comments provided by the participants (63%, 35% and 17%, respectively).

3.2.2.2 Study 4: CATA with emotion words described by emoji

In Study 4, emotion words were described by 3.1 emoji on average, with “indifferent” and “curious” described by the lowest number of emoji (1.4 and 1.5, respectively) and “happy” and “cheerful” described by the highest number of emoji (7.3 and 5.7, respectively). On average, the number of selected emoji was higher for positive emotion words than for negative emotion words (3.6 and 2.5, respectively).

Results of Study 3 and 4 were congruent in linking emoji and emotions words of several emoji. A summary of emoji described by emotion words (Study 3) and emotion words described by emoji (Study 4) evaluated by ≥40% of children can be found in Table 4.3. Nineteen emoji in Study 4 overlapped with the emotional meaning of Study 3, but emoji of Study 4 were linked with less emotion words in general. Aligning with results of Study 3, the interpretation of the meaning of negative emoji was clearer compared to the one of positive emoji as more differentiation was found. The emoji 😛, 🤯 and 😏 were found to have a more ambiguous meaning in both studies. The contingency table (%) of Study 4 can be found in the Supplementary Materials Table S 8.

Results of the Emoji Usage Questionnaire are reported in the Supplementary Materials Table S 3 (Study 3) and Table S 4 (Study 4) and will be further described in Chapter 4.

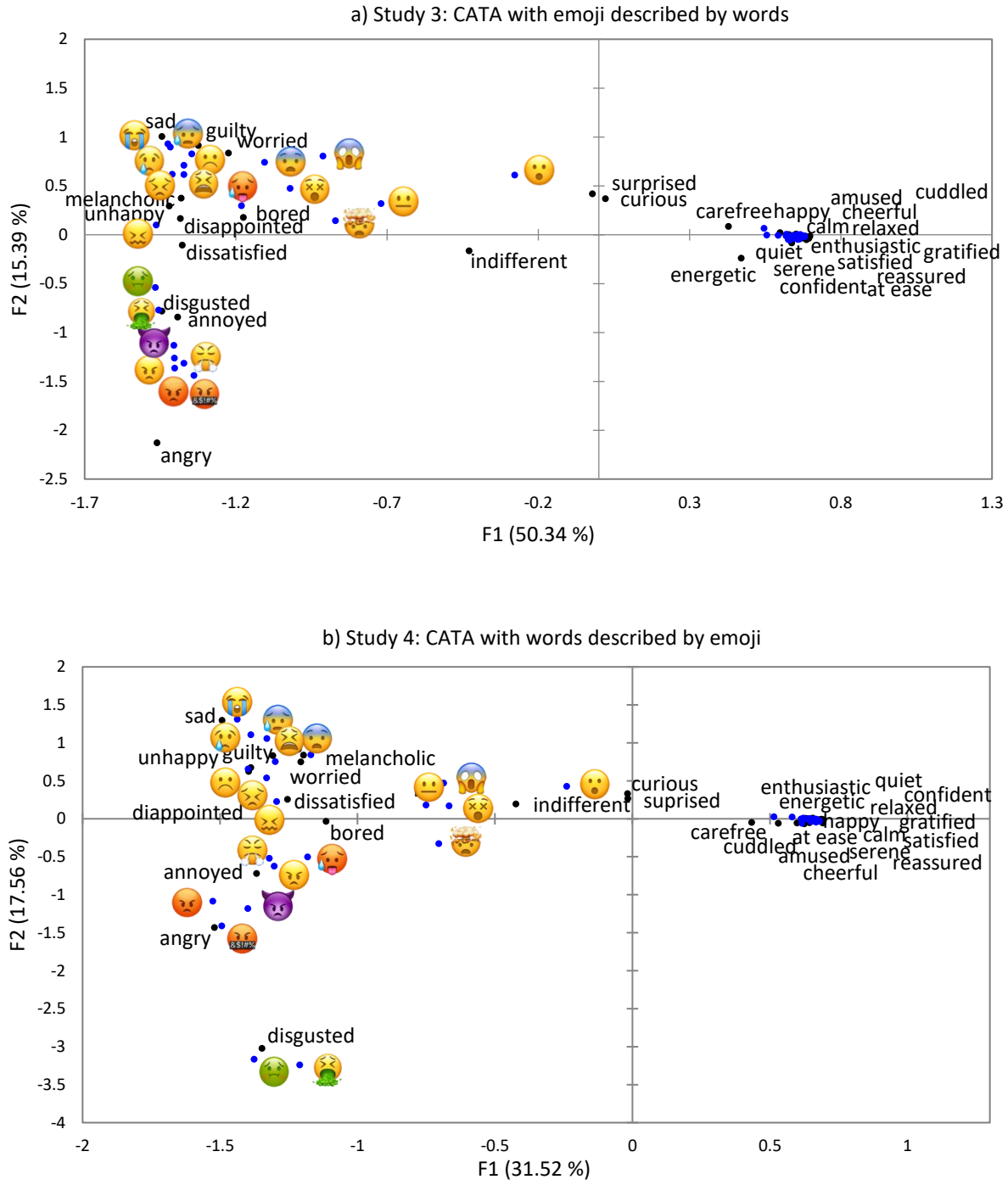


Figure 3.6 Emoji and emotion words representation in the first and second dimensions of the CA a) of the CATA task emoji described by emotion words (Study 3) and b) of the CATA task emotion words described by emoji (Study 4). Emoji 😀, 😃, 😄, 😁, 😆, 🙂, 😉, 😊, 😇, 🥰, 😍, 🤩, 😘, ☺️, 😋, 😛, 😜, 🤪, 😝, 🤑, 🤗, 😌, 😚, 🥳 and 😎 are not shown on the right side of the figure because they are overlapped.

3.3 Study 5: The semantic meaning of emoji using interviews

3.3.1 Material and methods

3.3.1.1 Participants

For the interviews it was aimed to include around 20-25 interviews as suggested by Spinelli & Monteleone (2018). In total, 19 children (53% boys) aged 12-13 attending a secondary school in the Florence area, Italy, attended. Only children who returned a signed consent form from their parents and who agreed to voluntarily participate in the study by signing their own consent form were allowed to participate. There were no other exclusion criteria as no child should feel excluded from the study. Recruitment criteria and data treatment were planned in accordance with the General Data Protection Regulation (GDPR) 2016/679 and the principles of the Declaration of Helsinki. The protocol of the study was approved by the Ethical Committee of the University of Florence, Italy.

3.3.1.2 Data collection

The interviews took place in a quiet classroom at the school and a desk with two chairs was set up: one for each child and one the interviewer (Figure 3.7). Each interview took approximately 15-20 minutes. Each child participated in two interviews (one for positive emoji and one for negative emoji) held on two different days to reduce mental overstrain. The interviews were held by four Italian native speaking researchers working in sensory- and consumer research at the University of Florence, Italy. Before the interviews started, one instructor (researcher) briefed the children about the procedure of the interviews. The children's responses were noted on a response scheme and the interviews were audio recorded with a smartphone. The interviewers ensured the protocol-based procedure and assisted in case of questions.

3.3.1.3 Procedure

The aim of the one-on-one interviews was to explore the semantic meaning of emoji more in-depth and to check if the used emotion words overlap with emotion words from Study 3 and 4. For the interviews, the emoji list of 46 food-related emoji was reduced to a shorter list of 28 emoji due to children's limited attention span and to decrease the risk of boredom effects during the interviews. Emoji that were described by emotion words selected by ≥40% of

children qualified to be included in the interviews. Eight emoji (😝, 😛, 🤗, 😘, 😠, 🤑, 🤯 and 🥵) were excluded directly and not used in the final questionnaire. Either they had a very ambiguous semantic meaning (based on Study 3 and 4) or if the meaning of emoji was quite similar with another emoji, the emoji that had a more complex meaning was included in the interviews. The emoji *drooling face* 🤤 was selected by less than 40% but included as it could be a relevant emoji when describing food experiences based on previous studies (Jaeger, Lee, Kim, et al., 2018).

One-on-one interviews were conducted by asking children about the emotional meaning of 28 emoji using a modified version of the Repertory Grid Method (EmoSemio approach, Spinelli et al., 2014). The resulting list included 16 positive emoji, 11 negative emoji and 1 emoji (*face with open mouth* 😮) with both positive and negative meaning, which was the only emoji included in both emoji groups (positive and negative). Classification was based on results of the projective mapping data (Study 2) dividing emoji into positive and negative valence along the first dimension (Figure 3.2a). Emoji were printed on 4x4 cm paper cards. Half of the children started with the positive block and half with the negative one and the following day children were interviewed with the opposite emoji block. Depending on if children started with the positive or negative emoji group, they were asked to give examples of foods they liked or disliked, respectively, to trigger emotions elicited by food experiences. The interview structure for the positive emoji group with 17 emoji was as follows:

1) Children were asked to think about and provide examples of their favorite foods and other foods they like (even if they are not their favorites). The interviewer recorded the responses.
2) The children were then asked to select an emoji from the list in front of them to describe how these foods make them feel. They were asked to rank the emoji cards to describe their indicated foods from the most liked to less appreciated but still liked foods (Figure 3.8Ea). The interviewer noted the order of emoji for each child and divided the emoji into triads (Triads 1-5 + one remaining pair: emoji 1,2,3/ 4,5,6/ 7,8,9/ 10,11 /12,13,14/ 15,16,17) to facilitate a structured conversation about emoji with the children.

The interviewer focused on one triad at a time, starting from the cards 1,2,3 (Figure 3.8b); the emoji cards of the triads not used at that moment were moved to the side of the desk to help the child focus only on the triad object of the interview. The interviewer's instructions for one triad were: "*The emoji you put on the first position (1), what does it express differently compared to the other two (always thinking you're using them to describe your experience of food)?*" [Child's answer] "*The emoji you put on the third position (3)/in the middle (2), what does it express differently compared to the other two (always thinking you're using them to describe your experience of food)?*". This was repeated for all the triads and the remaining emoji group. The same procedure was repeated for the negative emoji group with 12 emoji (Triads 1-4), in this case asking for examples or disliked (including the most disliked) foods.

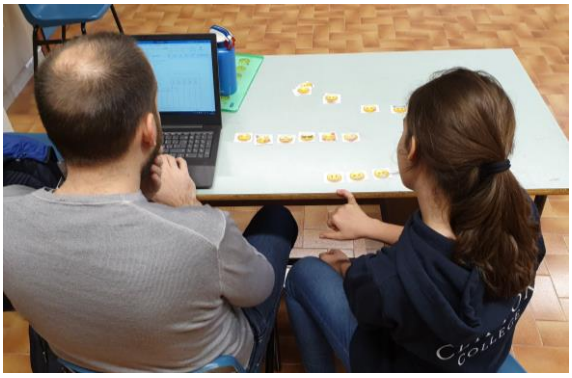


Figure 3.7 Experimental setup of the interviews with one instructor (left) and the child being interviewed (right); picture credits: Julia Sick.

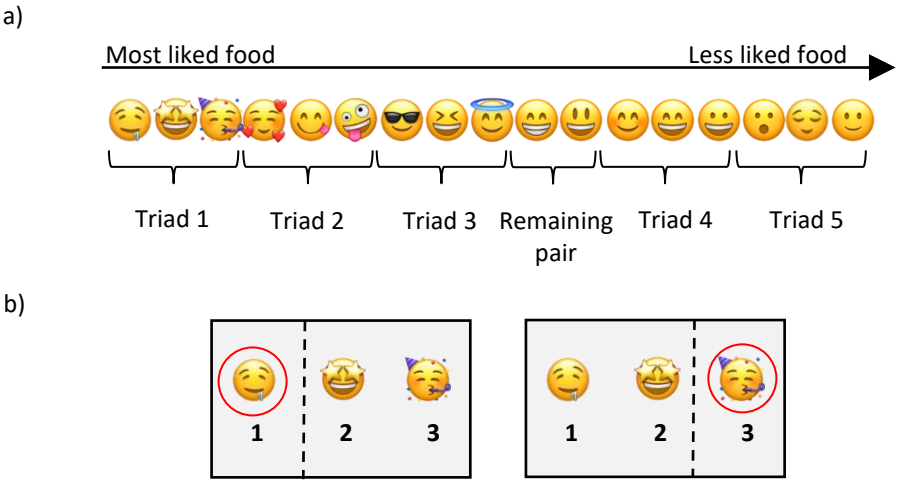


Figure 3.8 Experimental design of the one-on-one interviews using a modified version of the Repertory Grid Method (RGM) (EmoSemio approach, Spinelli et al., 2014) showing an example of the procedure of the positive

emoji group. a) Emoji ranked to describe from the most liked to the ones less liked food (among liked foods); b) Example of Triad 1 to ask to the child about similarities and differences in emotional meaning between emoji.

3.3.1.4 Data analysis

Interviews were analyzed through manual semiotic text analysis (Spinelli et al., 2017). Coding based on semantic meaning was applied by two researchers separately. A third researcher checked the analysis and the coding. Emotion phrases with a similar meaning were grouped into one group (e.g., “felice”, “felicissimo”, “molto felice” were grouped into “felice”) and translated into English by a researcher. The frequencies (%) of emotion constructs for each emoji were calculated. Emotion words (constructs) that were used by ≥10% of the participants were considered to describe the emotional meaning of a specific emoji.

The level of significance for all the analysis was set at $p \leq 0.05$. Statistical analyses were performed using XLSTAT (version 2018.7, Addinsoft, New York, NY, USA).

3.3.2 Results

A selection of emoji (n=28) was used for a more in depth-analysis in the one-on-one interviews. Prior to the interviews, eight emoji were excluded to limit the emoji list due to children’s limited attention span in the interviews. For negative emoji, the exclusion criteria were less restrictive as there were fewer negative emoji than positive. When there was a set of emoji that were very similar in their meaning (e.g., 😜 and 🤪 both described as happy, cheerful, amused, energetic), the emoji with the more complex meaning (🤪) was considered. In other cases, the emoji with the lower percentage of an emotion word that was specific for similar emoji (e.g., 😘 was excluded because it showed a lower percentage (17%) of “in love” compared to 😍 (63%) and 🥰 (35%)) was excluded. Other emoji either showed a very ambiguous meaning or were not associated with any emotion word in Study 3 and 4 and were excluded directly (e.g., 🤯 and 🥵).

Reported emotion word constructs for each emoji mentioned by ≥10% of children were summarized in Table 4.3. All 28 emoji were described with at least one emotion word evaluated by 11-84% of children. The word “happy” was associated with all positive emoji except for the emoji *face with open mouth* 😮. Some positive emoji were only described as “happy” (😀 and 🥰), while some were described with additional emotion words that are

described below. Emotion words constructs from the interviews were mostly overlapping with the meanings from Study 3 and 4. Some emoji were shown to have very diverse meanings e.g., while in Study 3 and 4 the *anxious face with sweat* 😰 was described as "worried" (53% and 41%, respectively), it was associated with various emotion words in the interviews: uncomfortable (26%), annoyed (11%), sad (11%), anxious (11%), I don't want it (11%), worried (11%), amazed/perplexed (11%), disgusted (11%).

Interviews were used to clarify the meaning of emoji more in-depth and to further reduce the emoji list for the final questionnaire. To avoid repetition of results in this thesis, a more detailed description of emoji meanings resulting from the interviews can be found in Chapter 4 on the development of the final emoji-based self-report questionnaire.

3.4 Discussion Studies 2-5 exploring the meaning of emoji

The current studies aimed at investigating the emotional meaning of emoji used to describe food experiences in 9-13-y.o. children. Results showed that the selected emoji were mainly discriminated according to valence (positive *vs.* negative). However, they were also differentiated according to the power dimension (control *vs.* lack of control of the situation) and, to a lower extent, according to the arousal dimension (high vs. low activation). In general, negative emoji were better discriminated in their emotional meaning than positive emoji. This could be explained by the fact that the span of perceptual differences of the emoji expressing positive meaning was smaller than the one of the emoji with a negative meaning. It may also be hypothesized that children found it easier to discriminate between negative emotions than between positive emotions, due to their emotional development. In fact, children acquire emotion categories gradually, but it has not been demonstrated if negative or positive emotions are acquired first (Widen & Russell, 2008). However, most of what we know about the development of emotion categories comes from studies of infant attention to highly stereotypical, posed facial configurations, ignoring the real-world variability (Hoemann et al., 2020). Furthermore, most of the studies on emotional development in children are limited to basic emotions, thus including only one positive emotion (happiness). On the other hand, these differences in discrimination ability between positive and negative emoji were not found in adults (Jaeger & Ares, 2017; Jaeger, Roigard, et al., 2019), thus indicating a specificity of this age range. Further studies are needed to better explain this finding.

Studies 2-5 provided consistent results and contributed to the understanding of the meaning of emoji in preadolescents. Projective mapping provided information on the semantic inter-relationships between emoji according to the dimensions structuring emotion meaning, while the two CATA approaches allowed to investigate the association between emoji and words. Interviews helped to explore the meaning of emoji even more in-depth and to clarify meanings of emoji that did not have a straightforward meaning in Study 3 and 4. Furthermore, from a methodological point of view, projective mapping was found to be very effective in determining similarities and differences of meanings of emoji in preadolescents and could be recommended as a method to explore the meaning of emoji.

3.4.1 The dimensional meaning of emoji: similarities and differences

Emoji were primarily separated according to valence on the first component, which is in agreement with other research that identified the valence dimension in emoji (Fontaine & Scherer, 2013; Jaeger, Roigard, & Ares, 2018; Jaeger, Roigard, et al., 2019; Rodrigues et al., 2018). Valence is the building block of emotional life (Barrett, 2006b) and this may explain this result. Emoji conveying a positive meaning were clearly separated from emoji conveying a negative meaning indicating that emoji have a distinct meaning in terms of valence, and this was true regardless of gender and age.

The categorization in positive and negative emoji was consistent with previous studies (Gallo, Swaney-Stueve, et al., 2017a). Additionally, neutral or moderately valanced emoji were found (Jaeger, Roigard, et al., 2019; Rodrigues et al., 2018) including the two emoji indicating "indifferent" and "surprised". For their positioning on the map, these emoji resulted as the most neutral compared to the others, which conforms with previous studies (Jaeger, Roigard, et al., 2019; Rodrigues et al., 2018), even if they were interpreted as slightly more negative (more similar to the negative emoji than to the positive emoji). Surprise can be both positive and negative (Fontaine & Scherer, 2013; Kim et al., 2004), while indifference in the case of food experience is generally associated with a not optimal product performance (Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015). Emoji faces with neutral facial expressions (e.g., *neutral face* 😐) are often used in questionnaires/scales with the intent to have neither a positive nor negative meaning (Laureati, Bergamaschi, & Pagliarini, 2015; Swaney-Stueve et al., 2018) and used as a neutral anchor point in hedonic scales used with children (Guinard,

2001) and in scales to measure emotional responses (Deubler et al., 2020). Though, attention has to be paid when used with preadolescents as they might interpret these emoji as more negative than expected.

Differently from previous studies on adults (Jaeger & Ares, 2017), the second dimension cannot be interpreted as arousal. This dimension can instead be interpreted as power for negative emoji and to some minor extent for positive emoji. In fact, the second dimension separated emoji expressing "angry" and "annoyed" from emoji expressing "sad" and "worried"/"surprised"/"fear". Power, and not arousal, discriminate anger from fear: both are high in arousal, but the former is high in power as well, while the latter is low in power. Sadness is the opposite to fear in terms of arousal but they both are low in power, and this may explain their close positioning on the map. The emoji expressing "disgusted" characterized by an intermediate level of power, were situated between the two groups described above. Positive emoji were not discriminated very well along the second dimension. However, some emoji on the bottom right side (Figure 3.2a) expressing e.g., "cheerful"/"amused"/"happy"/"energetic" (like 😜, 🤪) tended to be higher in power, whereas other emoji on the top right side (Figure 3.2a) expressing "love" (like 😘, 😍, 🥰) tended to be lower in power. The third dimension differentiated better the emoji conveying a positive meaning and might indicate arousal, discriminating the ones expressing e.g., "happy"/"serene" (😀, 😃) low in arousal, from the ones expressing "happy"/"love" (like 😘, 😍, 🥰) higher in arousal. This could be observed to a lower extent also on the left side of Figure 3.2b), where it can be seen that emoji expressing "angry" (like 😡, 😈) and "worried"/"surprised"/"scared/frightened" (like 😱) are now close to each other (both are high in arousal) and separated from emoji indicating "sad" (like 😭, 😢) (low arousal).

This difference in the relevance of the dimension of power in relation to the dimension of arousal may be explained by a different focus on aspects of the meaning of emoji in preadolescents compared to adults. In this age range the attention could be more on the control of the situation than on the physiological activation. This finding is also consistent with the theory of emotions as constructions made by a person to give meaning to the sensations he or she experiences (Barrett, 2006b).

3.4.2 The semantic structure of emoji according to preadolescents

The approach to identify the semantic structure of emoji in detail to describe food experiences has not been applied before with preadolescents. The present study extends previous research by asking children not only which emoji they found appropriate to describe how a food product makes them feel (Study 1, but also how they interpret emoji when describing their experiences (Studies 3-5). Several emotional meanings of emoji aligned with research findings based on adults (Jaeger, Roigard, et al., 2019) but some minor differences were shown as well. For example, in their research, *grinning face* 😀 was associated mainly with "happy" (99%) and "excited" (11%), while in our study it was associated with "happy" (66%), "serene" (54%), "cheerful" (50%) and "amused" (41%). The *smiling face with sunglasses* 😎 was associated mainly with "be/act cool" (63%), "happy" (23%), "relaxed/calm" (21%), while in our study it was also associated with "confident" (50%), "satisfied" (44%), "at ease" (44%) and "feeling cool" (11%). The *winking face* 😉 was linked with "wink" (30%) and "flirty/sexy" (20%), which may not be appropriate in the case of preadolescents (in our study interpreted as "happy" (49%), "cheerful" (40%) and "confident" (40%)). The *angry face* 😠 was also interpreted as "crazy/mad" (30%), which was only interpreted as "angry" (91%) and "annoyed" (53%) in our findings. Compared to adults, the frequency of selection of the emotion words was considerably higher (Jaeger & Ares, 2017). This may be due to age-related characteristics and may also be related to the context in which the task was performed - at school, in which usually children are required to pay attention and be concentrated. These differences in emoji meanings between children and adults support the importance of developing age-specific emoji lists for preadolescents to avoid ambiguity in the interpretation and following use of emoji in such self-report questionnaires.

Results showed that emoji ranged from having distinct meanings, a small set of related meanings to heterogenous meanings, which conforms with previous research findings (Bai et al., 2019; Jaeger, Roigard, et al., 2019). In general, negative emoji were shown to have more distinct meanings compared to positive emoji, which is in line with previous research (Jaeger & Ares, 2017). For some emoji, a very high agreement among children in linking emoji and emotions words was found, which was especially true for angry emoji (e.g., *enraged face* 😡, 79-95% in Studies 3-5), disgusted emoji (e.g., *nauseated face* 🤢, 79% in Studies 3 and 87% in

Study 4) and sad emoji (e.g., *loudly crying face* 😭, 53-86% in Studies 3-5). Emotions such as anger and sadness are frequent emotions in everyday life and this contributes to explaining this result (Scherer, Wranik, Sangsue, Tran, & Scherer, 2004). A further explanation could be that anger (Butler, Meloy-Miller, Seedall, & Dicus, 2018) and especially disgust (Rozin & Fallon, 1987) (both high in arousal) serve as "protective" emotions against incidences that could be potentially dangerous (e.g., consumption of poisonous food, threat etc.). Hence, these instances of emotions could be learnt from an early age and be more memorable when needed. Most positive emoji were described by the word "happy". Jaeger, Roigard, et al. (2019) reported that "happy" also occurred in several positive emoji of which some overlap with our findings. Preadolescents may use "happy" to describe general feelings of pleasantness (positive valence), which is learnt from early age and may be predominant for individuals of lower in emotional granularity (the inability to make finer distinctions between emotions). This may be especially true for children as their language/vocabulary is not yet as developed as the ones of adults and hence, suitable to characterize most positive emoji. This word might be learnt from early age and be in fact the most familiar word in children to describe a positive emotion. In a study with 4-8-y.o. children it was shown that happy was very accurately identified in emoji without experience in social media or smartphone use (Oleszkiewicz, Frackowiak, Sorokowska, & Sorokowski, 2017).

Positive emoji were also described by more words in general, which could be explained either by some ambiguity in the meaning of some emoji or that the use of positive emoji is more context dependent (Wijeratne, Balasuriya, Sheth, & Doran, 2016). We may also hypothesize that emoji expressing a basic emotion (e.g., disgusted, sad, angry, happy; Ekman, 1992) are more easily associated with a facial expression, represented in a stereotypical and exaggerated way in emoji. This may explain why these words are more easily associated with some emoji. On the other hand, we observed a pervasiveness of the word "happy" (or "content", a synonym in Italian), that was associated with almost all the emoji expressing a positive meaning. This may suggest that there is a variation in positive emotions that is not fully expressed by specific words or faces (Barrett, 2006b).

In many cases more than one emoji could be used to express similar meanings with relatively high agreement between participants. It was also shown that some emoji express a meaning that is not limited to one emotion word. This is for example the case of some emoji that

expressed both “angry” and “annoyed”. This is in line with Jaeger et al. (Jaeger & Ares, 2017) that showed the existence of multiple meanings for several emoji and associations between emoji and emotion words differing in strength. As noted, many positive emoji differ slightly graphically and expressed probably different intensities of emotions compared to negative emoji that in many cases indicated different discrete emotions. This is the case for example of the emoji 😀, 😃, 😄 and 😁 that expressed all “happy”, “cheerful” and “serene” (frequency > than 40%), with small differences, even if not statistically significant: the percentage of association of “cheerful” with the last two emoji was 71% and 64%, respectively.

Gallo, Swaney-Stueve, & Chambers (2017) suggested some emotion words as relevant and appropriate for 8-11-y.o. children to describe their emotions in response to food. The words “cheerful”, “disgusted” and “cool” were also found to be relevant in our study, however, this was not the case for “amazed”, “confused”, “excited”, “nervous”, “powerful”, “safe”, “thankful”, “tired”, “upset”, and “weird”. It should also be considered that the two studies were conducted in different languages (American English, in Gallo, Swaney-Stueve, & Chambers, (2017) and Italian, in our case) and this may contribute to explain these differences.

Moreover, the current findings indicated that a limited number of emoji should be excluded from studies with preadolescents as their meaning is unclear and not shared among this age group. Some emoji could be less familiar in general, but it should also be considered that preadolescents may differ in their experience in how they use emoji, and this may impact how their meaning is interpreted, e.g., there may be differences in social interaction or social media platforms leading to various “learned” meanings of the same emoji. This might explain in part the heterogeneous responses for the same emoji.

The results indicate that, especially in the case of positive valence, emoji that are used in questionnaires to measure emotional responses to food products should be selected with caution to avoid possible risks of misinterpretation or interpretation discrepancies.

3.4.3 Emoji and words: not always a straightforward link

Moreover, a large variability in children’s selection of words/emoji was observed, which was based on individual differences in ticking styles when selecting emoji using the CATA format and a variability in the strength of association when emoji are described by words or vice versa. In a recent study it was shown that children differ in ticking styles when using the CATA

task (Galler, Næs, Almli, & Varela, 2020). Some children could be more likely to tick only a few attributes per sample, increasing their number of ticked attributes per sample over the test, while some children tick a steadier number of attributes in general. It may be hypothesized that the number of selected attributes could be influenced by the emotional granularity of the person describing the emotion. For example, people lower in emotional granularity often use more global terms when expressing emotions and use some terms (e.g., “sad” and “angry”) interchangeably to describe a general unpleasant feeling (Barrett, 2006b). Children who added extra words to describe emoji (Study 3) could be higher in emotional granularity as they make finer distinctions between the meaning of emotion words.

The task to link emotion words with emoji and vice versa resulted in overlapping emotional meanings. However, when children described emotion words with emoji (Study 4), in some cases, children had difficulties to describe words with emoji. It is suspected that for children it is easier to describe emoji with emotion words than vice versa. In Study 4, there were emotion words that never reached the selection threshold of ≥40%. Using emoji in text communication is a learned/ acquired language, which requires the understanding of the appropriate usage of such icons. In contrast, the mother tongue acts as the meta language and therefore it is easier to describe another acquired language (in this case, emoji) with the metalanguage (emotion words).

In Study 3, only secondary school children participated. Initially, it was intended to include both primary and secondary school children, but at this time there were no primary school classes available to participate in the study. As secondary school children were older (12-13-y.o.) this may have contributed to the stronger link between emoji and emotion words due to their increased developmental ability to express and understand emotion words compared to younger children (9-11-y.o.).

3.4.4 Gender and age differences

Results showed that differences in gender and age were limited. All preadolescents independently from gender and age agreed on the discrimination on the first component, distinguishing emoji expressing a positive from emoji expressing a negative emotion. In the projective mapping task girls and older preadolescents (12-13-y.o.) discriminated according to the power dimension better among positive emoji compared to boys and younger

preadolescents (9-11-y.o.). This could be related to gender differences in children's emotional expression (Chaplin & Aldao, 2013). Girls may be higher in emotional granularity of positive emotions and therefore being able to make finer distinctions between positive emoji. Girls express more positive emotions than boys which further develop with increasing age (Chaplin & Aldao, 2013). In Study 1 it was shown that preadolescent girls selected several emoji more frequently when asked about how they feel about foods consumed in different eating contexts. Girls tended to use more positive emoji (83%) compared to boys (72%), but no significant differences were found.

The slight improvement in discrimination ability reported with age could be due to an improved cognitive development (Eccles, 1999) and ability to distinguish between emotion categories. This suggests that older preadolescents are higher in emotional granularity for positive emoji, while they are both granular for negative emoji. Moreover, older preadolescents were shown to be higher in user experience, familiarity, and social use of emoji. By using emoji more frequently, children may learn what they mean in different contexts thereby improving their ability to make finer distinctions between emoji meanings (increased emotional granularity). Most older children (12-13-y.o.) declared that emoji make their text messages more understandable and that they express something that normally cannot be described in words; a similar trend was reported in Study 1.

Altogether, these findings suggest that the meaning of food-related emoji is clearer to older (12-13-y.o.) than younger preadolescents (9-11-y.o.) as they were found to be more able to discriminate not only among emoji expressing a negative meaning but also among emoji expressing a positive meaning. Hence, self-report questionnaires using emoji to measure responses to foods should be used with caution in younger preadolescents (9-11-y.o.) as the meaning of emoji (especially positive emoji) is less clear to them with specific attention to avoid ambiguity and overlapping between emoji. However, as we did not include younger preadolescents in Study 3, further research is recommended to test the ability of 9-11-y.o. children to link emoji with emotion words.

3.4.5 Conclusions

Studies 2-5 contributed with new insights to uncover the meaning of food-related emoji evaluated by 9-13-y.o. preadolescents. The findings indicated that preadolescents

discriminated emoji to express food experiences according to valence (between positive *vs.* negative) and, to a lower extent, to power (control *vs.* lack of control) and arousal dimension (activation *vs.* absence of activation). In general, negative emoji were better discriminated in their emotional meaning than positive emoji. Specific emotion words were associated to negative emoji, whereas for positive emoji this association was less clear. Some positive emoji express a mix of emotions. In the projective mapping task, girls, and older preadolescents (12-13-y.o.) discriminated positive emoji slightly better along the power dimension compared to boys and younger preadolescents (9-11-y.o.), which could be related to an increased emotional granularity and user experience.

Taken together, these results suggest that there are emoji whose meaning is less clear than others and that should not be included in questionnaires. Many emoji have similar or partially overlapping meanings, while others have a very specific meaning. This information could be used to select emoji for a self-report questionnaire to be used with preadolescents to measure their emotional experiences of food products.

Chapter 4 The development of an emoji-based self-reported questionnaire to describe food experiences

This chapter is based on:

Sick, J., Monteleone, E., Dinnella, C., Pierguidi, L., & Spinelli, S. (2022). Development of an emoji-based self-report measurement tool elicited by foods in preadolescents. Food Quality and Preference, Pre-proof.

Abstract

Emoji evolved as an attractive instrument to measure emotions in preadolescents due to their potential to express a wide range of emotions. However, the emotional meaning of emoji can be ambiguous and is often not universal across age groups, which has not been considered when developing emoji questionnaires. Hence, this research aimed to develop an emoji-based self-report measurement tool to measure emotional responses to food products in preadolescents. In total, fie studies were conducted, and 454 preadolescents (aged 9-13 years) participated to develop the tool. First, preadolescents selected food-related emoji (Study 1, n=96), then they evaluated their dimensional emotional meaning using projective mapping (Study 2, n=162). They then evaluated the linguistic semantic meaning by describing emoji with emotion words (Check-All-That-Apply) (Study 3, n=92) and vice versa (Study 4, n=85). Finally, one-on-one interviews using a modified version of the Repertory Grid Method were conducted to investigate emoji more in-depth (Study 5, n=19). The findings resulted in 17 emoji pairs associated with specific linguistic semantic and dimensional (valence, power, and arousal) meanings. Based on this, we developed an emoji-based self-report measurement tool to measure emotions in response to food products with two suggested response formats, the CATA Emoji Pair Questionnaire and the Emoji Pair Rating Scale. Future research will test the discriminative ability of this tool over a wide range of food products. The questionnaire will allow for a better understanding of preadolescents' affective responses to food and could be used in food innovation targeted at preadolescents to promote healthier food behaviors.

4.1 Overview of the questionnaire development

Several steps were undertaken to develop the emoji-based self-report questionnaire (see Figure 4.1). First, it was necessary to reduce the list of available emoji obtained from Apple iOS 12.2 (Apple, Inc, Cupertino, CA) accessed through Emojipedia in April 2019 (Emojipedia, 2019). This was an important step due to the large number of available emoji (n=2776) at this time. For this reason, only facial emoji were included for further evaluation. Furthermore, facial emoji were assumed to simulate facial expressions and hence, identified as emotions. A researcher preselected all available facial emoji (in this doctoral thesis defined as round and usually yellow facial emoji varying in facial expressions e.g., *grinning face with big eyes* 😃) and emoji displaying people, animals, objects, food etc. were excluded. Then, preadolescents were asked to select from the preselected list of 92 emoji the ones that they thought were relevant to describe food experiences (Study 1). Next, the emotional meaning of 46 emoji (selected in Study 1) was explored to exclude emoji with similar or ambiguous/unclear meaning by preadolescents (Study 2-4). One-on-one interviews helped to explore the meaning of emoji more in-depth on a selection of 28 emoji (Study 5). Finally, a reduced list of 34 emoji (17 pairs) was obtained that constituted the emoji-based questionnaire.

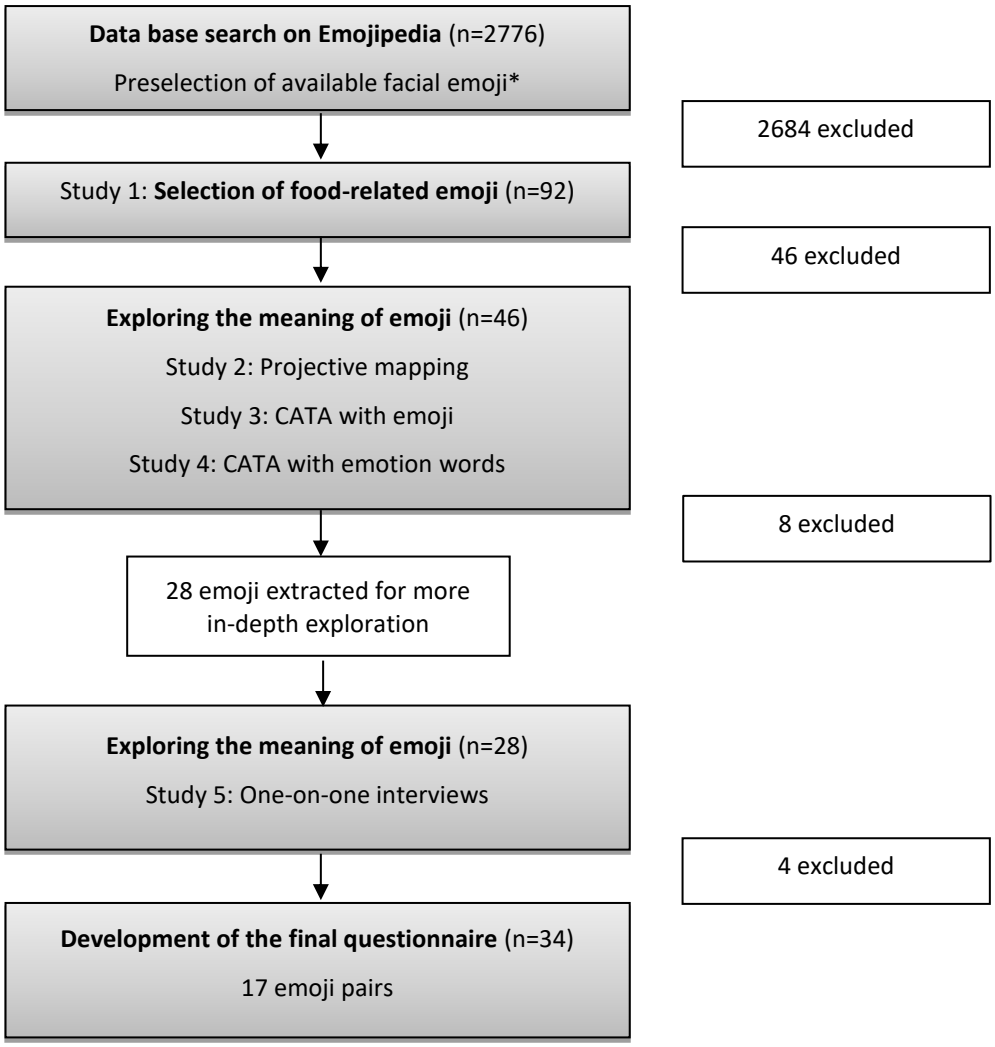


Figure 4.1 Flow-chart of the experiments to reduce the number of emoji and to explore their meaning to develop the final questionnaire; n=number of emoji included for each study; * in this doctoral thesis, facial emoji were defined as round and usually yellow facial emoji varying in facial expressions.

4.1.1 Material and methods

4.1.1.1 Participants

A total of 454 children (9-13-y.o.) that attended primary and secondary classes in schools based in the Florence area in Italy participated in Studies 1-5. An overview of the participating children for each study can be found in Table 4.1. Only children who returned a signed consent form from their parents and who agreed to voluntarily participate in the study by signing their own consent form could participate. For quantitative Studies 1-4 we aimed to include around 80-100 children to reach an adequate level for analyzing quantitative data. For the qualitative, one-on-one interviews (Study 5) it was aimed to include around 20-25 interviews as suggested

by Spinelli & Monteleone (2018). Furthermore, for the interviews only secondary school children (12-13-y.o.) were included due to their increased developmental ability to express emotions with words compared to younger children. There were no other exclusion criteria set. Recruitment criteria and data treatment were planned in accordance with the General Data Protection Regulation (GDPR) 2016/679 and the principles of the Declaration of Helsinki. The protocols of all studies were approved by the Ethical Committee of the University of Florence, Italy.

Table 4.1 Overview of Studies 1-5 including the number (% in brackets) of participating children and age range (total and divided by gender), school level and number of emoji included in each study.

	Study	Parameter	Total	Girls	Boys	School level	Emoji
Study 1	Emoji selection	n (%)	96 (100)	41 (43)	55 (57)	primary and secondary	92
		age range	9-13	9-13	9-13		
Study 2	Projective mapping	n (%)	162 (100)	87 (54)	75 (46)	primary and secondary	46
		age range	9-13	9-13	9-13		
Study 3	CATA emoji	n (%)	92 (100)	52 (57)	40 (43)	secondary	46
		age range	11-13	11-13	12-13		
Study 4	CATA emotion words	n (%)	85 (100)	46 (54)	39 (46)	primary and secondary	46
		age range	9-13	9-12	9-13		
Study 5	One-on-one interviews	n (%)	19 (100)	9 (47)	10 (53)	secondary	28
		age range	12-13	12-13	12-13		

4.1.1.2 Procedure

The development of the final questionnaire was based on Studies 1-5, which were described in detail in Chapter 2 (Study 1, The selection of emoji relevant to describe food experiences) and Chapter 3 (Study 2-5, The exploration of the meaning of emoji used to describe food experiences).

4.1.1.3 Data analysis

The emoji usage questionnaire (EUQ): Data of the EUQ from Studies 1-4 were merged and analyzed by calculating frequencies (%) of the total sample and separated by gender (boys *vs*. girls) and school level (elementary *vs.* secondary level). Gender and school level effects on Familiarity, Frequency of usage, Valence and Enjoyment were tested by using Kruskal-Wallis

One-Way Analysis of Variance by ranks. Chi-square test was applied to test differences in the distributions of the responses by gender and school level for each item of the other domains.

Consensus of Studies 2-4 and clustering of similar emoji groups: Hierarchical Multiple Factor Analysis (HMFA) was conducted on Study 2 (projective mapping), Study 3 (CATA with emoji described by emotion words) and Study 4 (CATA with emotion words described by emoji) to compare the meaning of emoji resulting from these studies. A first MFA was conducted on Study 2 as standard procedure to analyze projective mapping data, while a second MFA was conducted to compare the results of the first MFA (study 2) with Study 3 and 4. Emoji (n=46) were in rows and each study was treated as a table in columns; frequency tables were used for the two CATA questionnaires, while the coordinates of each emoji for each child were used in Study 2. The resulting partial coordinates map was used to compare the consensus of dimensional and semantic emoji meanings between studies.

Next, emoji groups differing in their emotional meaning were identified. An Agglomerative Hierarchical Cluster analysis (AHC) on the emoji coordinates (dimensions 1-3) resulting from the HMFA was conducted by using the dissimilarity measure Euclidean distance and Ward's method. Three dimensions, that accounted for 54.03 % of the variance, were selected based on the scree plot inspection. First, automatic truncation resulting into two clusters followed by forced truncation into smaller clusters (up to 7) were used to identify emoji groups with more specific emotional meaning.

The level of significance for all the analyses was set at $p \leq 0.05$. Statistical analyses were performed using XLSTAT (version 2018.7, Addinsoft, New York, NY, USA), except for HMFA that was conducted using RStudio (version 1.1.456, 2018, RStudio, Inc., Boston, MA, USA) and the package FactoMineR (Lê, Josse, & Husson, 2008; R Core Team, 2016).

4.1.2 Results

The following sections report the results of the Emoji Usage Questionnaire (Studies 1-4) and describe step-by-step how emoji were reduced to the final emoji pair list to be used in the emoji-based self-report questionnaire.

4.1.2.1 The Emoji Usage Questionnaire (EUQ) of Studies 1-4

Children (n=435) participating in Studies 1-4 were found to be regular users (71%) of emoji using them either “every day” (54%) or “a few times a week” (30%), (Supplementary Materials Table S 5). Children declared to send emoji most frequently to friends (85%), parents (57%) and relatives (56%) and mainly use positive emoji (69%) in their communication. Children’s enjoyment in using emoji was either “a lot” (64%) or “fairly” (29%).

Gender differences were found in the Motivation domain, where boys responded more than girls that emoji “are fun” (62%, p=0.036, compared to 52%) and that they “save time when sending messages” (26%, p=0.022, compared to 17%). Girls (74%) were found to use more positive emoji compared to boys (64%) (p=0.023).

Differences between school levels were found across several domains. Older children attending secondary school level (10-13-y.o.) were more familiar with emoji and used them more frequently ($p<0.0001$, respectively) compared to younger children attending elementary school (9-10-y.o.). In terms of Social use, older children send more emoji to friends ($p<0.0001$), siblings (p=0.004) and parents (p=0.003) compared to younger children. Younger children were motivated to use emoji because “they are fun” which corresponds with the overall Enjoyment domain, where younger children (75%) responded that they enjoy emoji “a lot” more than older children (58%) (p=0.001). However, more older children (60%) think that emoji “make the text messages more understandable” compared to younger children (34%, $p<0.0001$).

4.1.2.2 Consensus of Studies 2-4 and clustering of similar emoji groups

A HMFA on Studies 2-4 was conducted, which provides the consensus representation of the three studies. The superimposed representation of the partial clouds shows that the three tasks gave quite similar results in terms of emotional meaning of emoji. The studies show a better discrimination of negative emoji than positive emoji.

The high agreement between studies enabled the AHC analysis to be based on the shared emoji coordinates (dimensions 1-3) resulting from the HMFA. The AHC analysis helped to cluster into positive (n=25) and negative (n=21) emoji. For a more detailed interpretation of emoji, hierarchical cluster results with 4-7 clusters were evaluated, which enabled to build

several emoji clusters differing in their emotional meaning beyond valence (Figure 4.2). A satisfying clustering of emoji differing in their emotional meaning was found at the truncation level of 7 clusters.

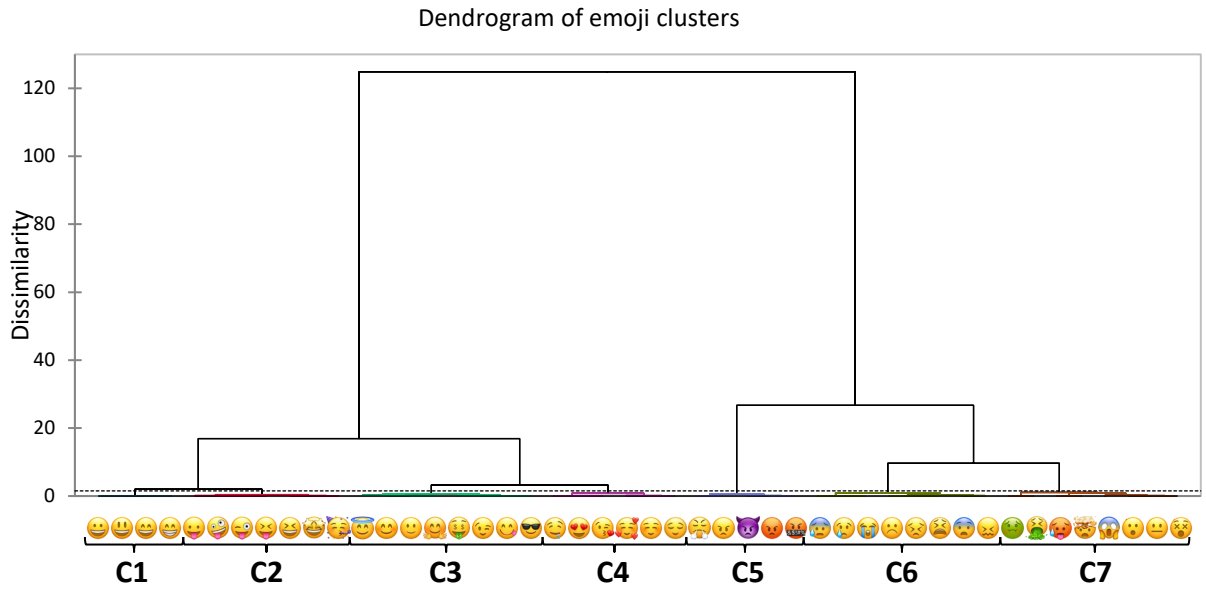


Figure 4.2 Dendrogram resulting from the Agglomerative Hierarchical Cluster Analysis (AHC) on dimensions 1-3 of the Hierarchical Multifactorial Cluster Analysis (HMFA) showing 7 emoji clusters (C1-C7).

Each of the 7 clusters contained between 4-8 emoji. Cluster 1-4 can be described as positive and cluster 5-7 as negative (see Table 4.2). Cluster 1 consisted of four emoji with laughing/smiling emoji (e.g., 😀), cluster 2 consisted of emoji showing their tongue (e.g., 😛) as well as excited and celebrating emoji (e.g., 🥳) . In general, cluster 3 resulted in emoji with lower activation level (e.g., 😊 and 😎) compared to emoji of cluster 1 and 2. Cluster 4 consists of emoji with hearts (e.g., 🥰) and some "content" emoji with closed eyes (e.g., ☺️). Cluster 5 consisted of a group of angry faces (e.g., 😡), cluster 6 consisted of mainly sad emoji (e.g., 😭), while cluster 7 consisted of a more diverse group of negative emoji with neutral (e.g., 😐), nauseated (e.g., 🤢) and surprised (e.g., 😮) emotional expressions.

The AHC helped to generally cluster emoji groups with similar emotional meaning based on Studies 2-4, but we also looked at each study separately to further explore the emotional meaning (in respect to their dimensional and semantic meaning) more in detail. This enabled further characterization of emoji across and within each cluster and will be described in the following sections.

Table 4.2 Emoji clusters resulting from the Agglomerative Hierarchical Cluster Analysis (AHC) with truncation into 7 clusters (C1-7), number of emoji and within-class variance per cluster.

	C1	C2	C3	C4	C5	C6	C7
Number of emoji	4	7	8	6	5	8	8
Within-class variance	0.035	0.113	0.194	0.192	0.213	0.216	0.321
	😀 😃 😄 😁	😆 😅 😛 😜 🤪 😝 🥳	🙂 😉 😊 😇 😋 🤑 🤗 😎	🥰 😍 😘 ☺️ 😌 😚	😤 😡 😠 🤬 😈	☹️ 😨 😰 😢 😭 😖 😣 😫	😐 🤢 🤮 🥵 😵 🤯 😮 😱

4.1.2.3 Study 3 and 4: The semantic meaning of emoji using the CATA format

The linkages between emoji and emotion words (emoji/emotion words selected by ≥40% of children) for both studies are described for each emoji cluster in the following paragraph.

Emoji in cluster 1 (😀, 😃, 😄, 😁) were described as “happy”, “cheerful”, “serene”, “amused”, “enthusiastic”. Emoji in cluster 2 (😆, 😅, 😛, 😜, 🤪, 😝, 🥳) were described as “happy”, “amused”, “energetic”, “enthusiastic”, “serene” and differs from cluster 1 as emoji were generally described by the emotion words “energetic” and “enthusiastic” referring to a meaning of higher activation. In addition, the emoji 🥳 was described as “festive” (22%). Emoji in cluster 3 (🙂, 😉, 😊, 😇, 😋, 🤑, 🤗, 😎) were described with emotion words of lower activation level compared to cluster 1 and 2. Emotional meanings of this group included “calm”, “quiet”, “happy”, “serene”, “cheerful”, “confident”, “satisfied” and “at ease”. Several emoji in this cluster were described with additional words: the emoji 🤑 was described as “rich” (26%), the emoji 😋 as “gluttonous” (14%) and “hungry” (10%), the emoji 😇 as “I am good/ I feel like an angel” (11%) and the emoji 😎 as “feeling cool” (11%).

Emoji in cluster 4 (🥰, 😍, 😘, ☺️, 😌, 😚) were described as “happy”, “cuddled”, “serene”, “calm” and “quiet”, which are also emoji indicating emotions lower in activation and “cheerful” indicating an emotion higher in activation. One group consisted of emoji with hearts (😍, 🥰 and 😘) described also as “in love” as mentioned in the additional comments

(63%, 35% and 17%, respectively). One emoji was described differently in the two studies; in Study 3, 😌 was described as “serene” (52%) and “calm” (44%), while in Study 4 it was used to describe mostly the word “quiet” (40%). Furthermore, the study indicates that “calm” and “quiet”, which are both words indicating pleasant deactivation, could have indifferent meanings for preadolescents. Compared to all other positive emoji, this emoji was the only one not associated with “happy”. Cluster 5 (😤, 😡, 😠, 🤬, 😈) was the emoji group with most distinct emotional meaning sharing the meaning “angry” of which some of them (😤, 🤬, 😠) were also described as “annoyed”. Emoji in cluster 6 (☹️, 😨, 😰, 😢, 😭, 😖, 😣, 😫) were described mostly as “unhappy” and “sad”, but further words included “disappointed”, “dissatisfied”, “worried”, “surprised”, “disgusted”, “annoyed”, “guilty” and “melancholic”. The emoji expressing “sadness” with larger agreement were 😢 and 😭 (75% and 87%, respectively).

Emoji in cluster 6 (😐, 🤢, 🤮, 🥵, 😵, 🤯, 😮, 😱) were described as “indifferent”, “bored”, “disgusted”, “surprised”, “worried” and “curious”. The emoji 😐 was described as “bored” (47%) in Study 4 but in Study 3 children this link was weak (13%). A distinct group included the emoji 🤢 and 🤮 that were mainly described as “disgusted” (87% and 84%, respectively). In the additional comments 🤢 was described as “urge to vomit/nauseated” (12%) and 🤮 as “feeling sick” (12%). The emoji 😵 was also described as “dead/deceased” (26%) and 😱 as “scared/frightened” (21%).

4.1.2.4 Study 5: The semantic meaning of emoji by using one-on-one interviews

A selection of emoji for each emoji cluster (2-6 emoji per cluster) was used for a more in depth-analysis in the one-on-one interviews. Prior to the interviews, eight emoji were excluded to limit the emoji list due to children’s limited attention span in the interviews. For details see section 3.3.2. Reported emotion word constructs for each emoji mentioned by ≥10% of children were summarized in Table 4.3.

In accordance with Study 3 and 4, emoji in cluster 1 (😀, 😃, 😄, 😁) were mainly described as very “happy”. One child described the emoji 😁 in response to a food as “*I liked the dish very much and* [the emoji] *is very happy and smiling, it communicates that it was very good*”.

Children described the emoji 😆 very similar to the other emoji of cluster 1 ("happy"), e.g., "I am happy that today I eat this food.", which suggests that this emoji is more similar to emoji of cluster 1 than cluster 2.

The emoji 🤩 was described as "content" and "wow (surprised)/impressed" ("*It is a food that when my dad prepares it for me, I have to eat it before the others. It's fixed in my mind, that it is a food that makes me happy*"). The emoji 🥳 was described as "happy" in a festive context (e.g., "*A dish that when you party, you can't wait to eat it.", "*[it makes me think to] *a party, such as when I eat the New Year's aperitivo.*" or "*I am very, very happy when I eat good things for Birthday*"), which corresponds to "festive" mentioned in the additional comments of Study 3.

Emoji that have been previously defined as cluster 3 (🙂, 😊, 😇, 😋, 😎) were generally described as indicating emotions characterized by lower activation level in line with the results of Study 3 and 4. For example, the emoji 🙂 was described as "less happy" compared to most other positive emoji (e.g., "*When they call me for dinner and there are meatballs: I do not want to go to eat even if I am hungry (I am forced to go). It makes me feel happy, but less happy, because I will have meatballs for dinner*"), but also lower in arousal "*I am happy, but calm, not excited at the sight of food.*"). The emoji 😇 was defined as "happy" but also as "feeling like an angel", which was mentioned in the additional comments of Study 3. One child mentioned using the emoji in the context of eating a rarely eaten but good food, which differs from other foods: "*Good but not like the others: I like the dish, I eat it but not many times*". The emoji 🥰 was described as indicating "happy", but also as expressing a feeling of being "in love" (e.g., "*You are in love with food*"), which corresponds with the additional comments of Study 3.

The emoji 😮 was described as indicating both positive (e.g., "*I am surprised because it is something that is not usually eaten: something new in a positive sense.*") and negative surprise in both interviews (positive and negative emoji group), however with a more negative tendency (e.g., "*Surprised by what I have to eat, in a negative sense.*"). The emoji 😱 was described as "surprised", but in contrast to the emoji 😮 it was associated exclusively with negative surprise and was associated with other negative emotions like "it makes me feel bad", "afraid" and "worried". A child described the emoji as "*I'm surprised to find it* [the food]

on my plate: they know I don't like it. The surprise is negative". The emoji 😐 was described as "indifferent" (e.g., it is used for foods that are tasting neither good nor bad) "*half and a half: I feel that it is not good, but it is not so bad either. It makes me feel good because there is worse than this*").

A group of emoji (e.g., ☹️, 😢 and 😭) –all present in cluster 6 - were described as mainly "sad" emoji, which corresponds with the semantic studies. It appeared that the emoji ☹️ was described as "less sad" ("*sad, a little less, sorry*") compared to 😭, which a child described as "very sad". In addition to "sad", the emoji 😫 was described by words such as "confined/I find it unfair" and "I want to complain".

The clearest meaning was shown for the emoji 😡 and 😤, which were both described as mainly "angry" and 😤 as a bit less angry than 😡 corresponding with Study 3 and 4 e.g., "*Similar to the emoji* 😡 *but less angry, [feeling] anger towards whoever cooked the dish.*"

Finally, four emoji (😃, 😰, 😋, 😌) were excluded either because they showed very similar emotional meaning to other emoji groups, or the meaning was still unclear.

Table 4.3 Summary table showing cluster groups and semantic meanings (Studies 3-5) of 46 emoji used to describe food experiences in preadolescents. For Study 3 (emoji described by emotion words) and Study 4 (emotion words described by emoji) attributes selected by ≥40% of children are displayed, but children's additional emotion words from the open-end response were displayed when selected by ≥10% of children (underlined); n=number of children participating in each study. For Study 5, emotion word constructs mentioned by ≥10% of children are displayed; * indicates that these emoji were not included in the interviews; whether emoji were included in the final questionnaire was indicated in the last column.

Cluster		Study 3 (n=92): CATA emoji described by emotion words	Study 4 (n=85): CATA emotion words described by emoji	Study 5 (n=19): One-on-one interviews	Final questionnaire
😀	1	**happy** (66%), **serene** (54%), **cheerful** (50%), **amused** (41%)	**happy** (58%), **cheerful** (47%)	**happy** (63%)	yes
😃	1	**happy** (78%), **cheerful** (55%), **serene** (44%), **enthusiastic** (40%)	**happy** (61%), **cheerful** (41%)	**happy** (47%), **content** (11%), **excited** (11%)	no
😄	1	**happy** (75%), **cheerful** (71%), **serene** (55%), **amused** (45%)	**happy** (57%)	**happy** (84%), **indifferent** (11%)	yes

	1	**happy** (70%), **cheerful** (64%), **amused** (60%), **serene** (45%), **enthusiastic** (42%)	**happy** (65%), **cheerful** (46%)	**happy** (63%), **relaxed** (11%), **quiet (indifferent in a positive way** (11%), **content** (11%), **smiling** (11%), **normal** (11%)	yes
	2	**happy** (66%), **cheerful** (64%), **amused** (47%), **enthusiastic** (40%)	**happy** (44%)	**happy** (74%), **content** (11%)	yes
	2	**happy** (64%), **energetic** (54%), **cheerful** (49%), **enthusiastic** (48%), **amused** (42%)	-	**happy** (53%), **content** (16%), **"wow" (surprised/impressed)** (11%)	yes
	2	**happy** (58%), **amused** (53%), **cheerful** (42%)	-	*	no
	2	**happy** (59%), **cheerful** (59%), **amused** (51%), **energetic** (41%)	-	*	yes
	2	**happy** (60%), **cheerful** (58%), **energetic** (57%), **amused** (53%), **crazy** (23%)	**amused** (40%)	**happy** (37%), **crazy** (32%), **amused** (11%), **makes me feel good** (11%)	yes
	2	**happy** (63%), **cheerful** (57%), **amused** (52%), **energetic** (41%)	-	*	no
	2	**happy** (70%), **cheerful** (70%), **energetic** (52%), **enthusiastic** (49%), **amused** (49%), **festive** (22%)	-	**happy** (63%), **suitable for a party** (47%), **suitable for a special occasion** (11%), **content** (11%)	yes
	3	**happy** (61%), **serene** (49%)	**happy** (44%), **quiet** (40%)	**happy** (less) (47%), **sad** (21%), **I have to make do with it** (16%), **forced** (16%), **indifferent** (16%), **calm** (11%)	yes
	3	**happy** (49%), **cheerful** (40%), **confident** (40%)	-	*	yes
	3	**happy** (64%), **cheerful** (52%), **serene** (47%), **calm** (44%)	-	**happy** (less) (37%), **makes me feel good** (21%), **content** (11%), **ashamed** (11%)	yes
	3	**serene** (60%), **happy** (55%), **quiet** (50%), **calm** (47%), **cheerful** (44%), **I am good/ I feel like an angel** (11%)	-	**happy** (26%), **I feel like an angel** (16%), **makes me feel special/important** (16%), **makes me feel good** (11%), **keeps myself from doing things** (11%), **new/mysterious** (11%), **calm** (11%)	yes
	3	**happy** (59%), **cheerful** (51%), **gluttonous** (14%), **hungry** (10%)	-	**gluttonous** (42%), **makes me feel good** (21%), **happy** (11%)	no

🤑	3	**happy** (51%), **satisfied** (46%), **cheerful** (42%), **rich** (26%)	-	*	no
🤗	3	**happy** (54%), **serene** (50%), **cheerful** (48%)	-	*	no
😎	3	**confident** (50%), **happy** (49%), **satisfied** (44%), **at ease** (44%), **feeling cool** (11%)	-	**happy** (26%), **proud** (26%), **makes me feel good** (21%), **beautiful** (16%), **superior** (11%), **lucky** (11%), **enjoyment** (11%)	yes
🥰	4	**happy** (61%), **cuddled** (58%), **serene** (44%), **cheerful** (42%), **in love** (35%)	**cuddled** (71%)	**happy** (26%)	yes
😍	4	**happy** (59%), **in love** (63%)	-	*	yes
😘	4	**happy** (46%), **in love** (17%)	-	*	no
☺️	4	**happy** (46%), **calm** (40%)	-	*	yes
😌	4	**serene** (52%), **calm** (44%)	**quiet** (40%)	**happy** (21%), **makes me feel superior** (11%), **makes me feel good** (11%), **forced** (11%), **proud** (11%), **indifferent** (11%)	yes
🤤	4	-	-	**I like it** (58%), **mouth watering** (32%), **well** (16%), **gluttonous** (11%), **happy** (11%)	no
😤	5	**angry** (74%), **annoyed** (50%)		**angry** (74%), **forced** (21%)	yes
😡	5	**angry** (95%)	**angry** (79%)	**angry** (84%), **disgusted** (11%)	yes
😠	5	**angry** (84%), **annoyed** (47%)	-	*	no
🤬	5	**angry** (91%), **annoyed** (53%)	**angry** (77%)	*	yes
😈	5	**angry** (86%)	**angry** (57%)	*	yes
😕	6	**sad** (69%), **unhappy** (54%), **disappointed** (51%), **dissatisfied** (46%)	**unhappy** (42%), **dissatisfied** (41%)	**sad** (42%), **does not make me feel good** (16%)	yes
😨	6	**worried** (57%), **surprised** (42%)	-	*	yes
😰	6	**worried** (53%)	**worried** (41%)	**uncomfortable** (26%), **annoyed** (11%), **sad** (11%), **anxious** (11%), **I don't want it** (11%), **worried** (11%), **amazed/perplexed** (11%), **disgusted** (11%)	no
😢	6	**sad** (75%), **unhappy** (61%), **disappointed** (47%)	**sad** (46%)	**sad** (53%), **suffering** (16%), **indifferent (negative)** (16%)	yes
😭	6	**sad** (86%), **unhappy** (66%)	**sad** (69%)	**sad** (53%), **I want to cry** (16%)	yes

	6	**unhappy** (46%), **sad** (44%), **disgusted** (44%), **annoyed** (40%)	-	*	yes
	6	**sad** (52%), **unhappy** (49%), **guilty** (47%), **disappointed** (46%)	-	*	yes
	6	**unhappy** (55%), **sad** (48%), **melancholic** (40%), **disappointed** (40%), **guilty** (40%)	-	**sad** (32%), **forced/ I find it unfair** (26%), **I want to complain** (16%), **desperate** (11%), **I want to cry** (11%), **I am satisfied/feeling pleased** (11%)	yes
	7	**indifferent** (58%)	**indifferent** (59%), **bored** (47%)	**indifferent** (42%), **satisfied** (11%), **content** (11%)	yes
	7	**disgusted** (87%), **urge to vomit/nauseated** (12%)	**disgusted** (79%)	**nauseated** (58%), **disgusted** (32%), **feeling sick** (26%), **makes me feel bad** (21%)	yes
	7	**disgusted** (84%), **feeling sick** (12%)	**disgusted** (75%)	*	yes
	7	**tired** (27%), **feeling hot** (20%)	-	*	no
	7	**surprised** (40%)**, worried** (40%), **dead/deceased** (26%)	-	*	yes
	7	-	-	*	no
	7	**surprised** (73%)	**curious** (46%), **surprised** (42%)	**positive group: surprised (negative)** (47%), **surprised (positive)** (32%), **surprised (positive and negative)** (16%) **negative group: surprised (negative)** (58%), **surprised (positive)** (11%), **surprised (positive and negative)** (11%)	yes
	7	**surprised** (58%), **worried** (48%), **scared/frightened** (22%)	-	**surprised (negative)** (53%), **makes me feel bad** (16%), **afraid** (11%), **worried** (11%)	yes

4.1.2.5 The development of the final emoji-based self-report questionnaire

Emoji expressing similar linguistic semantic and dimensional meanings (based on Studies 2-5) were grouped in pairs of two. This was done to facilitate the interpretation by the respondents following previous work in the emotion field (Jaeger, Lee, et al., 2019; Christelle Porcherot et al., 2010; Sacharin, Schlegel, & Scherer, 2012). After the interviews (Study 5), further 4 emoji

(*grinning face with big eyes* 😃, *anxious face with sweat* 😰, *face savoring food* 😋, *drooling face* 🤤) were excluded either because they showed very similar emotional meaning to other emoji pairs (😃, 😰), or the meaning was still unclear/ambiguous (😋, 🤤).

The final emoji list resulted in 17 emoji pairs (n=34 emoji) that were associated with specific emotion words (see Table 4.4). For simplification and readability, the set of emotion words for each emoji pair were reduced to two representative words, which will be used in the following sections. Each emoji pair resulted in different levels of valence (pleasure *vs.* displeasure), arousal (activation *vs.* deactivation) (see Figure 4.3a) and power (dominance/control/strength *vs.* submissiveness/lack of control/weakness) (see Figure 4.3b). For example, the emoji pairs 😍🥰 and 🤩😘, associated respectively with "happy, cuddled, serene, cheerful, in love" and "happy, cheerful, energetic, enthusiastic, amused, festive, suitable for a party, content, suitable for a special occasion, "wow" (surprised/impressed)", are positive and high in arousal in contrast to ☺️🙂 and 😇😊 (associated respectively with "happy, serene, calm, quiet, sad, I have to make do with it, forced, indifferent, calm" and happy, serene, cheerful, calm, quiet, I am good/ I feel like an angel, makes me feel good, makes me feel special/important, keeps myself from doing things, new/mysterious, calm, content, ashamed") that are positive and low in arousal. Among the negative emoji pairs, 😱😨 ("surprised, worried, scared/frightened, makes me feel bad, afraid") and 😡😈 ("angry, disgusted") are high in arousal, whereas 😢😭 ("sad, unhappy, disappointed, suffering, indifferent (negative), I want to cry") and ☹️😣 ("sad, unhappy, disappointed, dissatisfied, guilty, does not make me feel good") are low in arousal. When considering the power dimension, the positive emoji pairs 😏😎 ("happy, confident, at ease, satisfied, cheerful, feeling cool, proud, makes me feel good, beautiful, superior, lucky, enjoyment") and 😜🤪 ("happy, cheerful, energetic, amused, crazy, makes me feel good") are high in power opposing 😍🥰 ("happy, cuddled, serene, cheerful, in love") and ☺️🙂 ("happy, serene, calm, quiet, sad, I have to make do with it, forced, indifferent, calm") that are low in power. The negative emoji pairs 😡😈 ("angry, disgusted") and 🤬😤 ("angry, annoyed, forced") are high in power, while 😱😨 ("surprised, worried, scared/frightened, makes me feel bad, afraid") and 😢😭 ("sad, unhappy, disappointed, suffering, indifferent (negative), I want to cry") low in power.

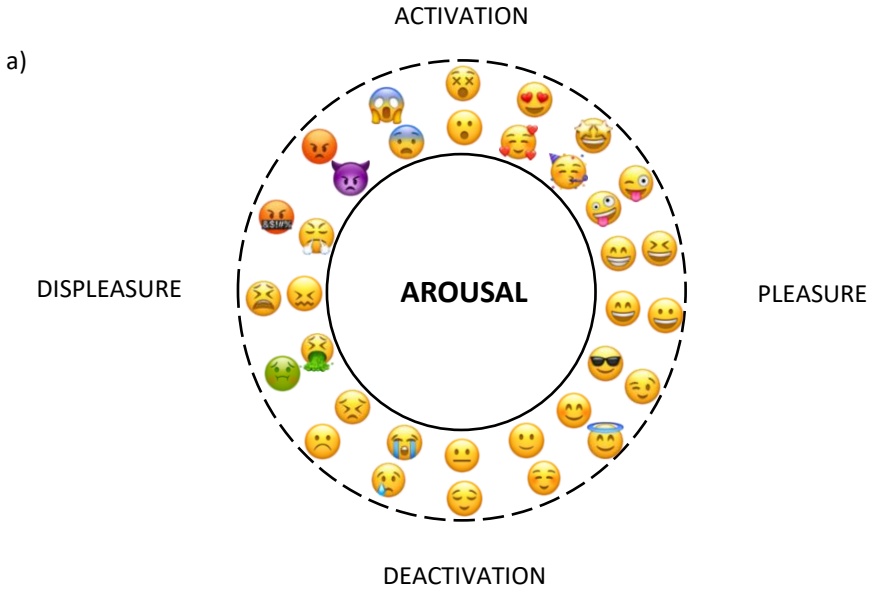
The AHC helped to pre-classify emoji with the most similar semantic and dimensional meaning. However, there were four emoji pairs (😆😁, ☺️🙂, 😌😐 and 😱😨) that were grouped even though they did not appear in the same cluster because the additional comments of Study 3 and the interviews clarified that in fact, they share aspects of their meaning. Additionally, the Euclidean distances resulting from the AHC of the grouped emoji pairs 😆😁, ☺️🙂 and 😱😨 were rather small (0.70, 1.08, and 0.60, respectively), apart from the emoji pair 😌😐 (Euclidean distance 2.8), which were grouped because they were both very low in arousal and positive and negative in valence. Furthermore, each emoji pair shares at least part of their semantic meaning (see Table 4.4), based on the studies that explored the link between words and emoji (Studies 3-5). It was possible to establish a distinct emotional meaning for each emoji pair, even though some emotion words overlap with emotion words from other emoji pairs.

Table 4.4 Semantic meaning of emoji pairs sharing overlapping emotional meaning; for simplification and readability, the emotion words for each emoji pair were reduced to two representative emotion words; [1] = emotion words from CATA questionnaires (Study 3 and 4), [2] = additional emotion words from open-ended responses (Study 3), [3] = emotion words constructs from one-on-one interviews (Study 5).

Emoji pairs	Representative emotion words	Semantic meaning (Studies 3-5)
😍🥰	cuddled – in love	happy[1], cuddled[1], serene[1], cheerful[1], in love[2]
🤩🥳	enthusiastic – festive	happy[1], cheerful[1], energetic[1], enthusiastic[1], amused[1], festive[2], suitable for a party[3], content[3], suitable for a special occasion[3], "wow" (surprised/impressed)[3]
😜🤪	energetic – crazy	happy[1], cheerful[1], energetic[1], amused[1], crazy[2], makes me feel good[3]
😆😁	cheerful – amused	happy[1], cheerful[1], amused[1], enthusiastic[1], serene[1], relaxed[3], quiet (indifferent in a positive way)[3], content[3], smiling[3], normal[3]
😀😄	cheerful – serene	happy[1], cheerful[1], serene[1], amused[1], indifferent[3]
😇😊	serene – calm	happy[1], serene[1], cheerful[1], calm[1, 3], quiet[1], I am good/ I feel like an angel[2], makes me feel good[3], makes me feel special/important[3], keeps myself from doing things[3], new/mysterious[3], content[3], ashamed[3]
😉😎	confident – at ease	happy[1], confident[1], at ease[1], satisfied[1], cheerful[1], feeling cool[2], proud[3], makes me feel good[3], beautiful[3], superior[3], lucky[3], enjoyment[3]

😌🙂	calm – quiet	happy[1], serene[1], calm[1, 3], quiet[1], sad[3], I have to make do with it[3], forced[3], indifferent[3]
😔😐	indifferent – calm	indifferent[1, 3], serene[1], calm[1], makes me feel superior[3], makes me feel good[3], forced[3], proud[3], satisfied[3], content[3]
😢😭	sad – unhappy	sad[1], unhappy[1], disappointed[1], suffering[3], indifferent (negative)[3], I want to cry[3]
☹️😣	dissatisfied – guilty	sad[1], unhappy[1], disappointed[1], dissatisfied[1], guilty[1], does not make me feel good[3]
😫😖	unhappy – annoyed	unhappy[1], sad[1], disgusted[1], melancholic[1], annoyed[1], guilty[1], forced/ I find it unfair[3], I want to complain[3], desperate[3], I want to cry[3], I am satisfied/feeling pleased[3]
🤢🤮	disgusted – nauseated	disgusted[1], urge to vomit/nauseated[1], feeling sick[2], makes me feel bad[3]
😡😤	angry – annoyed	angry[1], annoyed[1], forced[3]
😡😈	angry – disgusted	angry[1], disgusted[3]
😱😨	worried – scared	surprised[1], worried[1], scared/frightened[2], makes me feel bad[3], afraid[3]
😵😮	surprised – curious	surprised[1], worried[1], dead/deceased[2], curious[3]

a)



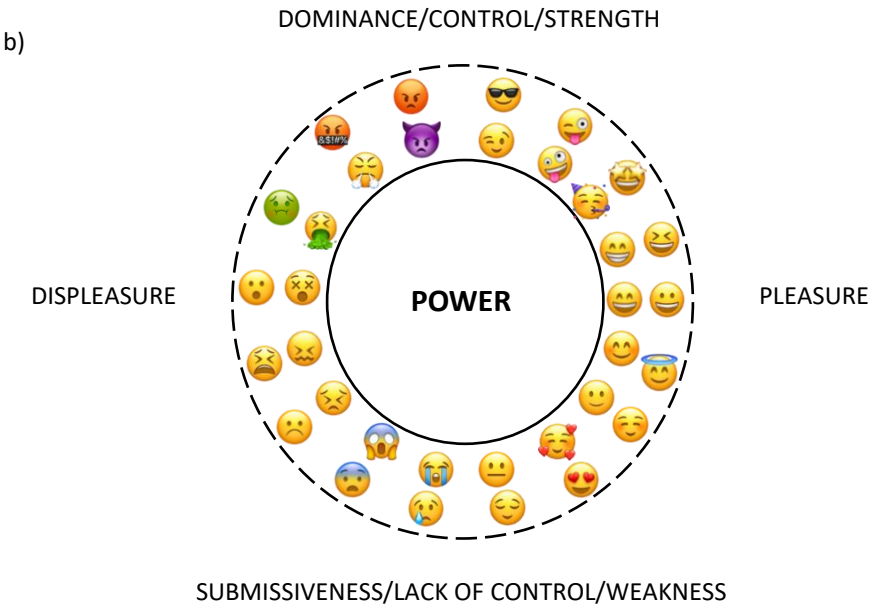


Figure 4.3 Emoji circumplex showing 17 emoji pairs based on similar meanings and levels of a) valence (pleasure *vs.* displeasure) and arousal (activation *vs.* deactivation) and b) valence (pleasure *vs.* displeasure) and power (dominance/control/strength *vs.* submissiveness/lack of control/weakness).

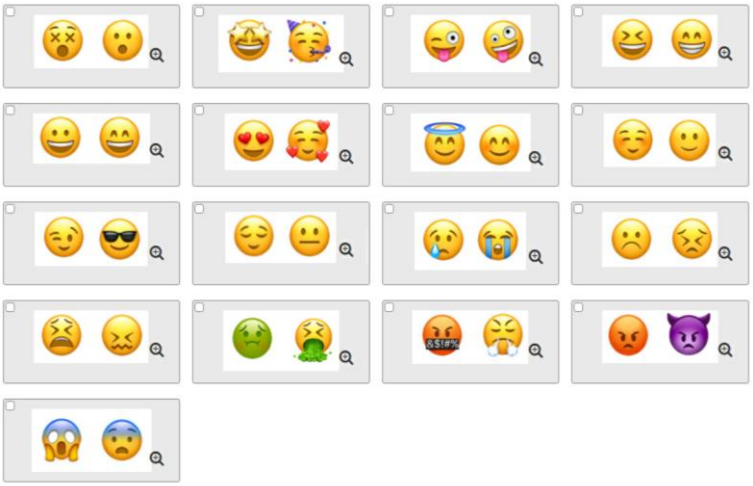
The circumplex was used here to facilitate the interpretation of the selected emoji, but the emoji pairs can be presented using different response formats and layout in a randomized order as it has been shown that circumplex and list formats (using CATA) obtained similar results using emotion words (Jaeger, Roigard, et al., 2021).

Emoji pairs can be presented as a simple CATA Emoji Pair Questionnaire (Figure 4.4a) or by using the emoji pairs in combination with a rating scale (Figure 4.4b). One of the advantages of using a rating scale is that the discriminant ability of emoji pairs could be increased for food products with very similar sensory properties/acceptability.

The **CATA Emoji Pair Questionnaire** works like the CATA questionnaires with emoji that have been already used by preadolescents to measure emotions elicited by foods (e.g., Gallo, Delores, et al. (2017) and Schouteten et al. (2019, 2018)), however, instead of selecting single emoji, children are asked to select pairs of emoji. Children are asked to check-all-emoji-that-apply to describe how they feel in response to a food item. "*How does the food make you feel? Choose as many emoji pairs as possible. If only one emoji from the group fits, select the group anyway.*" Children are asked to select at least one of the emoji pairs.

In the **Emoji Pair Rating Scale**, each emoji pair is rated on a 5-point categorical scale ranging from 1= does not fit at all to 5= fits very well. The idea is to ask children to taste one sample at a time and answer to the Emoji Pair Rating Scale for each sample tasted: "*How does this food make you feel? Look at the emoji pairs. For each group, indicate how much the emoji (one of the two or both) match the feeling you get from tasting the food sample.*"

a) CATA Emoji Pair Questionnaire



b) Emoji Pair Rating Scale

Figure 4.4 Examples of the emoji pair self-report questionnaires a) CATA Emoji Pair Questionnaire with 17 emoji pairs and b) Emoji Pair Rating Scale with an example of 3 emoji pairs with a categorical 5-point ranging from 1= does not fit at all to 5= fits very well. Both screenshots of the questionnaires were derived from the web-based software Compusense Inc.

4.2 Discussion

An emoji-based self-report questionnaire for preadolescents consisting of a food-specific emoji list with identified emotional meaning was developed. Five studies were conducted,

which include the selection of emoji evaluated as appropriate by preadolescents to describe food experiences (Study 1) and the exploration of the dimensional and semantic meaning of emoji resulting from Study 1 by using four different methods (Studies 2-5). The reported studies (projective mapping, CATA with emoji, CATA with words, and interviews) contributed with new knowledge to understand the meaning of food-related emoji in preadolescents and to reduce the list of the final selection of emoji used for the self-report questionnaire. The questionnaire can be used to study preadolescents' emotions elicited by foods.

4.2.1 Original aspects of the emoji-based self-report questionnaire

Emoji expressing similar semantic and dimensional meanings (based on valence, power, and arousal dimensions of selected emotion words and the projective mapping task) were grouped in pairs of two, which has not been done previously. We argue that the grouping of the two emoji with the most similar meaning allows to best identify the overall meaning of the emoji pair. A similar approach was conducted by Chrea et al. (2009) in the Geneva Emotion and Odor Scale (GEOS), where emotion terms were merged into groups and reduced to a set of representative emotion terms to describe the subjective emotions induced by odors. Their motivation was to reduce the set of terms to a smaller set of summary scales and to gain insight into the structure of emotions elicited by odors derived from affective and qualitative assessments. Jaeger, Roigard, Jin, Xia, et al. (2019) applied a similar method by assembling a questionnaire with 12 axes spanning the dimensions of pleasure and arousal, and their combinations. Each of the axes is presented by a pair of emotion words (e.g., happy/satisfied, energetic/excited, unhappy/dissatisfied). Including synonymous words could be advantageous in key product characteristics, which may not have been selected by some consumers or because they previously could not make sense of/relate to them. Similarly, in this approach, retaining emoji with wide overlapping meaning has the advantage of including two occurrences of emoji that may be used alternatively for different children to express a similar emotional meaning. Furthermore, two emoji may have a similar meaning but be perceived as suitable in different contexts (e.g., *star-struck* 🤩 and *partying face* 🥳). For example, in the interviews children mentioned that the emoji *star-struck* 🤩 is appropriate to use in a positive surprised and impressing context when someone prepares a food that he/she really likes, while the *partying face* 🥳 is more appropriate to describe foods in festive

contexts like parties, Birthday, New Year's Eve. In this way this PhD thesis offers a novel approach to measure children's food-elicited emotions with emoji.

The developed emoji list is a general list that can be applied to a wide range of food products compared to a product-specific list. General emotion lists usually contain more items than product-specific lists, which could lead to increased fatigue and boredom among children. However, the final emoji list was condensed to 17 emoji pairs being an adequate number of items as also highlighted by Schouteten et al. (2019), where 7-12-y.o. children mentioned that an emoji list should not include more than 25 items.

The advantage of the emoji list is that its preselection not only considers emoji varying in valence (positive, neutral, and negative) (Gallo, Swaney-Stueve, et al., 2017b; Lima et al., 2019; Schouteten et al., 2019; Swaney-Stueve et al., 2018), but also offers emoji differing in degrees of arousal and power. The emoji list developed by Gallo, Swaney-Stueve, Chambers, et al. (2017) contains a variety of 28 facial emoji including mostly emoji of lower activation level (except for the *grinning face* 😀 and *smiling face with heart-shaped eyes* 😍). Based on our research we were able to expand the emoji list to emoji with higher activation levels and emoji varying in power. In contrast, Schouteten et al. (2018) used a list with 33 emoji with preadolescents originally derived from Jaeger, Vidal, et al. (2017) that included around 10 emoji (out of 15 positive emoji) of higher activation level. As the range of emoji of low and high activation level can vary between other emoji lists to a considerable extent, this thesis aimed for a more balanced distribution of emoji of low/ high level of activation and power. This has never been considered before when developing food-specific emoji lists for preadolescents but could be a benefit by facilitating the interpretation of the results.

The standardized emoji list developed by Gallo, Swaney-Stueve, Chambers, et al. (2017), which was also used by Schouteten et al. (2019), includes 18 overlapping emoji (😜, 😀, 😢, 😱, 😤, 😎, 😭, 😡, 😣, 😌, 😆, 😍, 😰, 😔, 😊, 😏, 😮, 😖) that were also included in the emoji list. One notable difference is that the newly developed Emoji Pair Questionnaire consists of 16 further emoji relevant for preadolescents to describe food experiences with established emotional meaning (🥰, 🤩, 🥳, 🤪, 😄, 😄, 😇, 🙂, 😐, ☹️, 😫, 🤢, 🤮, 🤬, 😈 and 😵). This research showed that the emoji list developed by Gallo, Swaney-Stueve, Chambers, et al. (2017) contains emoji with similar emotional meaning that were paired in our questionnaire

(e.g., *crying face* 😢 with *loudly crying face* 😭, *face screaming in fear* 😱 with *fearful face* 😨 and *winking face* 😉 with *smiling face with sunglasses* 😎), reducing the number of options (in a CATA format) to avoid mental overstrain in children. Some emotions relevant to describe food experiences were not included in prior emoji lists for preadolescents. "Disgust" (represented here by *nauseated face* 🤢 and *face vomiting* 🤮) is an important emotion in food choice (Fallon & Rozin, 1983) as it is one of the emotions involved in preadolescents' food rejection (De Moura, 2007; Sick et al., 2019). Other emoji unique to the Emoji Pair Questionnaire are the emoji *star-struck* 🤩 and *partying face* 🥳 that are very positive, highly activated emotions that can be used e.g., in a festive eating context. Furthermore, we included rather newly developed emoji (e.g., *star-struck* 🤩) that were not yet present in former emoji lists (like Gallo, Delores, Swaney-Stueve, et al., 2017; Schouteten et al., 2019) for preadolescents. Some of these emoji look very similar to emoji used in the list by Gallo, Swaney-Stueve, Chambers, et al. (2017) e.g., *neutral face* 😐 *vs. confused face* 😕/ *expressionless face* 😑, *frowning face* ☹️ *vs. worried face* 😟, *tired face* 😫 *vs. weary face* 😩. Differences in emoji expressions are due to updated Unicode versions (here Apple iOS 12.2 *vs.* earlier Apple iOS versions) but deviations in emotional meanings seem to be rather small in this case. Future research may be needed to determine if different iOS versions may affect preadolescents' interpretation of food-related emoji.

Lastly, the Emoji Pair Questionnaire has the advantage that it was specifically developed with and for preadolescents ranging between 9-13 years, which included the selection of relevant emoji relevant to describe food experiences and the identification of their meaning to develop the questionnaire. This has been the first study that based the development of an age-appropriate emoji list on the semantic and dimensional meaning of emoji by a specific age group (9-13-y.o.).

It is suggested that when measuring preadolescents' food-elicited emotions, the emoji pairs can be applied either using a CATA format or using a rating scale, particularly when sensory variations among products are reduced. The circular valence x arousal circumplex-inspired emotion questionnaire layout was found to be of no particular benefit (nor hinderance) in adults using words (Jaeger, Roigard, et al., 2021) and for this reason this format is not the first

choice. The main characteristics of the Emoji Pair Questionnaire compared to previously developed questionnaires/lists/scale are summarized in Table 4.5.

Table 4.5 Characteristics of the Emoji Pair Questionnaire (highlighted in grey) and of previously developed emoji questionnaires/lists/scales: reference, age group, preselection of emoji, number of emoji used in the final version (and Apple iOS version), questionnaire format, dimensions considered in the questionnaire and if the questionnaire was standardized or product-specific are reported; quest. = questionnaire, y.o. = year-old.

Reference	Age group	Preselection of emoji	Emoji (n)	Quest. format	Dimensions	Standardized/ product-specific quest.
(Current research)	9-13-y.o.	9-13-y.o. children evaluating emoji appropriate to describe food experiences (Study 1, Sick, Spinelli et al., 2020) using CATA, projective mapping and Repertory Grid Method-based interviews (Study 2-5)	34 facial emoji (17 emoji pairs) Apple iOS 12.2	Emoji pairs evaluated with CATA or a rating scale (5-point scale)	Valence (8 positive, 1 neutral, 8 negative emoji pairs) Power (9 higher dominance, 8 lower dominance emoji pairs) Arousal (9 higher activated, 8 less activated emoji pairs)	Standardized
Gallo, Swaney-Stueve et al. (2017)	7-11-y.o.	Preselection by researcher, then focus groups with 8-11-y.o. children to identify food-related emoji (Gallo, Swaney-Stueve et al., 2017)	38 facial emoji in food image study 28 facial emoji in served food study Apple iOS 8.3	CATA	Valence (17 positive, 4 neutral emoji, 17 negative)	Standardized
Swaney-Stueve et al. (2018)	8-11-y.o.	Focus groups with 8-11-y.o. children to identify food-related emoji (Gallo, Swaney-Stueve et al., 2017)	7 facial emoji Apple iOS 8.3	Linear scale	Valence (3 positive, 1 neutral, 3 negative emoji)	Standardized
Schouteten et al. (2018)	11-13-y.o.	Emoji derived from previous research based on adults by analyzing tweets of four eating situations. (Jaeger, Vidal, et al., 2017)	33 facial emoji Apple iOS 9	CATA	Valence (15 positive, 2 neutral, 16 negative emoji)	Standardized
Schouteten et al. (2019)	8-11-y.o.	Focus groups with 8-11-y.o. children to identify food-related emoji (Gallo, Swaney-Stueveet al., 2017)	38 facial emoji Apple iOS 8.3	CATA	Valence (17 positive, 4 neutral emoji, 17 negative emoji)	Standardized

Schouteten et al. (2019)	8-11-y.o.	Two-step procedure: emoji were retrieved from prior research studies with 8-11-y.o. children (focus groups: Gallo, Swaney-Stueve, et al., 2017) and adults (Jaeger, Lee, et al., 2017). Then, 7-12-y.o. children indicated the applicability of these emoji for a range of biscuits (Schouteten et al., 2018) and thereafter researchers made the final selection.	20 emoji (15 facial and 5 non-facial emoji) Apple iOS 8.3	CATA	Valence (15 positive, 3 negative, 2 neutral emoji)	Product-specific (speculoos biscuits)
Lima et al. (2019)	6-12-y.o.	Emoji were selected (by researcher) from an emoji list (n=30) developed for adults (Jaeger, Lee, & Ares, 2018). The study included 16 of the 30 emoji but the selection procedure was not described in detail.	16 facial emoji Apple iOS 6.0	CATA	Valence (7 positive, 1 neutral, 8 negative emoji)	Standardized
Da Cruz et al. (2021)	7-14-y.o.	Preselection based on children that were presented with a list of 33 emoji (based on adults that were ranked as the most used emoji related to food in Twitter, Jaeger & Ares, 2017) and asked to select all emoji that they felt described their emotional experience during consumption of the fermented milk products using CATA.	15 facial emoji EmojiOne 2021	CATA	Valence (9 positive, 1 neutral, 5 negative emoji)	Product-specific (fermented milk products)

4.2.2 Conclusions

The findings resulted in 17 emoji pairs associated with specific semantic and dimensional (valence, power, and arousal) meanings. Based on this, an emoji-based self-report measurement tool was developed to measure emotions in response to food products with two suggested response formats, the CATA Emoji Pair Questionnaire and the Emoji Pair Rating Scale. The questionnaire will allow better understanding of affective responses to food and could be used in food innovation targeted to preadolescents to promote healthier food behaviors. Furthermore, further studies should test the persistence of the same semantic structure here described across different languages and cultures.

Chapter 5 The meaning of emoji in a cross-cultural context: Italy *vs.* Norway

Abstract

Emoji are supposed to simulate facial expressions that convey specific emotions or other situational meanings that are language-independent indicators of emotions with shared meanings between different cultures. However, some research demonstrated that the meaning of emoji can differ across countries in adults, but little is known about preadolescents. The aim of this study was to compare the emotional meaning of food-related emoji between 11-13-y.o. Italian (n=92) and Norwegian (n=109) preadolescents through a cross-cultural study by repeating Study 3 (CATA emoji described by emotion words) with Norwegian preadolescents. Spearman's correlation on the relative frequencies resulting from the Cochran's Q test and Multiple Factor Analysis (MFA) on the total frequencies of emotion words between countries were applied to compare the emotional meaning between countries. Italian and Norwegian preadolescents were found to describe emoji with overlapping emotional meaning, which was consistent with previous research with adults. This is the first study of its kind comparing the semantic meaning of emoji (between Italy and Norway) relevant to describe food experiences in preadolescents. The results allowed the application of the emoji-based self-report questionnaire in Norwegian preadolescents to describe emotions in response to different food stimuli.

5.1 Study 6: The semantic meaning of emoji comparing Italy and Norway

Previously, the Emoji Pair Questionnaire was developed in Italy consisting of 17 emoji pairs varying in emotions that can be used to measure preadolescents' food-elicited emotions. Consequently, a cross-cultural study was conducted to compare the meaning of emoji between Italy and Norway.

5.1.1 Material and methods

5.1.1.1 Participants

In total, 201 children aged 11-13 (M=12, SD=0.3, in both gender groups) were recruited from secondary school classes in Italy (n=92, 57% girls, Study 3) and Norway (n=109, 47% girls). Italian children were recruited from two/three public schools in the Florence area of Italy and Norwegian children were recruited from two public Norwegian schools in the Viken area of Southern Norway. Children had to return a consent form signed by themselves and their parents, where they consented to voluntarily participate in the study. Recruitment criteria and data treatment were planned in accordance with the General Data Protection Regulation (GDPR) 2016/679 and the principles of the Declaration of Helsinki. The protocol of the study was approved for each country by the Ethical Committee of the University of Florence and The Norwegian Center for Research Data (NSD) No. 715734.

5.1.1.2 Data collection

The test lasted approximately 45-60 minutes per class and was conducted during school time. The children sat in rows and with approximately 1m from each other to not disturb each other. Children conducted the test either on tablets or laptops provided by their schools and were all confident in using such devices. In Italy, all children used the same tablets (Acer Iconia One 10, Android 7.0), while in Norway children used laptops or tablets - either their own or provided by the schools. The questionnaire itself was conducted using the web-based software tool Compusense Cloud (version 20.0.7557.33837, Compusense Inc., Guelph, ON, Canada).

Instructions to children were given by a researcher employed at each university/research institute and followed a structured protocol similar to Study 3, however, countries differed in the way where the researcher was located at the time of the test session. In Italy, the

researcher and two assistants were physically present in the classroom, while in Norway, the researcher gave instructions remotely via online conference (this action was undertaken in Norway due to the unexpected COVID-19 pandemic and tightened regulations to prevent the spread of the virus). The teacher's laptop was used to connect the instructor with the school class that enabled the instructor could see and hear the children, while the children could see and hear the instructor at the same time. The instructor led the test session by first sharing a short PowerPoint presentation that was projected in the class's white board to explain the test step-by-step. One to two teachers were present per class throughout the entire test session to facilitate the online setup, but also to ensure a quiet atmosphere in the classroom. In both countries, children were allowed to ask questions during the instructions and the test session by rising their hand and addressing their question either directly to the instructor or through the teacher.

5.1.1.3 Selection of emoji and emotion words

Like Study 3 with Italian preadolescents, Norwegian preadolescents evaluated 46 emoji appropriate to describe their emotions elicited by foods of various eating contexts resulting from Study 1. Emotion words used in Study 3 were translated from Italian to English and then from English to Norwegian and checked for correct translation individually by two bilingual sensory science researchers of the research institute Nofima Ås, Norway. The emotion word "afraid" was added to the emotion word list in the Norwegian study because it was found that Italian children frequently used "afraid" in the additional comments to describe e.g., *face screaming in fear* 😱. The final list emotion word list with translations used in each country can be found in Table 5.1.

Table 5.1 Selection of emotion words following the 12-point circumplex structure of core affect. Emotion words with English, Norwegian and Italian translation.

	Dimension	English	Norwegian	Italian
I	**Pleasant Activation**	energetic	energisk	pieno di energia
II	**Activated Pleasure**	enthusiastic	entusiastisk	entusiasta
		amused	underholdt	allegro/a
		cheerful	glad	divertito/a
III	**Pleasure**	happy	lykkelig	felice
		satisfied	fornøyd	soddisfatto/a
		cuddled	kost med/bortskjemt	coccolato/a
		gratified	tilfreds	gratificato/a

IV	**Deactivated Pleasure**	confident	sikker	sicuro/a
		at ease	komfortabel	a mio agio
		reassured	beroliget	rassicurato/a
V	**Pleasant Deactivation**	relaxed	avslappet	rilassato/a
		calm	rolig	calmo/a
		serene	fredelig	sereno/a
		carefree	ubekymret	spensierato/a
VI	**Deactivation**	indifferent	likegyldig	indifferente
		quiet	stille	tranquillo/a
VII	**Unpleasant Deactivation**	bored	kjeder meg	annoiato/a
VIII	**Deactivated Displeasure**	sad	trist	triste
		melancholic	melankolsk	malinconico/a
IX	**Displeasure**	unhappy	ulykkelig	infelice
		dissatisfied	misfornøyd	insoddifatto/a
		disappointed	skuffet	deluso/a
X	**Activated Displeasure**	guilty	skyldig	in colpa
XI	**Unpleasant Activation**	annoyed	irritert	infastidito/a
		disgusted	avsky/ekkelt	disgustato/a
		angry	sint	arrabbiato/a
		worried	bekymret	preoccupato/a
		afraid	redd	-
XII	**Activation**	surprised	overrasket	sorpreso/a
		curious	nysgjerrig	incuriosito/a

5.1.1.4 Study procedure

The study procedure followed the protocol of the same CATA questionnaire conducted with Italian preadolescents (see section 3.2.1.4 describing procedures of Study 3: CATA with emoji described by emotion words). One emoji was presented at a time and children were asked to select all emotion words they found appropriate to express the meaning of each of the emoji. Emoji were presented in two blocks of emoji (2x23 emoji) for each child to give a refreshing break. Emoji were randomized within each block and the presentation order of the two blocks was balanced across children. The order of emotion words was balanced for each emoji. As soon as they finished, children were offered a riddle that helped to keep the quiet atmosphere in the class. Before the test day, the teacher went through the definitions of each of the 30 emotion words to ensure all children knew the same interpretation. If children wanted to reassure themselves about the meaning a specific emotion word, they could do so by searching the definition that was available in the questionnaire.

Additionally, children were asked about gender and age and to answer to some questions about emoji usage (Emoji Usage Questionnaire - EUQ), which included the following domains: Familiarity, Frequency of usage, Social use, Motivation, Valence and Enjoyment in using emoji.

5.1.1.5 Data analysis

Data from the EUQ were analyzed by computing frequencies (%) of responses for each country. Differences between countries (Norway *vs.* Italy) and genders (by merging the Norwegian and Italian data set) on Familiarity, Frequency of usage, Valence and Enjoyment were tested by using Kruskal-Wallis One-Way Analysis of Variance by ranks. Chi-square test was applied to test differences in the distributions of the responses between gender groups for each item of the other domains.

Data analyses followed the ones as described previously for Study 3: Cochran's Q test with Sheskin as a post-hoc test was conducted to establish the meaning of emoji from the CATA questionnaire evaluated by Norwegian children. Frequency tables (emoji x CATA word combinations) were created, and Correspondence Analysis (CA) was applied on the total sample of Norwegian children. Emotion words selected by ≥40% of children for each emoji were considered as important emotion words to describe a specific emoji. For the open-ended responses, additional words were grouped by their meaning and all emotion word constructs ≥10% were considered as a further emotional meaning for a specific emoji.

Two statistical analyses were used to compare the emotional meaning between countries: 1) Spearman's correlation was applied on relative frequencies resulting from Cochran's Q test to compare correlations of emotion words between countries (Italy *vs.* Norway). 2) Multiple Factor Analysis (MFA) was computed to compare the total frequencies of emotion words between countries (Norway *vs.* Italy), and genders (girls *vs.* boys) by merging data of Norway and Italy. RV coefficients were calculated to compare the plots by gender (girls *vs.* boys) and country (Norway *vs.* Italy).

The level of significance for all the analysis was set at $p \leq 0.05$. Statistical analyses were performed using XLSTAT (version 2021.2.1, Addinsoft, New York, NY, USA).

5.1.2 Results

5.1.2.1 The Emoji Usage Questionnaire (EUQ): A comparison between Norway and Italy

Differences between Italy and Norway were found in several domains (see Supplementary Material Table S 6): Children from Italy were found to be more familiar with emoji ($p<0.0001$) and to use emoji more frequently ($p<0.0001$) compared to children from Norway. Children from both countries also differed in the Motivation domain. Italian children stated more than the Norwegian ones that "emoji make text message more understandable" ($p=0.0023$), "emoji highlight a part of the message" ($p=0.006$) and that "emoji express something that normally can't be described in words e.g., how to feel" ($p<0.0001$). Italian children showed a higher enjoyment compared to Norwegian children ($p<0.0001$), but Norwegian children stated that in general they use more positive emoji ($p=0.018$).

For Norwegian children, gender differences were found for the domains Familiarity, Frequency of usage, Social use, Motivation and Enjoyment. Girls stated to use emoji more regularly (65%) ($p=0.002$) and to use them every day (72%) compared to boys that use emoji mostly "a few times a week" (54%) ($p<0.0001$). Girls send emoji more often to siblings (61% *vs.* 29% boys) and to teachers (25% *vs.* 3% boys) ($p=0.001$, respectively). Boys are motivated to send emoji because they are "more fun" (48% *vs.* 29% girls) ($p=0.044$). However, girls think that emoji "make the text messages more understandable" (59% *vs.* 34% boys, $p=0.011$), that "they highlight a part of the message" (20% *vs.* 7% boys, 0.048%) and that "they express something that normally can't be described in words, e.g., how he/she feels" (45% *vs.* 19% boys, $p=0.003$) more than boys. Finally, girls stated to enjoy emoji "a lot" (49%) compared to 18% boys who mostly stated to enjoy emoji "fairly" (47% *vs.* 37% girls) ($p<0.0001$). These results are mostly in line with the Italian data that are reported in the Supplementary Materials Table S 3. Both countries showed gender differences in the domains Familiarity, Frequency of use and Social use, but not Valence. However, Norwegian children also showed gender differences in the domains Motivation and Enjoyment, which was not the case for Italian children.

5.1.2.2 Cross-cultural comparison of semantic meaning of emoji between Norway and Italy

Spearman's correlation on the relative frequencies from the Cochran's Q test) shows that 28 ($p<0.0001$, respectively) out of 30 emotion words are positively correlated between Italy and

Norway (range of correlation: 0.542 - 0.928). The two emotion words “indifferent” (p=0.439) and “quiet” (p=0.297) are not correlated between countries (Table 5.2).

Table 5.2 Spearman’s correlation on relative frequencies (resulting from Cochran’s Q test) to compare correlation of emotion words (n=30) between Norway and Italy; the emotion word “afraid” was not used in the Italian study.

Emotion words	Correlation	p-value
curious	0.560	**<0.0001**
surprised	0.855	**<0.0001**
energetic	0.884	**<0.0001**
enthusiastic	0.902	**<0.0001**
cheerful	0.878	**<0.0001**
amused	0.836	**<0.0001**
happy	0.864	**<0.0001**
satisfied	0.853	**<0.0001**
cuddled	0.542	**<0.0001**
gratified	0.772	**<0.0001**
confident	0.832	**<0.0001**
at ease	0.783	**<0.0001**
reassured	0.852	**<0.0001**
carefree	0.841	**<0.0001**
relaxed	0.910	**<0.0001**
calm	0.910	**<0.0001**
serene	0.853	**<0.0001**
indifferent	-0.117	0.439
quiet	0.157	0.297
bored	0.739	**<0.0001**
sad	0.896	**<0.0001**
melancholic	0.677	**<0.0001**
unhappy	0.850	**<0.0001**
dissatisfied	0.814	**<0.0001**
disappointed	0.860	**<0.0001**
annoyed	0.928	**<0.0001**
disgusted	0.878	**<0.0001**
angry	0.780	**<0.0001**
worried	0.886	**<0.0001**
guilty	0.824	**<0.0001**
afraid	-	-

Additionally, the Multiple factor analysis (MFA) on the total frequencies (n) of emotion words shows a high correlation along the first and second dimension (accounting for 65.19% of total variance) between Italian and Norwegian preadolescents. The first dimension (accounting for 48.96% of variance) divides emotion words into positive (left side) and negative (right side)

emotion words, while the second dimension (accounting for 16.23% of variance) can be interpreted as power (high power on the upper side *vs.* low power lower side of the map) (Figure 5.1). For example, in the literature "angry" and "annoyed" are described as high in power opposing emotions "worried", "sad" and "guilty", which are low in power (Fontaine & Scherer, 2013). The emotion words "indifferent", "curious", "surprised", "quiet", "cuddled", "energetic", "dissatisfied" and "disappointed" do not seem to be well described. The contingency table (%) of Study 6 can be found in the Supplementary Materials Table S 9 and emotion words mentioned ≥40% of children comparing Norway vs. Italy can be found in the Supplementary Materials Table S 10.

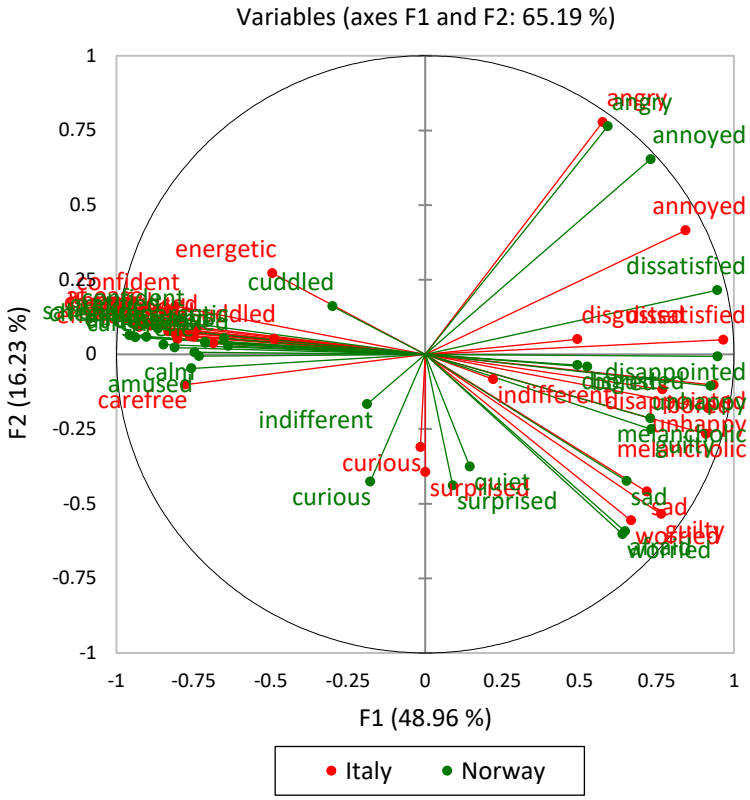


Figure 5.1 Multiple factor analysis (MFA) on the total frequencies (n) of emotion words between Italy and Norway.

Figure 5.2 demonstrates that emoji have a similar dimensional meaning in both countries. In both countries, negative emoji were better discriminated along the second dimension (interpreted as power) compared to positive emoji, dividing negative emoji into emoji of high power (top right, e.g., *pouting face* 😡, *face with symbols on mouth* 🤬) and emoji low in power (bottom right, e.g., *face screaming fear* 😱, *crying face* 😢), which agrees with findings

of results on projective mapping (Study 2) and the two CATA approaches (Study 3 and 4) with Italian preadolescents. Consequently, it can be concluded that there is a good agreement how Norwegian and Italian preadolescents describe emoji with words. The RV (=0.953) coefficient confirm high agreement between data of both countries.

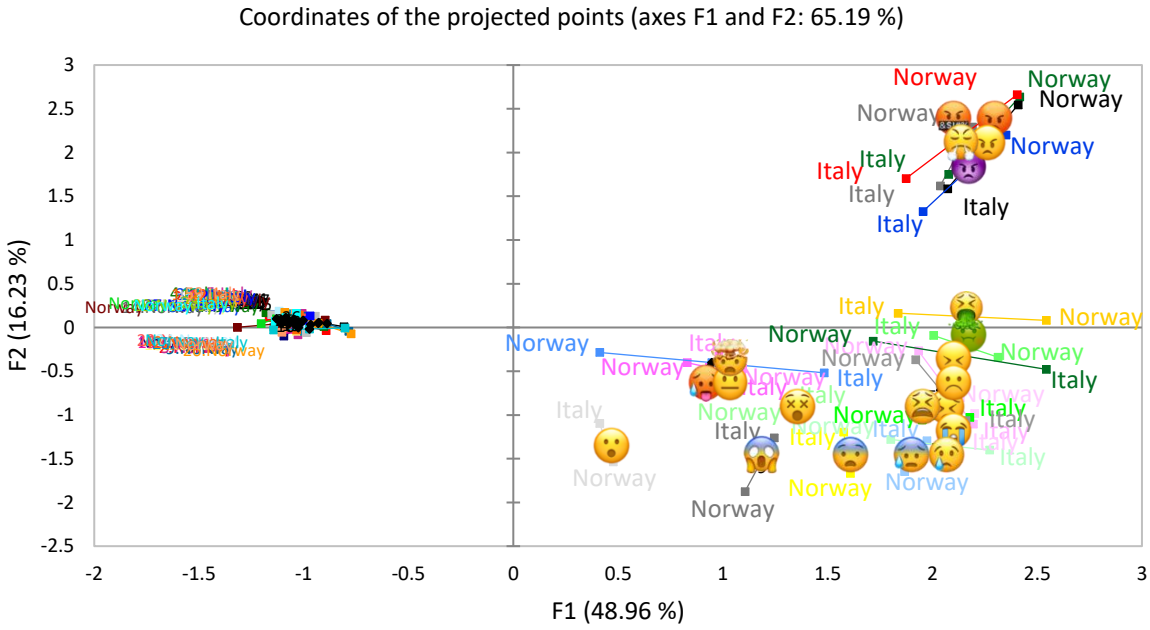


Figure 5.2 Multiple Factor Analysis (MFA) of coordinates of the projected points comparing the meaning of emoji between countries. Emoji 😀, 😃, 😄, 😁, 😆, 🙂, 😉, 😊, 😇, 🥰, 😍, 😂, 😘, ☺️, 😋, 😛, 😜, 🤪, 😝, 🤑, 🤗, 😌, 🤤, 🥳 and 😎 are not shown on the left side of the figure because they are overlapped.

5.1.2.3 Comparing the semantic meaning of emoji between girls and boys

When merging the data of Norway and Italy, it was observed that there were no differences between girls and boys on how emoji are interpreted (Figure 5.3). The first and second dimension (accounting for 66.41% of total variance) can be interpreted as valence and power, respectively, which overlaps with results of the MFA (Figure 5.1). The emotion words “curious”, “surprised”, “quiet”, “cuddled”, “energetic”, “indifferent” and “disgusted” were not well described. The map showing coordinates of projected map (not shown here) also did not show differences in emoji dimensions. The RV coefficient yields 0.983 when comparing data of girls and boys indicating a very high agreement between genders.

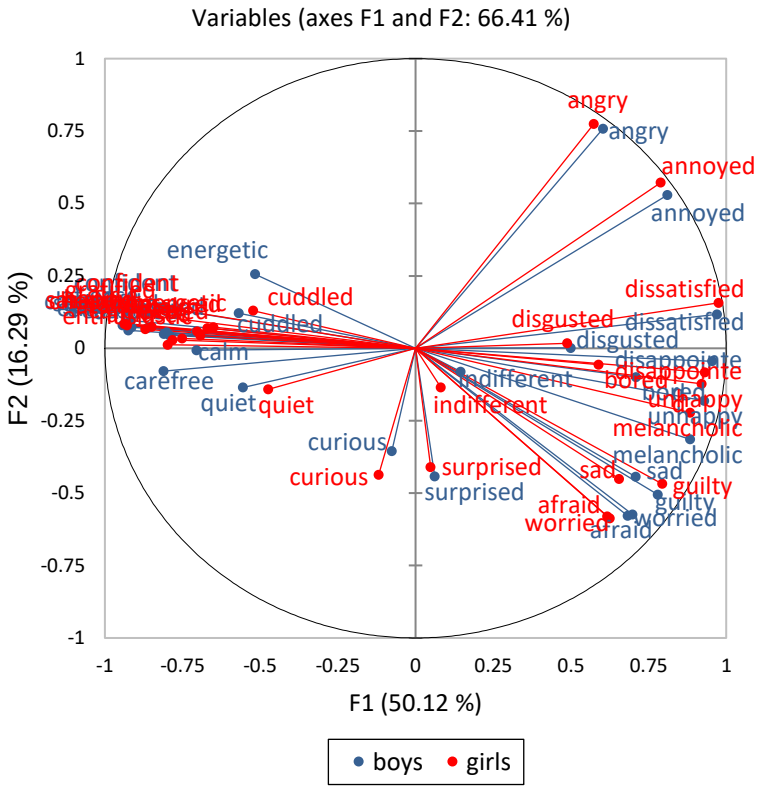


Figure 5.3 Multiple factorial analysis (MFA) on the total frequencies (n) of emotion words between boys and girls (merged data of Norway and Italy).

5.1.2.4 Comparison of additional comments between Norwegian and Italian children

Additional words (grouped by their meaning) were mentioned by ≥10% of Norwegian children in the open-ended response option (see Supplementary Materials Table S 9). Results are mostly overlapping between countries: In both Norwegian and Italian children the *smiling face with heart-eyes* 😍 was described as expressing "in love" (12% and 63%, respectively), the *zany face* 🤪 was described as expressing "crazy" (13% and 23%, respectively), the *smiling face with sunglasses* 😎 was described as "feeling cool" (17% and 11%, respectively), the *money-mouth face* 🤑 was described as "rich" (10% and 26%, respectively), the *nauseated face* 🤢 was described as "nauseated" (18% and 12%, respectively; "urge to vomit/nauseated" in Italian children) and the *face savoring food* 😋 was described as "hungry/tasty" (11%) in Norwegian children and as "hungry" (10%) and "gluttonous" (14%) in Italian children.

The *face vomiting* 🤮 was described as "nauseated" in Norwegian children (15%) and as "feeling sick" by Italian children (12%). The *hot face* 🥵 shared the meaning "feeling hot" (23%

and 20%, respectively), but was also described as tired (27%) in Italian children. The *face with crossed-out eyes* 😵 was described as "dead/surprised" (21%) in Norwegian children and as "dead/deceased" (26%) in Italian children. The *exploding head* 🤯 was described as "surprised/shocked" (12%) and the *anxious face with sweat* 😰 as "uncomfortable/stressed" (11%) by Norwegian children, but Italian children did not associate these emoji with any additional words.

5.2 Discussion

5.2.1 The semantic meaning of emoji comparing Italy and Norway

Study 6 compared the semantic emotional meaning of emoji between Italian and Norwegian preadolescents. Overall, findings demonstrated that emoji meanings highly overlap between countries, with 28 out of 30 emotion words being significantly correlated. This is in agreement with prior studies comparing the semantic meanings of emoji across different languages in four countries (English - USA and UK, Spanish - Spain and Italian - Italy) (Barbieri et al., 2016). Barbieri et al. (2016) stated that despite the differences in emoji use across languages, the overall semantics of the most frequently used emoji are comparable. Also, Jaeger & Ares (2017) did not find major differences of internet meanings for emoji resources of different cultural background, even when comparing Chinese consumers to meanings reported in Western websites. As Norway and Italy are both European countries, cultural differences in emoji use may be little. Also, Novak et al. (2015) investigated the sentiment of emoji of 13 European languages (Albanian, Bulgarian, English, German, Hungarian, Polish, Portuguese, Russian, Serbian/Croatian/Bosnian, Slovak, Slovenian, Spanish and Swedish) and reported agreement in emoji meaning with the highest agreements found among English- and Polish-speakers.

Oleszkiewicz et al. (2017) asked 4-8-y.o. children to match human faces and emoticons faces and found high agreement for the emotion categories "happy" and "sad". In the current study, emoji expressing "happy" and "sad" were also well described in both countries. Moreover, children from Norway and Italy mostly agreed on the meanings describing emoji expressing "angry", "disgusted" and "surprised", however, in the study by Oleszkiewicz, Frackowiak, Sorokowska, & Sorokowski (2017) children had difficulties in describing these emotions (described as "basic emotions" in their study). In the current study, children were older (9-13-

y.o.), which may already have a better understanding and increased ability to associate specific words with facial expressions.

Some emoji did not share an overlapping meaning between countries or were not described at all in at least one country. For example, Norwegian children did not associate the *relieved face* 😌, *neutral face* 😐, *hot face* 🥵 and face with *crossed-out eyes* 😵 with any emotion word in contrast to Italian children that described the emoji with "serene, calm", "indifferent", "tired, hot feeling" and "surprised, worried, dead/deceased", respectively. The *exploding head* 🤯 was not described (selected by <40%) by Italian children but interpreted as "surprised" (65%) by Norwegian children. In prior research, also some emoji were interpreted differently from language to language (Barbieri et al., 2016) and overall usage of emoji in conversation were shown to differ by culture (Lu et al., 2016). Some research even showed that there are differences in emoji interpretations within the same culture, regardless if the emoji is presented in a context or in isolation (Miller, Kluver, Thebault-Spieker, Terveen, & Hecht, 2017; Miller et al., 2016). Certain emoji, including those with cultural significance may be at greater risk of misinterpretation and should possibly be avoided in generic research instruments (Jaeger, Xia, Lee, et al., 2018). Some differences in emoji meanings could also be related to the use of different platforms (e.g., Apple, Facebook, Android) as some platforms might be more used in some countries/cultures, which might also influence emoji usage in a cross-cultural context. Consequently, when applying emoji questionnaire attention should be paid to the most frequently platforms used in a specific country to decrease the risk of misinterpretations of emoji.

In general, the emotion words "indifferent", "curious", "surprised", "quiet", "cuddled", "energetic", "dissatisfied" and "disappointed" were not well described by emoji in neither of the countries. Children in this age group may find it difficult to describe specific emoji with these words. "Indifferent" and "quiet" were the only emotion words that were not correlated between countries. While in Italy the *neutral face* 😐 was interpreted as "indifferent" by 58% of children, only a very few Norwegian children linked the emoji with "indifferent" (15%). Similarly, "quiet" was one of the emotion words used to describe the *smiling face with halo* 😇 by Italian children, which was not really linked to this emoji by Norwegian children (14%). Norwegian children did not use "quiet" to describe any of the emoji (all were lower than 40%).

Both emotion words ("indifferent" and "quiet") are low in activation level, which could be related to differences in the use of activation level in emotional expression between countries. As mentioned by Schouteten & Meiselman (2021) certain cultures might avoid expressing strong feelings and affect from other people as well as themselves. In a recent study, the recently developed *shushing face* 🤫 was linked with "quiet" in adults when evaluating food names (Schouteten et al., 2022), following, it could be interesting in future research to test the suitability of this emoji to express "quiet" in children.

Some of the differences in the interpretation of emoji could be explained by differences in emoji familiarity and emoji usage frequency. Italian children were more familiar, used emoji more often and enjoyed emoji more compared to Norwegian children. Generally, familiarity of emoji was high in both countries (97% Italian and 89% Norwegian children used emoji either regularly or occasionally), however, some research indicated that the familiarity of emoji influences the meaningfulness of emoji (Rodrigues et al., 2018). The fact that Italian children enjoyed using emoji more than Norwegian children, could be related to differences in data collection in the schools. In Italy, data were collected in the schools with instructors and assistants being present in the classroom, which could have led to a higher engagement of children participating in the study.

Furthermore, translating emotion words into different languages may have affected the results of the study. Even though the emotion words were translated and back translated by Italian and Norwegian native speakers, there is always a risk in translating emotion words into different languages/cultures. In the Italian study, most positive emoji were described by "happy", while in the Norwegian study most positive emoji were described by "cheerful". "Happy" and "cheerful" are both very positive and activated emotion words describing very similar emotional constructs. As this pattern was observed throughout most positive emoji, it may be that when translating the emotion words from English to Italian and Norwegian, the word resulted in a slightly different meaning for each country.

5.2.2 Conclusions

In summary, the general meanings of emoji overlap between Italian and Norwegian children with some minor differences for some emoji. This enables the application of the emoji-based self-report questionnaire with Norwegian children to describe emotional responses to foods

(see Chapter 6). Future research should investigate if emoji meanings also overlap with children of other countries/cultures to apply the questionnaire across different countries/cultures.

Chapter 6 The validation of the emoji-based self-report questionnaire using food names and tasted food models

Abstract

A new emoji-based self-report measurement tool, the Emoji Pair Questionnaire, has been developed to measure food-elicited emotions in preadolescents. The aim was to validate and apply the Emoji Pair Questionnaire (two response formats) with Norwegian preadolescents to assess its emotional profiles and discriminant ability in response to food (food names and tasted food models). In total, 148 Norwegian children (11-13-y.o.) participated in the study by asking them to evaluate 28 food names in terms of familiarity (5-point categorical scale), stated liking (7-point-Likert scale) and emotions using the CATA Emoji Pair Questionnaire. Furthermore, they were asked to taste food models (grapefruit juice spiked with sucrose: 0, 40, 80, 160 g/L; and vegetable broth spiked with sodium chloride: 0, 3, 6, 12 g/L) and evaluate them in terms of liking (LAM scale) and emotions using the Emoji Pair rating scale. Findings showed that emoji pairs varied between food categories of food names and were able to discriminate between familiar foods despite similar liking. Emoji pairs also discriminated significantly among familiar food products within the food categories fruits, vegetables, and desserts/juices. Grapefruit juice samples (spiked with sucrose) differed in liking and in associated emoji pairs, but vegetable broth samples (spiked with sodium chloride) were discriminated neither in liking nor emoji pairs. The Emoji Pair Questionnaire offers a novel approach that can be used as a CATA questionnaire or a rating scale to discriminate between foods. Both response formats proved to be effective especially when differences among products are small.

6.1 Study 7a: The validation of the emoji-based self-report questionnaire using food names and tasted food models

The aims of Study 7 were to validate the Emoji Pair Questionnaire with food names and tasted food models (Study 7a), to identify different emotional patterns of responses to foods, to cluster children according to these and to test these clusters for differences in individual differences in sensory responsiveness to basic tastes, personality traits and liking for the products (Study 7b). The rationale behind this study is that a different emotional pattern is associated to differences in liking for these products, taste responsiveness and/or personality traits. Chapter 6 will describe study procedures of Study 7, but results will focus on the validation of the emoji-based self-report questionnaire only. Results of Study 7b will be presented in Chapter 7.

6.1.1 Material and methods

6.1.1.1 Participants

In total, 165 children were recruited in two public Norwegian schools in the Viken area of Southern Norway. A total of 148 children aged 11-13 (M=12, SD=0.3, in both gender groups, 52% girls) completed the test. Children had to return a consent form signed by themselves and their parents, where they consented to voluntarily participate in the study. Recruitment criteria and data treatment were planned in accordance with the General Data Protection Regulation (GDPR) 2016/679 and the principles of the Declaration of Helsinki. The protocol of the study was approved by The Norwegian Center for Research Data (NSD) No. 715734.

6.1.1.2 Selection of food names

Twenty-eight food items were selected to represent the sensory variety in the fruit (n=10), vegetable (n=10), and dessert/juice (n=8) categories, as shown in Table 6.1. The products were selected including familiar and unfamiliar options in the two countries (Norway and Italy) based on previous studies (Dinnella et al 2016, Monteleone et al 2017, Laureati et al. 2018). considering products commonly consumed in Europe. Within each food category, it was intended to select food items differing in basic tastes e.g., dark chocolate (more bitter, less sweet) *vs.* milk chocolate (less bitter, sweeter) to be used in a choice test. For the vegetable category it was intended to oppose items low *vs.* high in bitterness. Vegetable items were

selected based on a previous study (unpublished data by Agovi (2022)) with 121 Italian preadolescents (60% girls) aged 9-12 years (M=11, SD=1.1, in both gender groups) that were asked to select among four sensory properties (sweet, sour, bitter, and delicate) to describe vegetables (CATA approach). Cochran's Q test was applied to analyze the CATA data. Six vegetable pairs (lettuce *vs.* rucola ($p<0.001$), spinach *vs.* lettuce ($p=0.047$), rucola *vs.* spinach ($p<0.001$), carrot *vs.* squash ($p=0.007$), squash *vs.* tomato ($p=0.003$), and broccoli *vs.* green beans ($p=0.001$) were found to significantly differ in bitterness frequencies. Moreover, vegetable pairs (green beans *vs.* corn, green beans *vs.* carrots, and green beans *vs.* peas) differing in sweetness frequencies were considered assuming that sweeter vegetables were less bitter.

Table 6.1 Food names (n=28) for each food category used in Study 6.

Fruits (n=10)	**Vegetables (n=10)**	**Desserts/juices (n=8)**
Apple	Arugula	Dark chocolate
Clementine	Broccoli	Fruit yogurt
Grapes	Carrot	Grapefruit juice
Grapefruit	Corn	Milk chocolate
Kiwi	Green beans	Natural yogurt
Orange	Iceberg salad	Orange juice
Pineapple	Peas	Strawberry sorbet
Raspberry	Spinach	Vanilla ice cream
Strawberry	Squash	
Watermelon	Tomato	

For each fruit and dessert/juice category it was intended to oppose bitter or sour *vs.* sweet items. The selection was based on research by Martin, Visalli, Lange, Schlich, & Issanchou (2014) and Laureati et al. (2018), where a trained panel evaluated several foods to create a food "taste" database. For instance, apples (less sour) oppose orange (sourer). Opposing food pairs and their target tastes can be found in Table 6.2. The validity of the oppositions in both countries was checked to ensure a similar level of familiarity/unfamiliarity.

Table 6.2 Evaluated target taste for each food name and opposing pairs of food names for each food category (fruits, vegetables, and desserts/juices) used in Study 6.

Food category	Target taste	Low intensity taste	High intensity taste
Fruits	Sour	Apple	Orange
	Sour	Watermelon	Orange
	Sour	Pineapple	Grapefruit
	Sour	Grapes	Kiwi
	Sour	Clementine	Kiwi
	Sour	Strawberry	Raspberry
Vegetables	Bitter	Lettuce	Arugula
	Bitter	Lettuce	Spinach
	Bitter	Spinach	Arugula
	Bitter	Corn	Green beans
	Bitter	Carrots	Squash
	Bitter	Tomato	Squash
	Bitter	Green beans	Broccoli
	Bitter	Carrots	Green beans
	Bitter	Peas	Green beans
Desserts/juices	Sour	Apple juice	Grapefruit juice
	Bitter	Milk chocolate	Dark chocolate
	Sour	Vanilla ice cream	Lemon sorbet
	Sour	Fruit yogurt	Plain yogurt

6.1.1.3 Selection of tasted food models

Grapefruit juice (Cevita, Bama AS, Norway) and vegetable broth (Maggi, Nestle SA, Norway) were used as tasted food models. Grapefruit juice was selected because of the natural presence of bitterness and sourness (Gous, Almli, Coetzee, & de Kock, 2019), which can be suppressed by the addition of sucrose (Green, Lim, Osterhoff, Blacher, & Nachtigal, 2010). The vegetable broth was selected because it contains monosodium glutamate (MSG) that is perceived as umami and does not hold any meat ingredients that could pose a problem for some religions and personal diets. The addition of sodium chloride into the broth was aimed to elicit saltiness. Other selection criteria of the food models were that they needed to be easy to prepare, store, transport, and serve.

Four different concentrations of added sucrose (0, 40, 80, 160 g/L) were evaluated in grapefruit juice and four different concentrations of added sodium chloride (0, 3, 6, 12 g/L) were evaluated in vegetable broth (see Table 6.3). The juice itself already contains around 6.9 g/L of natural sugars, while the vegetable broth contains around 10 g/L of salt at the base. Therefore, this resulted in a final concentration of sugar at around 6.9, 46.9, 86.9 and 166.9 g/L, respectively in grapefruit juice, while salt content resulted in 10, 13, 16 and 22 g/L in

vegetable broth. However, for clarity, the concentrations in this thesis were referred to the amount of added tastant to the food models. Sweetness, bitterness, and sourness were investigated as target sensations in grapefruit juice, while saltiness and umami were investigated in vegetable broth. The amount of added tastant for each grapefruit juice and vegetable sample to elicit different intensities of target tastes was selected based on a pretest with trained panelists at the University of Florence, Italy, (n=4) and the research institute Nofima Ås, Norway, (n=11), and finally with 10-13-y.o. Norwegian children (n=9) (see Ervina, 2021).

Pre-weighed amounts of sucrose were added to the grapefruit juice and stirred until completely dissolved. The mixture was then filtered by using a sieve to remove the fruit pulp and stored in a closed container at 4 °C before being transferred into disposable cups. The vegetable broth samples were prepared by adding 14 g of vegetable broth powder into one liter of hot water (80 °C) and pre-weighted amounts of sodium chloride were added. The vegetable broth mixture was stirred until the broth powder and sodium chloride were completely dissolved, then filtered using a sieve to remove any vegetable chunks. Excess fat formed at the surface of the vegetable broth samples was removed using a spoon. The grapefruit juice and vegetable broth samples (20 mL) were served in 50 mL closed disposable cups and labeled with three-digit random codes. All food samples and taste compounds were food grade and purchased from a local supermarket. The sample preparation was conducted at the sensory laboratory at Nofima Ås, Norway.

All samples were prepared one day before the test, stored in a refrigerator at 4 °C overnight, and distributed to the school on the day of testing. The samples were kept at room temperature until the evaluation time, approximately 4 h from retrieval from the refrigerator.

Table 6.3 Food models with type and amount of added tastant (final sucrose/sodium chloride concentrations in brackets) for each sample, and target basic tastes measured for each food model; g/L = grams per liter.

Food models	Added tastant	Sample 1	Sample 2	Sample 3	Sample 4	Basic tastes
Grapefruit juice	Sucrose $C_{12}H_{22}O_{11}$	0 g/L (6.9 g/L)	40 g/L (46.9g/L)	80 g/L (86.9 g/L)	160 g/L (166.9 g/L)	sweet sour bitter
Vegetable broth	sodium chloride NaCl	0 g/L (10 g/L)	3 g/L (13 g/L)	6 g/L (16 g/L)	12 g/L (22 g/L)	salty umami

6.1.1.4 The tasting kit

Each child received samples (grapefruit juice and vegetables broth) in two boxes labeled as Box A for liking evaluation and Box B for taste responsiveness evaluation (Figure 6.1). Each box included four grapefruit juice samples at different sucrose concentrations (0, 40, 80, 160 g/L) and four vegetable broth samples at different sodium chloride concentrations (0, 3, 6, 12 g/L). Box A included plain crackers (Gluten Free Classic by Wasa, Barilla Switzerland AG, plain, gluten free and lactose free) for mouth rinsing and Box B contained a PROP disc. In addition, children were provided with plain water and spitting cups.

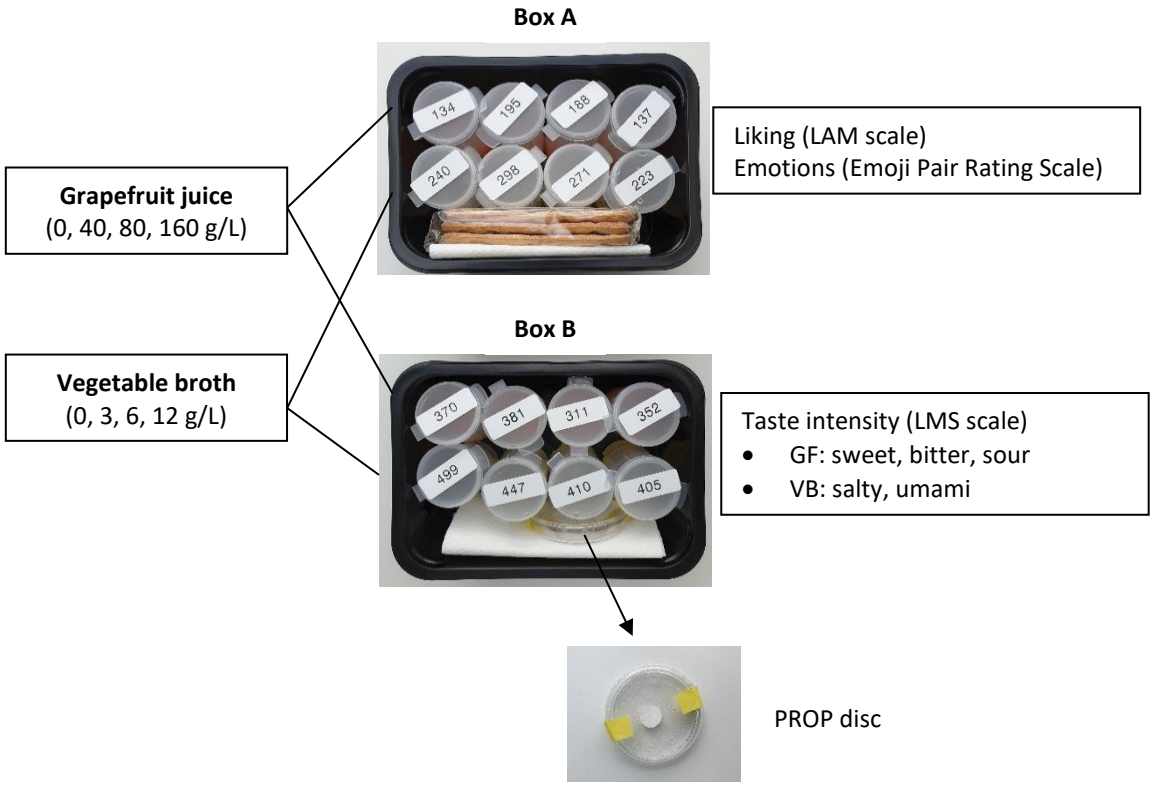


Figure 6.1 Taste kit Box A and Box B with four samples of grapefruit juice (GF) and four samples of vegetable broth (VB) varying in sucrose and sodium chloride concentrations, respectively. Box A was used to measure liking and emotions, Box B to measure taste intensity of basic tastes; LAM (Labeled Affective Magnitude) scale, LMS (Labeled Magnitude Scale).

6.1.1.5 Data collection

The study was conducted remotely via video conference (Microsoft Teams, Microsoft Corporation, Redmond, Washington, United State) as of restrictions to visit the schools physically caused by the COVID-19 pandemic. Children sat in their regular classroom, while the instructor (researcher) was based at the research institute Nofima Ås, Norway (Figure

6.2a) and b). The video conference was projected onto a large screen in front of the class and a video camera in the classroom was turned on so that the researchers could monitor the test remotely. Children were able to ask questions directly to the instructor or through the teacher at any time. The teacher assisted the instructors with any practicalities necessary to run the test (e.g., setting up the video conference, distributing the taste kits and water etc.). The study lasted approximately two hours per class with a 15-minute break in between and was conducted during school time. The children sat in rows and with approximately 1 m apart to not disturb each other. Children conducted the test either on tablets or laptops provided by their schools and were all confident in using such devices. The questionnaire itself was conducted using the web-based software Compusense Cloud (version 20.0.7557.33837, Compusense Inc., Guelph, ON, Canada).

a) b)

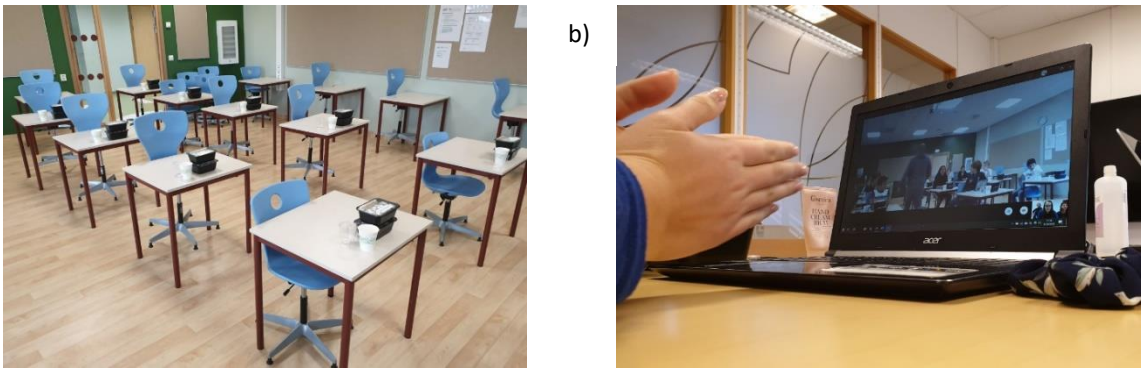


Figure 6.2 a) Setup of the data collection in the schools (left) and b) the remote testing at the research institute Nofima Ås, Norway; photo credits: Julia Sick.

6.1.1.6 Study procedure

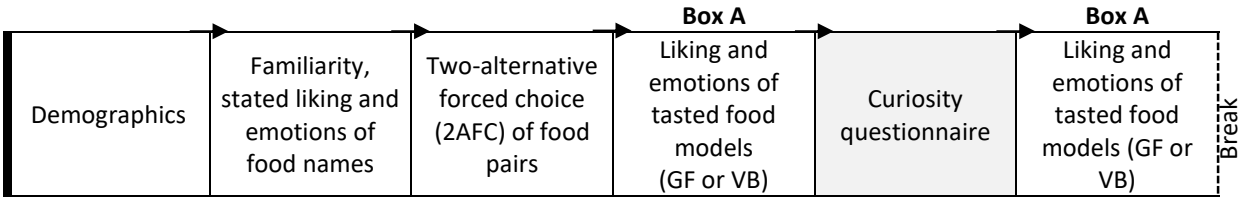
Study 7 was divided into two parts (Figure 6.3). In Part 1, children were asked about general questions on demographics (gender, age, and school), familiarity (5-point categorical scale), stated liking (7-point-Likert scale) and emotions (using the CATA Emoji Pair Questionnaire) in response to 28 food names. In addition, children were asked about their liking and emotions (using the Emoji Pair Rating Scale) in response to tasted food models of Box A and to answer the curiosity questionnaire. After Part 1, children were given a short break of approximately 15 min to refresh their minds and they had the possibility to complete a riddle. In Part 2, children were asked about intensity perception of tasted food models of Box B, and to answer the questionnaires of food neophobia, sensitivity to reward and punishment and sensation

seeking. Lastly, children were asked to complete a PROP test to measure their responsiveness to bitterness.

In the beginning of each part, an instructor presented a short PowerPoint presentation (Microsoft Corporation, Redmond, Washington, United States) to introduce the children to the test and to explain the questionnaires and scales to ensure all children were confident in doing the test on their own. Also, the five basic tastes were recalled with images and age-appropriate examples were given to train the children in the use of the scale (Goldstein, Daun, & Tepper, 2007).

Procedures of PROP testing, sensory responsiveness to basic tastes in tasted food models and personality trait questionnaires are described in detail in the following Chapter 7. The two-alternative forced choice (2AFC) will not be further considered in this thesis.

Part 1



Part 2

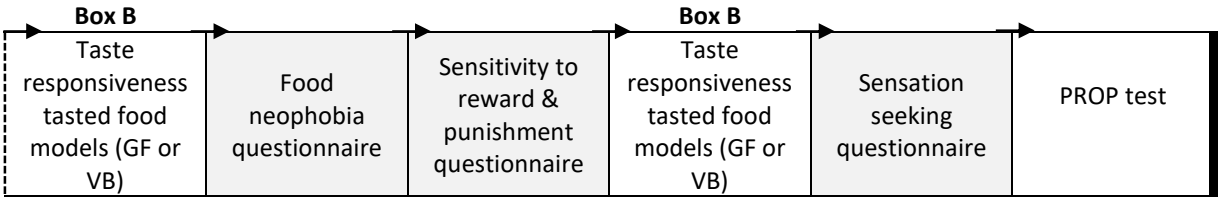


Figure 6.3 Procedure of Study 7 divided into Part 1 and 2; GF = grapefruit juice, VB = vegetable broth.

6.1.1.7 Familiarity, stated liking, and emotional responses to food names

The 28 food names were presented one at a time by first asking about how familiar the food items were to them (5-point categorical scale; 1 = I do not know it, 2 = I know it but have never tasted it, 3 = I have tasted it but rarely eat it, 4 = I occasionally eat it, 5 = I regularly eat it) (Tuorila, Lähteenmäki, Pohjalainen, & Lotti, 2001). If children were familiar to the food item (by responding to one of the anchor points between 3-5 of the familiarity scale), they were asked about how much they like the food item adopting the hedonic scale by Peryam & Pilgrim (1957) of which the two extreme anchor points were removed (7-point hedonic scale; 1 =

dislike very much, 2 = dislike moderately, 3 = dislike slightly, 4 = neither like nor dislike, 5 = like slightly, 6 = like moderately, 7 = like very much) and how this make them feel by selecting all emoji pairs (n=17) that apply (CATA Emoji Pair Questionnaire, Figure 6.4a). The instructions for the CATA emoji pair scale were as follows: "*How does the food make you feel? Choose as many emoji pairs as possible. If only one emoji from the group fits, select the group anyway.*" Children were asked to select at least one of the emoji pairs. Emoji pairs were presented in a random and balanced order for each child. Food names were randomized following a 4x Williams Design (4 Latin Squares).

6.1.1.8 Liking and emotional responses to tasted food models

Children's liking of tasted food models was measured using the Labeled Affective Magnitude Scale (LAM) with the anchor points: greatest imaginable dislike (0.00), dislike extremely (12.25), dislike very much (22.25), dislike moderately (34.06), dislike slightly (44.69), neither like nor dislike (50.00), like slightly (55.62), like moderately (68.12), like very much (78.06), like extremely (87.11) and greatest imaginable like (100) (Cardello & Schutz, 2004; Schutz & Cardello, 2001). Emotions of tasted food models were evaluated by using the Emoji Pair Rating Scale with 17 emoji pairs rated on a 5-point categorical scale (two anchor points at 1 = Not at all and 5=Very much, Figure 6.4b). Emoji pairs were randomized for each child and sample. It was mandatory to rate all 17 emoji pairs. Children were asked to taste one sample at a time and to rate liking and emoji for each sample tasted. The instructions for emoji evaluation were as follows: "*How does the food make you feel? Look at the emoji pairs. For each group, indicate how much the emoji (one of the two or both) match the feeling you get from tasting the food sample.*".

Children were asked to take a sip of a sample (swallowing was not mandatory) and then asked to rate their liking and emotions. Children were instructed to rinse their mouth with water in between tastings and were provided with some plain crackers to clean their palate after a set of grapefruit juice or vegetable broth samples. Children conducted the tasting sessions individually and at their own pace by following the on-screen instructions of their devices. After children finished all samples of Box A, they were given a refreshing break, which also ensured that all children were ready at the same time for the instructions of Part 2. The evaluation of intensity of basic tastes of food models (Part 2) followed the same procedures

of Part 1. Within each set of tasted samples (e.g., grapefruit juice), samples were randomized following 6x Williams Design (6 Latin Squares).

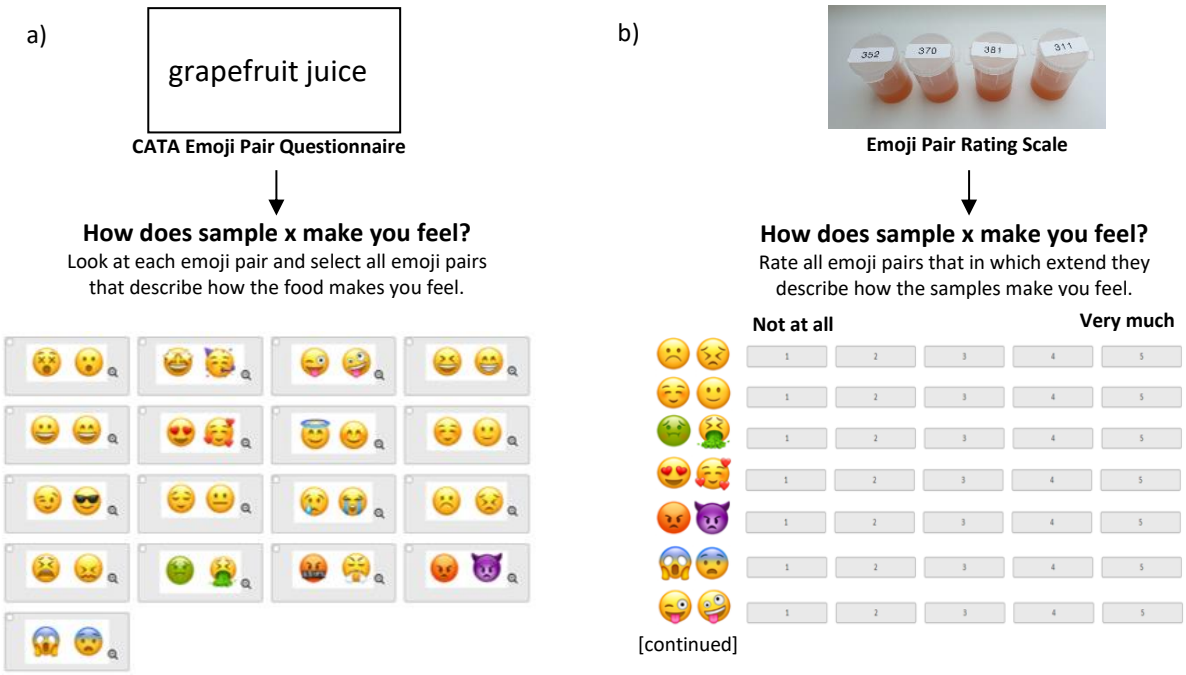


Figure 6.4 Emoji Pair Questionnaire formats used for the evaluation of a) food names (CATA Emoji Pair Questionnaire and b) tasted food models (Emoji Pair Rating Scale).

6.1.2 Data analysis

6.1.2.1 Familiarity, stated liking, and emotional responses of food names

Familiarity and liking were evaluated across all food names using One-way ANOVA with Tukey's test as post-hoc test. Spearman correlation coefficient test on the raw data was conducted to investigate the relationship between familiarity and liking across food items as well as to test the relationship between emoji pairs and liking across food samples (grapefruit juice and vegetable broth, respectively).

6.1.2.2 The discriminant ability of the CATA Emoji Pair Questionnaire using food names

Correspondence analysis was conducted on the frequency tables (n) of food names using Sheskin as a post-hoc test. Emotional responses to food names were analyzed for each food category separately. As only familiar food items were evaluated both for liking and emotions, food items that were evaluated by the same children were extracted: it was aimed to include as many children as possible (around 100 children) that evaluated most food items within each

food category. Correspondence Analysis was conducted on the frequency tables (n) of each food category using Sheskin as a post-hoc test. Only emoji pairs with selection frequencies >10% by children were retained. The average mean liking for each food category was analyzed and ANOVA was applied to calculate differences in mean liking between food items for each food category. To facilitate the interpretation of the results, liking was included as a supplementary variable in the Correspondence Analysis for each food category.

6.1.2.3 Liking and emotional responses to tasted food models

Mixed model ANOVA was used to evaluate the discriminant ability of hedonic (liking) and emotional responses to tasted food models. The statistical model was built (for grapefruit juice and vegetable broth separately) with liking and emoji pairs as dependent variables and children and concentrations (four concentrations of sucrose and sodium chloride, respectively) as explanatory variables. Sucrose and sodium chloride concentrations were considered fixed and children as random effect. The restricted maximum likelihood (REML) method was applied for fitting the model and post-hoc Tukey's HSD test was computed for pairwise comparison between samples.

The level of significance for all the analysis was set at $p \leq 0.05$. Statistical analyses were performed using XLSTAT (version 2021.2.1, Addinsoft, New York, NY, USA).

6.1.3 Results

6.1.3.1 Familiarity, stated liking, and emotional responses of food names

As expected, the Spearman correlation coefficient test showed that familiarity and liking were positively correlated (0.66, $p<0.0001$) and therefore, familiarity was not further considered. Significant positive correlations were found for liking of familiar foods and positive emoji pairs ($p<0.0001$, respectively): 😍🥰 (0.53), 🤩🥳 (0.43), 😇😊 (0.33), 😆😁 (0.29), 😀😁 (0.26), 😉😎 (0.26), 😜🤪 (0.24) and ☺️🙂 (0.16). Significant negative correlations were found for liking of familiar foods and negative emoji pairs ($p<0.0001$, respectively): 🤢🤮 (-0.37), ☹️😣 (-0.34), 😫😖 (-0.31), 😌😐 (-0.31), 😵😮 (-0.22), 🤬😤 (-0.22), 😡😈 (-0.18), 😢😭 (-0.12) and 😱😨 (-0.09).

6.1.3.2 The discriminant ability of the CATA Emoji Pair Questionnaire among familiar foods (presented using names)

Visual inspection of the first and second dimension (accounting for 83.28% of total variance) of the Correspondence Analysis demonstrates that emoji pairs vary between food categories and were able to discriminate between food names (Figure 6.5). The first dimension (accounting for 72.80% of variance) separates food names described by positive (left side of the quadrants) and negative (right side of the quadrants) emotions (e.g., milk chocolate described by 🤩🥳 (“enthusiastic - festive”) opposing green beans described by 🤬😤 (“angry - annoyed”)). It can be observed that foods with more bitter tastes are described with negative emotions, while foods with sweeter tastes are described by positive emotions. The second dimension (accounting for 10.48% of variance) can be interpreted as the arousal dimension dividing food names described by activated (upper side of the quadrants) and deactivated (lower side of the quadrants) emotions (e.g., green beans described by 😡😈 (“angry - disgusted”) opposing arugula described by 😌😐 (“indifferent - calm”)). Food names described by negative emotions show a better discrimination along the arousal dimension compared to food names described by positive emotions.

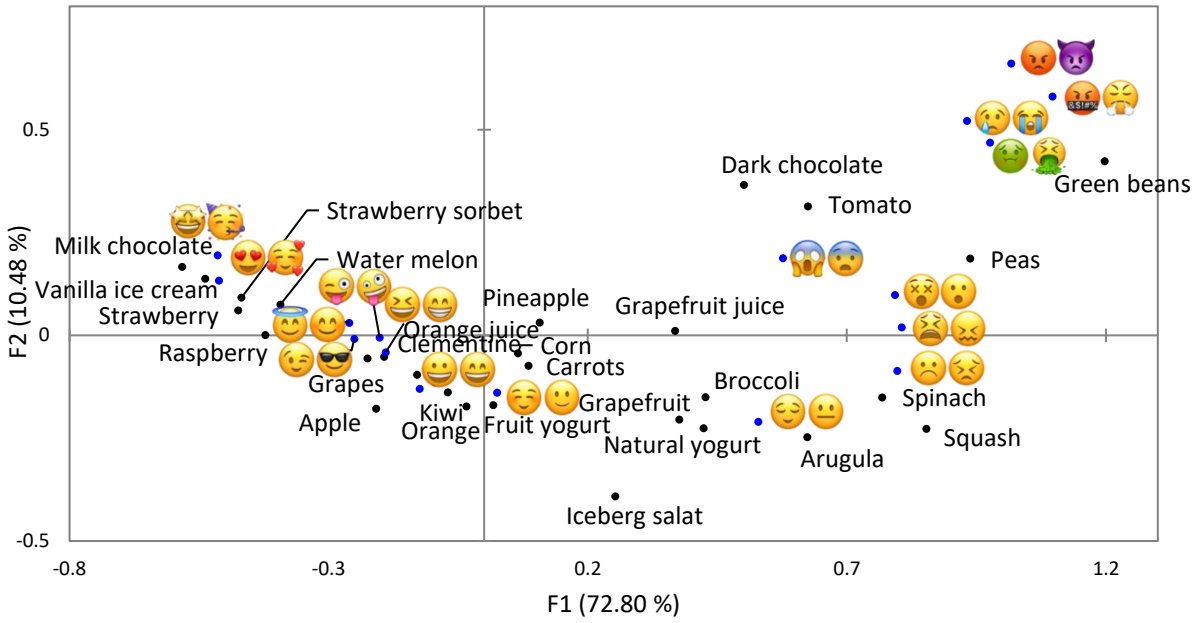


Figure 6.5 Emotional responses to all food names (n=28) evaluated by 148 preadolescents. Representation of the first and second dimensions of the Correspondence Analysis (CA) of the CATA task (Study 7a) food names described by emoji pairs (n=17) using the CATA Emoji Pair Questionnaire.

The fruit category consisted of 9 food items (by excluding grapefruit[1]) that were evaluated by 120 children and showed a mean liking of 5.9±1.3. The dessert/juice category consisted of 6 food items (by excluding grapefruit juice and strawberry sorbet[2]) and showed a mean liking of 5.6±1.6. The vegetable category consisted of 6 vegetables (by excluding arugula, iceberg salad, squash, and green beans[3]) evaluated by 103 children and showed the lowest mean liking of 4.7±1.8 compared to the other food categories. Emoji discriminated significantly among familiar food products within the food categories: fruits, vegetables, and desserts/juices ($p<0.0001$).

In the vegetable category, both liking and emoji pairs discriminated between several food items, but emoji pairs also discriminated between food items despite similar liking. For example, carrots are significantly more liked and associated with the emoji pair 😜🤪 (17%;

[1] Grapefruit was excluded as it was the least familiar food item within the fruit category.
[2] Grapefruit juice and strawberry sorbet were excluded as they were the least familiar food items within the dessert/juice category.
[3] Arugula, iceberg salad, squash, and green beans were excluded as they were the least familiar food items within the vegetable category.

"energetic - crazy") compared to peas (4%). Corn and carrots are significantly more liked and significantly associated more with the emoji pair 😍🥰 (20% and 19%, respectively; "cuddled - in love") than peas (3%) and spinach (2%).

No significant differences were found between liking of broccoli, spinach, and tomato, but differences in emoji pairs were reported. Broccoli was associated with the emoji pair ☺️🙂 ("calm - quiet"), spinach was associated with the emoji pair 😌😐 ("indifferent - calm") and tomatoes were associated with the emoji pair 🤢🤮 ("disgusted - nauseated") (Table 6.4).

Visual inspection of the first and second dimension (accounting for 88.27% of total variance, Figure 6.6) of the CA indicates that vegetables are differentiated by positive emoji/emotions (left side) and negative emoji/emotions (right side). The second dimension (accounting for 24.41% of variance) was not very clear but for negative emotions, it seems that vegetables were divided into ones described by emoji/ emotions lower (😐😌 for spinach) and higher in activation (🤢🤮 for tomato). Emoji pairs 😄😀, 😉😎, ☹️😣 and 😫😖 did not discriminate between any of the items of the vegetable category.

Table 6.4 Emotional and hedonic responses to vegetables (n=6) evaluated by 103 preadolescents. Results of the Cochran's Q test (%) with Sheskin as a post-hoc test (emotional responses) and mean liking using ANOVA with Tukey's HSD test as post-hoc test (hedonic responses); [a,b,c] different letters in a row indicate significant differences between vegetables according to post-hoc tests; in bold = frequencies (%) in the same row with different letters are significantly different at p<0.05; in grey = emoji pairs discriminating between vegetables despite similar liking.

Emoji pairs	Peas	Spinach	Tomato	Broccoli	Corn	Carrots	p-value
😜🤪	**4 a**	33 ab	8 ab	10 ab	13 ab	**17 b**	**0.013**
😆😁	7 a	9 ab	12 ab	11 ab	**21 b**	18 ab	**0.010**
😀😁	13	14	17	18	14	23	0.199
😍🥰	**3 a**	**2 a**	11 ab	9 ab	**20 b**	**19 b**	**<0.0001**
😇😊	7	8	18	12	17	19	**0.022**
☺️🙂	**15 a**	**17 a**	**22 a**	**40 b**	28 ab	27 ab	**<0.0001**
😉😎	3	33	10	11	10	11	0.175
😌😐	35 ab	**46 b**	**19 a**	33 ab	**22 a**	**27 a**	**0.000**
☹️😣	13	13	10	9	9	7	0.656
😫😖	8	12	13	33	33	4	0.111
🤢🤮	16 ab	**7 a**	**20 b**	9 ab	**8 a**	**5 a**	**0.001**
Mean liking	**3.9 a**	**4.2 ab**	**4.4 ab**	**4.8 bc**	**5.4 c**	**5.5 c**	**<0.0001**

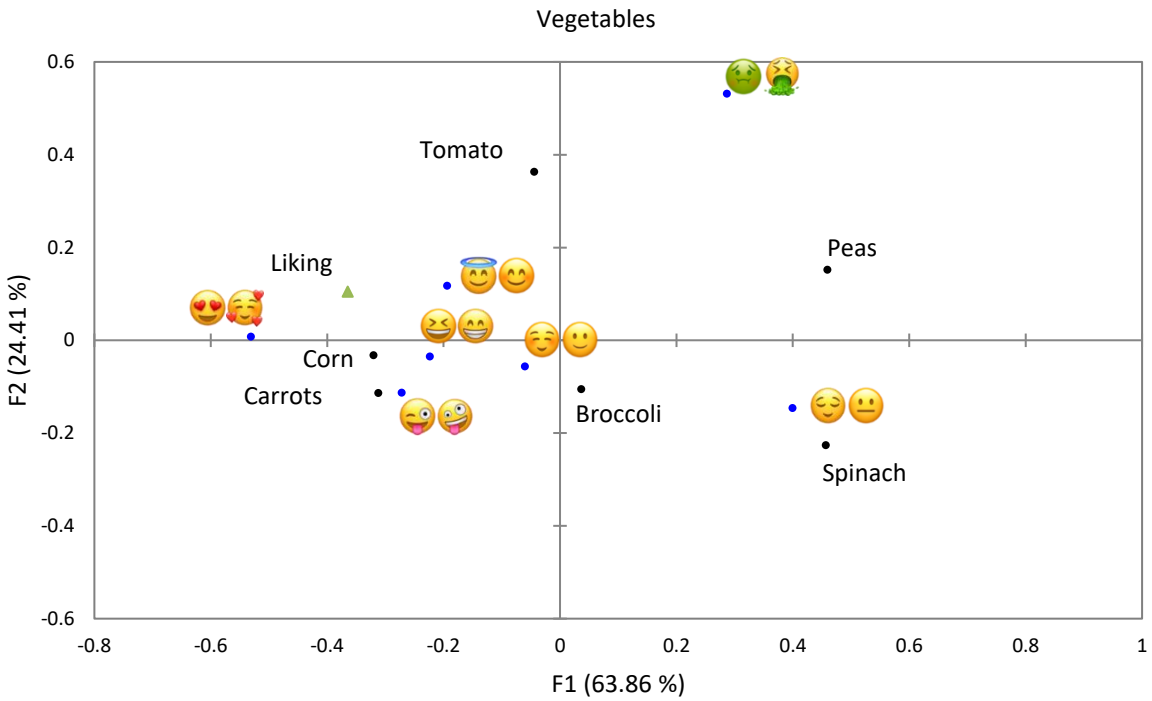


Figure 6.6 Emotional responses to vegetables (n=6) evaluated by 103 preadolescents. Representation of the first and second dimensions of the Correspondence Analysis (CA) of the CATA task (Study 7a) food names described by emoji pairs (n=17).

Interestingly, in the dessert/ juice category, natural yogurt (M=5.5) and orange juice (M=5.8), did not differ in liking but in emoji pairs/emotions; natural yogurt was associated with the emoji pair 😔😐 ("indifferent - calm") (39% *vs.* 17%, p<0.0001), while orange juice was associated with the emoji pair 😌🙂 ("calm - quiet") (30% *vs.* 13%, p=0.045) and 😍🥰 ("cuddled – in love") (28% *vs.* 10%, p<0.0001) predicting a preference for the orange juice over natural yogurt (Table 6.5). Visual inspection of the first and second dimension (accounting for 89.16% of total variance) of the Correspondence Analysis demonstrates that food items were associated with positive (left side of the quadrant) and negative emoji/emotions (right side) along the first dimension (accounting for 79.15% of variance). Similar to the vegetable category, the second dimension (accounting for 10.01% of variance) was not very clear for positive emoji/emotions, but for negative emoji/emotions food items seem to be discriminated along the arousal dimension (e.g., natural yogurt described by emotions lower in activation (😔😐, "indifferent - calm") opposing dark chocolate described by emotions

higher in activation (🤢🤮, “disgusted - nauseated”) and (😫😖, “unhappy - annoyed”) (Figure 6.7).

Table 6.5 Emotional and hedonic responses to desserts/fruit juices (n=6) evaluated by 95 preadolescents. Results of the Cochran’s Q test (%) with Sheskin as a post-hoc test (emotional responses) and mean liking using ANOVA with Tukey’s HSD test as post-hoc test (hedonic responses); ^{a,b,c,d,e} different letters in a row indicate significant differences between desserts/fruits according to post-hoc tests; in bold = frequencies (%) in the same row with different letters are significantly different at $p<0.05$; in grey = emoji pairs discriminating between desserts/juices despite similar liking.

Emoji pairs	Dark chocolate	Fruit yogurt	Natural yogurt	Orange juice	Vanilla ice cream	Milk chocolate	p-value
🤩🥰	**5 a**	**10 a**	**3 a**	**15 a**	**40 b**	**47 b**	**<0.0001**
😜🤪	13 ab	13 ab	**5 a**	**7 a**	16 ab	23 b	**0.001**
😆😁	18 ab	19 ab	**14 a**	19 ab	27 ab	31 b	**0.019**
😀😄	16 ab	19 ab	**13 a**	23 ab	24 ab	**31 b**	**0.011**
😍🥰	**18 ab**	**16 ab**	**10 a**	**28 b**	**47 c**	**66 d**	**<0.0001**
😇😊	**16 ab**	**15 ab**	**11 a**	20 abc	**35 c**	**30 bc**	**<0.0001**
☺️🙂	24 ab	28 ab	**13 a**	**30 b**	23 ab	26 ab	**0.045**
😉😎	**11 a**	13 ab	10 a	19 ab	22 ab	**25 b**	**0.001**
😔😐	**22 a**	**20 a**	**39 b**	**17 a**	**7 a**	**7 a**	**<0.0001**
😫😖	**10 b**	3 ab	5 ab	2 ab	2 ab	**0 a**	**0.010**
🤢🤮	**14 b**	**2 a**	7 ab	**3 a**	**1 a**	**1 a**	**<0.0001**
Mean liking	**4.6 a**	**5.5 b**	**5.5 b**	**5.8 b**	**6.4 c**	**6.6 c**	**<0.0001**

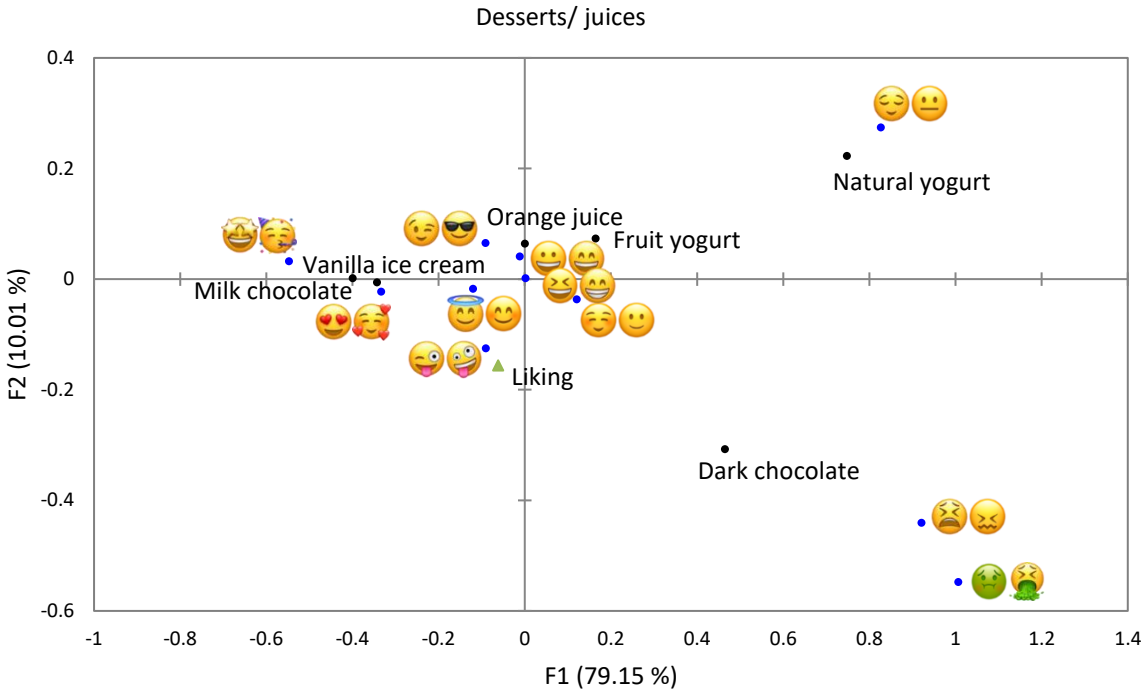


Figure 6.7 Emotional responses to desserts/juices (n=6) evaluated by 95 preadolescents. Representation of the first and second dimensions of the Correspondence Analysis (CA) of the CATA task (Study 7a) food names described by emoji pairs (n=17).

In the fruit category, both liking and emoji pairs discriminated between food items, however, in this case emoji were not discriminating despite similar liking between food items (Table 6.6). Visual inspection of the first and second dimension (accounting for 95.46% of total variance) of the Correspondence Analysis demonstrates that the most liked fruits such as strawberry, watermelon and raspberry were associated with very positive emoji/ emotions that are higher in activation like 😍🥰 ("cuddled - in love") and 🤩🥳 ("enthusiastic - festive") (Figure 6.8). The interpretation of the second dimension (accounting for 6.47% of variance) is limited as it accounts for very low variance.

Table 6.6 Emotional and hedonic responses to fruits (n=9) evaluated by 120 preadolescents. Results of the Cochran's Q test (%) with Sheskin as a post-hoc test (emotional responses) and mean liking using ANOVA with Tukey's HSD test as post-hoc test (hedonic responses); [a,b,c,d] different letters in a row indicate significant differences between fruits according to post-hoc tests; in bold = frequencies (%) in the same row with different letters are significantly different at p<0.05.

Emoji pairs	Pineapple	Clementine	Orange	Kiwi	Apple	Grapes	Raspberry	Watermelon	Strawberry	p-value
🤩🥰	**19 ab**	**17 ab**	**13 a**	**11 a**	**14 a**	**18 ab**	23 abc	**33 c**	**28 bc**	**<0.0001**
😜🤪	18	13	13	18	15	15	20	15	13	0.649
😆😄	20	17	20	19	24	18	22	26	28	0.342
😀😁	19	23	26	28	31	28	35	28	28	0.142
😍🥰	**21 ab**	**20 ab**	**17 a**	**23 ab**	**22 ab**	**34 bc**	**42 cd**	**53 d**	**55 d**	**<0.0001**
😇😊	19	17	17	18	23	23	28	29	30	**0.009**
☺️🙂	23	32	26	30	24	25	26	27	28	0.788
😉😎	11	13	16	12	14	14	18	18	18	0.547
😔😐	**27 b**	14 ab	18 ab	23 ab	16 ab	20 ab	**11 a**	14 ab	**8 a**	**0.001**
Mean liking	**5.3 a**	**5.5 a**	**5.5 a**	**5.7 ab**	**6.0 bc**	**6.1 bc**	**6.3 cd**	**6.3 cd**	**6.6 d**	**<0.0001**

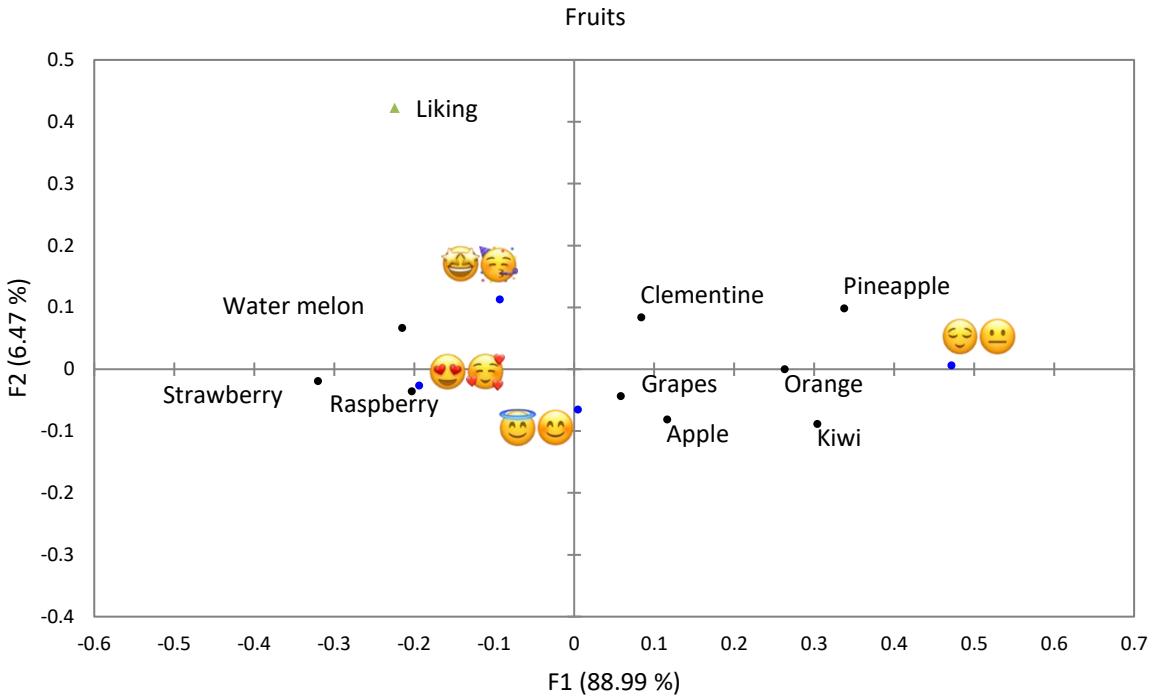


Figure 6.8 Emotional responses to fruits (n=9) evaluated by 120 preadolescents. Representation of the first and second dimensions of the CA of the CATA task (Study 7a) food names described by emoji pairs (n=17).

6.1.3.3 The discriminant ability of the Emoji Pair Rating Scale among tasted food models

Results showed that liking discriminated between samples of grapefruit juice ($p<0.0001$), but not vegetable broth ($p=0.853$) (see Figure 6.9). Some emoji pairs 🤩🥰, 😜🤪, 😆😄, 😀😄, 😍🥰, 😇😊, ☺️🙂, 😉😎 ($p<0.0001$, respectively), 😫😖 ($p=0.001$), ☹️😣 and 🤢🤮 ($p=0.003$, respectively), 😵😮 ($p=0.004$) and 🤬😤 ($p=0.032$) (see Table 6.7) discriminated between grapefruit juice samples, however, no emoji pairs discriminated between vegetable broth samples.

For grapefruit juice samples, liking and positive emoji ratings increased, while negative emoji ratings decreased with increasing sucrose concentration. While there were no significant differences in liking between the two middle samples (40 and 80 g/L sucrose), the 80 g/L sample was associated with the emoji pair 😀😄 (“cheerful - serene”) indicating that the sweeter sample was associated with a more positive and activated emotion.

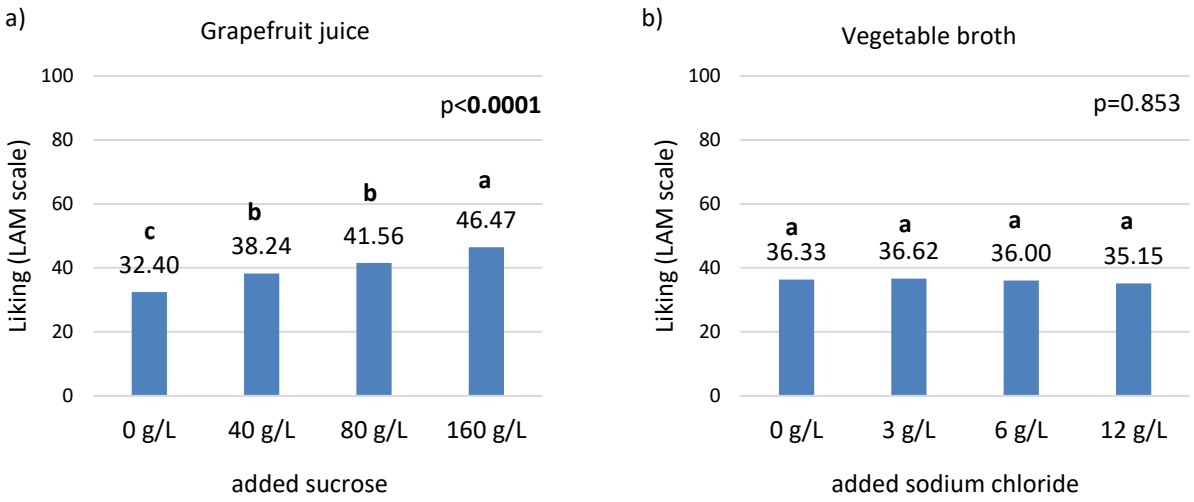


Figure 6.9 Liking (LAM scale) of a) grapefruit juice and b) vegetable broth samples

Table 6.7 Liking (1-100) and emoji (1-5) discrimination for each sample of grapefruit juice including F-value, p-value (significant values marked in bold); letters display significant pairwise comparisons for grapefruit juice samples; in bold = frequencies (%) in the same row with different letters are significantly different at p<0.05; in grey = emoji pairs discriminating despite similar liking.

	F-value	p-value	0 g/L	40 g/L	80 g/L	160 g/L
Liking	21.5	**<0.0001**	**32.4 c**	**38.2 b**	**41.6 b**	**46.5 a**
😵😮	4.4	**0.004**	**2.8 a**	**2.7 a**	2.5 ab	**2.4 b**
🤩😘	12.0	**<0.0001**	**1.6 c**	**1.8 b**	**2.0 ab**	**2.0 a**
😜🤪	7.7	**<0.0001**	**1.7 b**	**2.0 a**	**2.0 a**	**2.0 a**
😆😁	14.1	**<0.0001**	**1.6 c**	**1.9 b**	**2.0 ab**	**2.2 a**
😀😁	22.0	**<0.0001**	**1.6 c**	**1.9 b**	**2.1 a**	**2.2 a**
😍🥰	15.1	**<0.0001**	**1.5 c**	**1.8 b**	**2.0 ab**	**2.1 a**
😇😊	15.3	**<0.0001**	**1.6 c**	**1.9 b**	**2.0 ab**	**2.2 a**
☺️🙂	10.6	**<0.0001**	**1.7 b**	**2.0 a**	**2.1 a**	**2.2 a**
😉😎	11.1	**<0.0001**	**1.6 b**	**1.8 a**	**2.0 a**	**2.0 a**
😔😐	1.4	0.229	2.1	2.2	2.2	2.4
😢😭	2.0	0.120	2.3	2.3	2.2	2.0
☹️😣	4.8	**0.003**	**2.9 a**	**2.8 a**	2.7 ab	**2.5 b**
😫😖	5.6	**0.001**	**3.2 a**	2.9 ab	**2.9 a**	**2.7 b**
🤢🤮	4.7	**0.003**	**3.1 a**	2.9 ab	2.8 ab	**2.6 b**
😡😤	3.0	**0.032**	**2.4 a**	2.4 ab	2.3 ab	**2.1 b**
😡😈	1.9	0.130	2.4	2.3	2.2	2.2
😱😨	2.3	0.078	2.7	2.6	2.4	2.4

6.2 Discussion

In this study the aim was to validate the two response formats of the Emoji Pair Questionnaire. The CATA Emoji Pair Questionnaire was validated and applied to familiar food names, while the Emoji Pair Rating Scale was validated and applied to tasted foods models. Both questionnaire formats resulted in emotional profiles that helped to interpret the differences among products more in depth and in some cases were able to discriminate between food items despite similar liking. This is in agreement with previously developed emotion measurement questionnaires showing that emotions were discriminating between products even though there were no differences between liking of the products (Cardello et al., 2012; Lima et al., 2019; Schouteten et al., 2019, 2018; Spinelli et al., 2015). The sections below will discuss the findings of the two response formats of the questionnaire.

6.2.1 The discriminant ability of the CATA Emoji Pair Questionnaire using food names

The current results showed that familiar food presented using names were discriminated by emotions using the CATA Emoji Pair Questionnaire as well as liking. Furthermore, for some food names, emotions discriminated, even when a significant difference in acceptability was not found. This is particularly meaningful as the study was conducted only on familiar foods, thus reducing the variability among the products. The results indicate that even when differences between products are limited or absent in terms of acceptability and familiarity, the Emoji Pair Questionnaire is able to discriminate the emotional experience of the products. It is also interesting to note that the CATA format as used in this study is well known to have a lower discriminant ability when used to evaluate emotional responses to products with small differences (Ares & Jaeger, 2017).

Studies using the CATA approach with emoji to measure emotional responses to foods in preadolescents found that emoji discriminated between different foods (Gallo, Swaney-Stueve, et al., 2017b; Lima et al., 2019; Schouteten et al., 2019, 2018), which supports the importance of using emoji in product discrimination. However, using emoji pairs (instead of single emoji) in the CATA questionnaire is a new method that has never been investigated before neither with adults nor children. In this study it was shown that different foods elicited different emotions, and the best discrimination was found for positive emoji pairs/emotions, which is in accordance with previous findings (Cardello et al., 2012; Da Cruz et al., 2021;

Schouteten et al., 2019). This could be explained by the fact that some foods are more "emotional". For instance, chocolate is considered as a more emotional food in contrast to other foods that can be described as less emotional (e.g., oatmeal and carrots were less emotional foods compared to chocolate when presented as food names) (Cardello et al., 2012). Furthermore, in our study, milk chocolate and vanilla ice cream were described by very positive and higher in activation emotions (🤩🥳, "enthusiastic - festive" and 😍🥰, "cuddled - in love") compared to iceberg salad and natural yogurt described by emotions lower in activation (😌😐, "indifferent - calm"). This suggests that emotion associations with products vary by category and are occasion specific (Piqueras-Fiszman & Jaeger, 2014b). In the fruit category, only a very limited number of emoji pairs discriminated between products, which was limited to two positive (😍🥰, "cuddled - in love" and 🤩🥳, "enthusiastic - festive") and one neutral emoji pair (😌😐, "indifferent - calm") whereas emotions did not outperform liking in their discriminant ability. This may be due to smaller differences in liking among products evaluated in this category (mean liking ranged from 5.3 to 6.6, compared to 3.9 to 5.5 in the vegetable category and 4.6 to 6.6 in the dessert/juice category). However, future research should investigate if these findings remain similar with different fruits and if presenting these fruits as written stimuli (food names) *vs.* actually tasting the food stimuli influence the results as previously it was shown that this can impact emotional responses in preadolescents (Gallo, Swaney-Stueve, et al., 2017b).

Furthermore, this study demonstrated that the CATA Emoji Pair Questionnaire was able to discriminate between very similar food products such as milk chocolate and dark chocolate. Milk chocolate was associated with 😍🥰 ("cuddled - in love"), 🤩🥳 ("enthusiastic - festive") and 😉😎 ("confident - at ease"), while dark chocolate was associated with 🤢🤮 ("disgusted - nauseated") and 😫😖 ("unhappy - annoyed"). The questionnaire also discriminated between natural yogurt and fruit yogurt (natural yogurt was associated with the emoji pair 😌😐 ("indifferent - calm"). This is an important finding indicating that the CATA Emoji Pair questionnaire has the ability to discriminate between rather similar products.

In this study, foods were discriminated by both positive and negative emoji pairs. Food names elicited mainly positive emotions, which was observed within but also across food categories, which is coherent with the fact that only familiar foods were selected. These results confirm

the hedonic symmetry as described by Desmet & Schifferstein (2008) and support previous findings that people mainly use positive emotions to describe food and beverage products (Cardello et al., 2012; Ferrarini et al., 2010; King & Meiselman, 2010). In a study with children, researchers observed greater positive emotional responses toward familiar milk brands compared to unfamiliar brands (Pelsmaeker et al., 2013). However, some negative emoji pairs were significant discriminators between some food items. For example, the emoji pair 🤢🤮 ("disgusted - nauseated") discriminated tomato from spinach despite similar liking and helped to further characterize the differences in hedonic responses between dark chocolate and fruit yogurt, while the emoji pair 😫😠 ("unhappy - annoyed") helped to further characterize the differences in hedonic responses between dark chocolate and milk chocolate.

While previous research indicated that emotions and liking responses do not always conform (King, Meiselman, & Carr, 2010; Christelle Porcherot et al., 2010), it has to be emphasized that this study in support of previous findings (Cardello et al., 2012) showed a significant correlation between hedonic measurement and emotions. A correlation between liking and emoji valence was reported, in line with Schouteten et al. (2019). Furthermore, it has been found that familiarity and liking of food items were positively correlated. This relationship is not surprising and corresponds with findings that familiarity of a food increases liking and consumption (Cooke, 2007).

In addition to the observation that food items were discriminated along the valence dimension (across and within food categories), there was a discrimination between food names along the arousal dimension. However, the strongest discriminating dimension was the valence dimension dividing food names into positive and negative evaluated emotions, which is in agreement with Schouteten et al. (2019). This is not surprising as valence has been indicated as the *basic building block* that characterizes every emotion and that everybody is able to perceive (Barrett, 2006b). It has been argued that emotions that strongly correlate with liking have low distinctive value compared to liking, whereas emotions that weakly correlate with liking are of special interest, as they apparently convey information not captured by liking. Indeed, valence positively correlates with liking, while activation does not show this straightforward relation with liking (Gutjar et al., 2015). Instead, arousal seems to capture some particular information on how a food is experienced (Gutjar et al., 2015). It has been found that food items were discriminated by emotions varying in arousal along the second

dimension, which may be one of the components that explain why emotions discriminated better compared to liking in some cases. For example, tomato and spinach were discriminated by emoji pairs/emotions of different activation level; while tomato was associated with emotions higher in activation like 🤢🤮 ("disgusted - nauseated"), spinach was associated with emotions lower in activation like 😌😐 ("indifferent - calm"). Also, prior studies indicated that the second dimension of the CA plot with emoji could be interpreted as arousal (Jaeger, Lee, et al., 2017; Schouteten et al., 2018), but this was not always straightforward in this and the study of Schouteten et al. (2019), especially for positive emotions.

6.2.2 The discriminant ability of the Emoji Pair Rating Scale using tasted food models

By testing the Emoji Pair Rating Scale on tasted food models, it was demonstrated that emoji and liking ratings discriminated between samples of grapefruit juice varying in sweetness but not vegetable broth varying in saltiness. Even though samples were pretested prior to the study in preliminary tests, this last sample did not seem to work with preadolescents presenting a sensory variation not able even to produce variations in liking. Several reasons could explain these results: firstly, the differences in sodium chloride concentrations between samples were not distinct enough for preadolescents to be able to detect/taste differences between samples. A study found that children that children's (6-14-y.o) preference was not affected when modulating sodium chloride concentrations in cereal (Bobowski & Mennella, 2019). It was shown that children prefer higher amounts of salt than adults (Beauchamp & Cowart, 1990; Mennella, Finkbeiner, Lipchock, Hwang, & Reed, 2014), following they need longer periods of time before changes become evident and the sodium chloride concentrations in this study may not have been sufficient for children in this study. Secondly, children may have found vegetable broth samples as "odd" to taste in this study context. Appropriateness of food products in a context was shown to influence emotional responses; the frequency and intensity of positive emotion terms was generally higher with more appropriate contexts, decreasing with the appropriateness ratings (and vice versa for the negative emotion terms) (Piqueras-Fiszman & Jaeger, 2014a). Normally, vegetable broth would be integrated in a meal (like a hot meal) and not served on its own at room temperature. This may have affected how children perceived vegetable broth in this context in contrast to grapefruit juice that was more appropriate to taste. Thirdly, children generally showed a rather strong dislike and negative emotions for all vegetable broth samples resulting

in a general rejection for all vegetable broth samples. Future research should investigate if by adjusting the sodium chloride concentrations would elicit emotions to discriminate between vegetable broth samples.

For grapefruit juice samples, both liking ratings and positive emoji pairs gradually increased with increasing sucrose content. This indicates that children prefer the sweeter samples, which is not surprising given that preference for sweetness is innate (Reed & Knaapila, 2010) and sweetness is strongly associated with children's acceptance of food (Fry Vennerød, Nicklaus, Lien, & Almli, 2018; Mennella et al., 2014). Also, sweeter foods were shown to elicit more positive emotions as compared to negative emotions in a study by Kim, Prescott, & Kim (2017). There were 13 of 17 emoji pairs (😵😮, 🤩🥰, 😜🤪, 😆😄, 😀😄, 😍🥰, 😇😊, ☺️🙂, 😉😎, ☹️😣, 😫😖, 🤢🤮 and 🥵😤) that discriminated between grapefruit juice samples. While all positive emoji pairs discriminated, there were three negative emoji pairs (😢😭, 😡😈, 😱😨) and one neutral emoji pair (😌😐) that did not discriminate between samples. This again conforms with the theory of hedonic symmetry (Schifferstein & Desmet, 2010) that consumers mostly use positive emotions to evaluate emotions elicited by food products. All positive emoji pairs and the surprised emoji pair 😵😮 ("surprised - curious") discriminated between the least sweet (0 g/L) and sweetest samples (160 g/L). Less emoji pairs discriminated between 0 and 40 g/L samples (🤩🥰, 😜🤪, 😆😄, 😀😄, 😍🥰, 😇😊, ☺️🙂 and 😉😎) which could be explained by the fact that the difference in sucrose concentrations was difficult for children to perceive. Interestingly, only one (negative) emoji pair 😫😖 ("unhappy - annoyed") was able to discriminate between the 80 and 160 g/L samples supporting a preference for the sweeter sample. There was one emoji pair 😀😄 ("cheerful - serene") that discriminated between the 40 and 80 g/L sample despite similar liking.

Schouteten et al. (2019) found that only the *smiling face with heart-eyes* 😍 was able to partially discriminate between equally highly liked samples when using the standardized emoji list. This emoji (grouped with *smiling face with hearts* 🥰) was also found to be an important discriminating emoji in all food categories (food names) when using the CATA Emoji Pair Questionnaire. When using the Emoji Pair Rating Scale, this emoji pair was also an important discriminator, but liking was also discriminating.

In a focus group, 8-11-y.o. children indicated that the neutral emoji could be seen more as "so-so" or "just okay" (Gallo, Swaney-Stueve, et al., 2017a). Also in the study by Schouteten et al. (2018) for the two neutral emoji *neutral face* 😐 and *expressionless face* 😑 a negative correlation with the overall liking score was found. This indicates that children might associate these neutral emoji with a more negative meaning compared to adults (Jaeger & Ares, 2017), which is in line with findings of Study 2. However, when children evaluated food models, a negative correlation of the *neutral face* 😐 and overall liking (Study 7a) was not shown.

Finally, this study supports previous findings that emoji can be used to obtain discriminatory emotional profiles when working with similar samples or samples of the same product category (Schouteten et al., 2019, 2018).

6.2.3 Emotional responses and sensory properties of foods

Previous literature suggested a link between emotional responses to food products and their sensory properties (Spinelli & Jaeger, 2019; Spinelli et al., 2019). In fact, emotions can be elicited by specific sensory properties that characterize it (e.g., sweet makes one feel happy, etc.) (Spinelli & Jaeger, 2019). Interestingly, foods more plain in taste (e.g., iceberg salad and natural yogurt) are described by lower aroused emotions (e.g., 😌😐 "indifferent - calm"), while it seems that the most disliked foods characterised by bitter tastes (e.g., green beans, dark chocolate, peas), and liked foods characterized by sweet tastes (milk chocolate, vanilla ice cream, strawberry sorbet) are described by emotions characterised as higher in activation (e.g., 🤩🥳 "enthusiastic - festive" and 😍🥰 "cuddled - in love", respectively).

For the grapefruit juice samples it was demonstrated that with increasing sucrose concentration (and thereby supression of bitterness and sourness (Green et al., 2010)) children rated the sweeter (and less bitter and sour) samples higher in positive emotions. As sweetness is one of the innate tastes that contributes to food acceptance in children (L. Cooke, 2007), it is obvious that sweet taste elicits positive emotions. Interestingly, the emoji that discriminated among samples (not significantly different in liking) was 😀😁 ("cheerful - serene"), which was characterized by an average activation but a clear positive valence.

6.2.4 Conclusions

In summary, both the CATA Emoji Pair Questionnaire and the Emoji Pair Rating Scale were found to be useful tools to measure preadolescents' emotional responses to food names and

tasted food models. Importantly, the emoji questionnaires were perceived as a fun/less boring activity by preadolescents that could be more likely when using word-based emotion methods.

Part III Individual differences in children's food preferences

Chapter 7 Emotional responses to food, sensory sensitivity, and personality traits

Abstract

Investigating the role of individual differences in food-elicited emotions is important to better understand consumer's food choices. Currently, there is a research gap in studying individual differences in preadolescents' food preferences, especially when assessing emotions in response to food. The aim of this study is to investigate individual differences by clustering children according to patterns of emotional responses to grapefruit juice spiked with sucrose (0, 40, 80, and 160 g/L) by applying Principal Component Analysis and Agglomerative Hierarchical Cluster Analysis. Children were classified into three clusters, which were tested for differences in personality traits (food neophobia, sensation seeking, sensitivity to reward and punishment, curiosity trait) and PROP status using Chi-square test, and responsiveness to basic tastes using ANOVA. Cluster 1 (C1) scored higher in emoji expressing positive emotions, while Cluster 3 (C3) scored higher in emoji expressing negative emotions. Cluster 2 (C2) scored lower in all emoji (C2) demonstrating a lower emotional engagement with the products compared to C1 and C3. The three clusters were also found to differ in liking, sensitivity to reward (fun seeking), responsiveness to sweet, sour, and ability to discriminate between food samples. C3 that reported the highest average scores of negative emoji for all the tasted samples, not only expressed the lowest mean liking, but also expressed the highest average score for "surprise", interpreted as negative surprise. In contrast, the C1 that expressed the highest average scores for positive emoji, and which had the highest mean liking for the samples also expressed "surprise", which is interpreted as positive surprise. Clusters did not differ in responsiveness to bitterness, PROP status and other personality traits, hence, more research is needed to investigate the relationship between emotions, sensory sensitivity, and personality traits.

7.1 Study 7b: Emotional responses to food, sensory sensitivity, and personality traits

The purpose of this part of the study was to investigate individual differences in emotional responses to grapefruit juices differing in sensory properties (sweetness, bitterness, and sourness) by clustering children according to patterns of emotional responses and by testing the clusters for differences in PROP (6-n-prophylthiouracil) status, sensory responsiveness to basic tastes and personality traits (food neophobia, sensation seeking, sensitivity to reward and punishment, and curiosity trait).

7.1.1 Material and methods

The details about study participants, data collection and study procedures can be found in Chapter 6 (Study 7a: validation of the Emoji Pair Questionnaire) as this was conducted under the same study. The following sections will describe the procedures and data on sensory properties evaluation including sensory responsiveness to basic tastes in grapefruit juice, PROP test, as well as personality trait questionnaires.

7.1.1.1 Sensory responsiveness to basic tastes of tasted food models

In Part 2 of Study 7, children received the tasting kit Box B to evaluate the perceived intensity of basic tastes in the grapefruit juice (sweet, sour, bitter) food models. Children's responsiveness to basic tastes in the tasted food models was measured via the Labeled Magnitude Scale (LMS) (Green et al., 1996). The scale was labeled with the anchor points: barely detectable (1.4), weak (6.1), moderate (17.2), strong (35.4), very strong (53.3) and strongest imaginable (100) (Green et al., 1996). Tasted food models were presented in a randomized balanced order within and across sample type and across children following a 6x Williams Design (6 Latin Squares). The tastings followed the same procedures as described for liking and emotional responses to tasted food models in Chapter 6.

7.1.1.2 PROP test

The PROP test was conducted at the end of the study to reduce the risk that any supertasters would get demotivated from tasting any further samples (see Figure 6.3). Responsiveness to PROP was measured using paper discs (Oftedal & Tepper, 2013; Pickering, Simunkova, & DiBattista, 2004). The PROP discs were impregnated with 50 mmol/L of PROP adopting procedures by Zhao, Kirkmeyer, & Tepper (2003). Children received step-by-step instructions

on their screen to conduct the test individually with an integrated timer: first, children were instructed to take a sip of water before applying the PROP disc. Then, children were instructed to place the disc on the anterior part of their tongue (an image with the correct position on the tongue was shown on the screen) and to hold the disc for 25 seconds in their mouth until completely soaked with saliva. After removing the paper disc, children were asked to wait for further 20 seconds until rating the perceived bitterness on a Labeled Magnitude Scale (LMS) (Green et al., 1996). PROP status was classified into "low taster", "medium taster" and "supertaster".

7.1.1.3 Personality trait questionnaires

Children were asked to answer to different personality trait questionnaires including food neophobia, sensation seeking, sensitivity to reward and punishment, and curiosity trait. An overview can be found in Table 7.1.

Food neophobia was measured using the age-appropriate Italian Child Food Neophobia Scale (ICFNS) consisting of 8 items (4 neophobic and 4 neophilic items) to measure children's reluctance to try novel foods (Laureati, Bergamaschi, et al., 2015). A 5-point-categorical scale (1 = very false, 2 = false, 3 = so-so, 4 = true, 5 = very true) was used to record the responses (Laureati, Bergamaschi, et al., 2015). The neophobia score was calculated by summating the scores for all statements for each child (with reversed neophilic scores). Food neophobia scores ranged from 8 (considered as low food neophobia) to 40 (considered as high food neophobia). Items of the Italian Child Food Neophobia Scale with translations (English, Norwegian, Italian) can be found in Table S 12.

Sensation seeking, defined as the desire for varied, novel, and complex sensations and experiences and the willingness to take physical and social risks to experience such sensations, was measured using the Italian version of the Brief Sensation Seeking Scale (BSSS) (Primi, Narducci, Benedetti, Donati, & Chiesi, 2011) that has been validated in English by Hoyle, Stephenson, Palmgreen, Lorch, & Donohew (2002). The scale consists of 8 items of which item BSSS4 was removed as it was not found appropriate for Norwegian preadolescents yielding a score range from 7 to 35. Items of the Brief Sensation Seeking Scale with translations (English, Norwegian, Italian) can be found in Table S 13.

Sensitivity to reward and punishment was measured by using the Italian version of the Behavioral Inhibition & Behavioral Activation (BIS/BAS) scale originally developed by Carver & White (1994). The scale was reduced from 48 to 20 items including 13 items to measure behavioral activation system (BAS subscale) and 7 items to measure behavioral inhibition system (BIS subscale). The BAS subscale is further divided into the subscales reward responsiveness (5 items that focus on positive responses to the occurrence or anticipation of reward), drive (4 items pertaining to the pursuit of desired goals) and fun seeking (4 items reflecting both a desire for new rewards and a willingness to approach a potentially rewarding event on the spur of the moment) (Carver & White, 1994). The BIS subscale scores range from 7 to 35, the BAS subscale scores range from 13 to 65, the reward responsiveness subscale scores range from 5 to 25, the drive and the fun seeking subscale scores range from 4 to 20, respectively. Items of the BIS/BAS scale with translations (English, Norwegian, Italian) can be found in Table S 14.

The **curiosity trait** can be commonly defined as the recognition, pursuit, and desire to explore novel, uncertain, complex, and ambiguous events (Kashdan et al., 2018). The curiosity trait was measured using a reduced version of the Five-dimensional Curiosity Scale developed by Kashdan et al. (2018). The two subscales Joyous exploration (JE) (5 items) and Social curiosity (SC) (5 items) were used as they were most appropriate to measure the curiosity trait in preadolescents. In addition, two further items were added to each subscale to measure children's curiosity specifically related to food (JE: "*I am curious about trying new foods.*") and if children consider themselves as curious in general (SC: "*I consider myself as a curious person.*"). The JE subscale and the SC subscale range from 6 to 30, respectively. Items of the curiosity scale with translations (English, Norwegian, Italian) can be found in Table S 15.

The Norwegian versions of the questionnaires were obtained using a forward-translation method: Two Norwegian native speakers (researchers in sensory and consumer science at Nofima, Norway) independently translated the questionnaires from English to Norwegian and then compared their translations with the purpose of assessing equivalence (Hoyle et al., 2002). Finally, if necessary, the researchers adjusted the translation accordingly to obtain the final questionnaire. To avoid confusion in children in using the scales, 5-point categorical scales (1 = I strongly disagree, 2 = I slightly disagree, 3 = I neither agree nor disagree, 4 = I kind

of agree, 5 = I very much agree) were used for all scales (except for food neophobia) to record children's responses (Hoyle et al., 2002).

Table 7.1 Summary of personality trait questionnaires, items and domains, anchor point of the scales and references.

Personality trait	Scale	Items and domains	Anchor points of scale	References
Food neophobia	**The Italian Child Food Neophobia Scale (ICFNS)**	8 items	5-point categorical scale 1 = Very false 2 = False 3 = So-so 4 = True 5 = Very true	Original version: Pliner & Hobden (1992) Italian version: Laureati, Bergamaschi, et al. (2015)
Sensation seeking	**Brief Sensation Seeking Scale (BSSS)**	8 items	5-point categorical scale: 1 = I strongly disagree 2 = I slightly disagree 3 = I neither agree nor disagree 4 = I kind of agree 5 = I very much agree	Original version: Hoyle, Stephenson, Palmgreen, Lorch, & Donohew (2002) Italian version: Primi, Narducci, Benedetti, Donati & Chiesi (2011)
Sensitivity to reward and punishment	**Behavioral Inhibition & Behavioral Activation Scale (BIS/BAS)**	20 items with 2 subscales: - BIS subscale - BAS subscale further divided into reward responsiveness, drive, and fun seeking	5-point categorical scale: 1 = I strongly disagree 2 = I slightly disagree 3 = I neither agree nor disagree 4 = I kind of agree 5 = I very much agree	Original version: Carver & White (1994) Italian version: Leone, Leone, Pierro & Mannetti (2002)
Curiosity trait	**The Five-Dimensional Curiosity Scale**	12 items with 2 subscales: - Joyous exploration - Social curiosity	5-point categorical scale: 1 = I strongly disagree 2 = I slightly disagree 3 = I neither agree nor disagree 4 = I kind of agree 5 = I very much agree	Original version: Kashdan et al. (2018)

7.1.1.4 Data analysis

Children were grouped according to patterns of emotional responses to tasted grapefruit juice samples (see Chapter 6). First, a Principal Component Analysis (PCA) (type: covariance) was conducted on the raw emoji pair data (as columns) with children as rows (ratings 1-5 of the

Emoji Pair Rating Scale). The PCA based segmentation was chosen due to good interpretability of the clusters and more balance in cluster sizes, which is essential for following statistical analysis (ANOVA). This method is also referred to as interpretation-based segmentation, where subjects can be divided into clusters based on primary interest (Næs, Varela, & Berget, 2018). Then, an Agglomerative Hierarchical Cluster Analysis using Euclidean distance and Ward's method was applied on the first three dimensions of the PCA. Lastly, A PC-ANOVA was applied to check if clusters differ in the positive or negative direction (Luciano & Næs, 2009). The factor scores of the first three dimensions of the PCA were added to the raw data and then an ANOVA was applied with liking, emoji pairs (n=17) and PCA factor scores (dimensions 1-3) as dependent variables and clusters (C1, C2, C3), samples (0, 40, 80 and 160 g/L) and interaction between clusters and samples as qualitative explanatory variables. Tukey's HSD test was used as post-hoc test for pairwise comparison between samples. To compare cluster characteristics in terms of emotional responses across grapefruit juice samples, an arbitrary cut-off of ≥2.5 was used to label an emoji pair as "representative" for a specific cluster.

To test the clusters for individual differences in sensory responsiveness, ANOVA was applied with intensity ratings (for sweet, sour, bitter) as dependent variables and clusters (C1, C2, C3) and samples (0, 40, 80, 160 g/L) as explanatory variables. Differences between clusters in familiarity towards grapefruit juice were assessed by using ANOVA.

All personality trait questionnaires were tested for internal consistency (Cronbach's α). Correlations between items were measured applying Principal Factor Analysis on the scores using Pearson (n) correlation coefficients applying Varimax rotation. To interpret the relationship between clusters (C1, C2, C3) and personality traits, children were classified into three groups according to their level of sensitivity for each personality trait: "low" (children with scores in the lower 25^{th} percentile of the personality trait scores), "medium" (children with scores between the 25^{th} and 75^{th} percentiles) and "high" (children with scores in the upper 25^{th} percentile). Chi-square test with Fisher's exact test as post-hoc test was used to test for differences between clusters and level of personality trait. The procedure for assessing the relationship between clusters and PROP status followed the same procedure classifying children into three groups of "non-taster" (NT) (lower 25^{th} percentile), "medium taster" (MT) (between the 25^{th} and 75^{th} percentile) and "supertaster" (ST) (upper 75^{th} percentile). Chi-

square test was used to analyze gender differences (girls *vs.* boys) for personality trait levels (low, medium, high) and PROP status (non-taster, medium taster, super taster).

7.1.2 Results

7.1.2.1 Clustering children according to emotional patterns of grapefruit juice samples

The PCA biplot on emotional responses to tasted grapefruit juice samples is reported in Figure 7.1. The first two principal components accounted for 58.01% of the total variability. The first principal component (37.41% of total variance) distinguishes children scoring higher positive emoji (left side) and children scoring higher negative emoji (right side) in evaluating the grapefruit samples. Children are also separated along the second principal component, which explains 20.60% of total variance. Agglomerative Hierarchical Cluster Analysis (AHC) allowed to identify three clusters differing in emoji/emotional patterns of response to products (Figure 7.2).

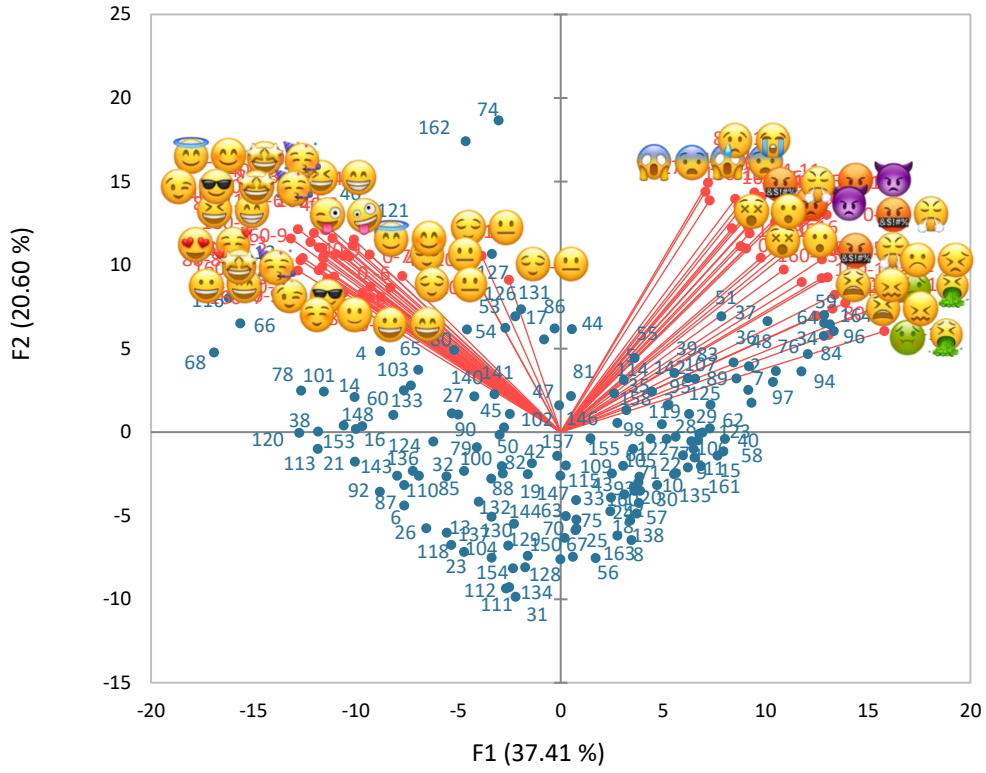


Figure 7.1 Representation of the first and second dimension of the biplot of the Principal Component Analysis (PCA) on raw emoji pair data (based on the Emoji Pair Rating Scale ranging from 1-5) of tasted grapefruit juice samples; blue = represents subjects (n=148); red = emoji pairs for each sample (0, 40, 80, 160 g/L).

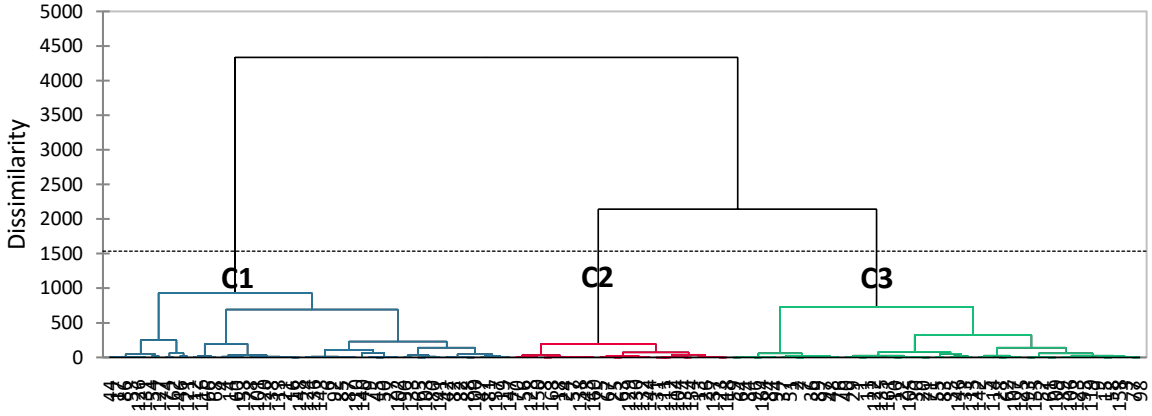


Figure 7.2 Dendrogram with cauterization into 3 clusters (C1, C2, C3) resulting from the Agglomerative Hierarchical Cluster Analysis (AHC).

According to the PC-ANOVA, each cluster was significantly different for emoji groups ($p<0.0001$, respectively) and liking ($p<0.0001$) (Table 7.2). Cluster 1 (C1, n=40%) is

characterized by children that feel most positive towards the grapefruit juice samples and show the highest mean liking (M=63.1). Cluster 2 (C2, n=21%) is characterized by children, who reported lower scoring to all emoji in general, and particularly the emoji expressing higher arousal (surprised, angry) and have a rather low mean liking (M=35.0) towards the samples. An important characteristic of this cluster is that children do not really use any of the emoji pairs to describe the food samples compared to the other two clusters. Cluster 3 (C3, n=39%) is characterized by children who feel most negative and most surprised towards the food samples. They also show the lowest mean liking (M=21.5) compared to the other two clusters. Emoji pair characteristics for each cluster are summarized in Figure 7.3 The PC-ANOVA comparing the first three dimensions of the PCA between clusters (see Table 7.2) supported the results of emoji pairs and liking. Differences between clusters were found for all three dimensions: the first dimension (explaining 48.51% of variance), which can be interpreted as the valence dimension (pleasantness *vs.* unpleasantness), shows that C1 feel most positive, C2 neutral with a tendency to feel slightly more negative and C3 feels most negative towards the samples. C2 differs significantly to the other clusters in the second dimension (explaining 25.53% of variance), which can be interpreted as the arousal dimension (activation *vs.* deactivation). C2 also differs significantly in the third dimension (explaining 5.08% of variance) compared to the other clusters, however, the interpretation of this dimension is less clear.

In general, clusters were rather unfamiliar with grapefruit juice (C1: M=2.7, C2: M=2.3, C3: M=2.2; familiarity scale: 2 = I know it but have never tasted it, 3 = I have tasted it but rarely eat it), but a significant difference in familiarity was found between clusters (p=0.011). C1, who had the highest mean liking, was more familiar (M=2.7) compared to C3 (M=2.2), who had the lowest mean liking and was the least familiar to grapefruit juice. No significant difference was found for C2 (M=2.3) and the other two clusters, but it is similar to C1.

Table 7.2 Differences in mean liking, emoji pair ratings, direction in PCA dimensions (F1-3) between clusters (C1, C2, C3) across tasted grapefruit juice samples; in bold = mean ratings in the same row with different letters are significantly different at p<0.05.

	F-value	p-value	C1	C2	C3
Liking	203.9	**<0.0001**	**63.1 c**	**35.0 b**	**21.5 a**
😵😮	63.1	**<0.0001**	**2.3 b**	**1.9 a**	**3.3 c**
🤩🥳	279.3	**<0.0001**	**3.0 b**	**1.3 a**	**1.1 a**
😜🤪	211.2	**<0.0001**	**3.0 b**	**1.5 a**	**1.3 a**
😆😁	306.6	**<0.0001**	**3.1 b**	**1.4 a**	**1.3 a**
😀😁	325.9	**<0.0001**	**3.2 c**	**1.5 b**	**1.2 a**
😍🥰	282.5	**<0.0001**	**3.0 b**	**1.3 a**	**1.1 a**
😇😊	309.3	**<0.0001**	**3.2 b**	**1.4 a**	**1.2 a**
☺️🙂	272.7	**<0.0001**	**3.2 c**	**1.5 b**	**1.3 a**
😉😎	265.2	**<0.0001**	**3.0 b**	**1.3 a**	**1.2 a**
😔😐	32.8	**<0.0001**	**2.8 b**	**1.8 a**	**2.1 a**
😢😭	100.6	**<0.0001**	**2.0 b**	**1.2 a**	**3.0 c**
☹️😣	89.7	**<0.0001**	**2.2 a**	**2.3 a**	**3.6 b**
😫😖	94.8	**<0.0001**	**2.2 a**	**2.6 b**	**3.8 c**
🤢🤮	175.7	**<0.0001**	**2.0 a**	**2.3 b**	**4.1 c**
🤬😤	188.1	**<0.0001**	**1.9 b**	**1.3 a**	**3.5 c**
😡😈	143.4	**<0.0001**	**1.9 b**	**1.3 a**	**3.3 c**
😱😨	63.8	**<0.0001**	**2.3 b**	**1.8 a**	**3.2 c**
F1-PCA	427.4	**<0.0001**	**2.7 c**	**-0.3 b**	**-2.3 a**
F2-PCA	122.5	**<0.0001**	**0.8 b**	**-1.9 a**	**0.6 b**
F3-PCA	9.4	**<0.0001**	**-0.1 a**	**0.3 b**	**-0.1 a**

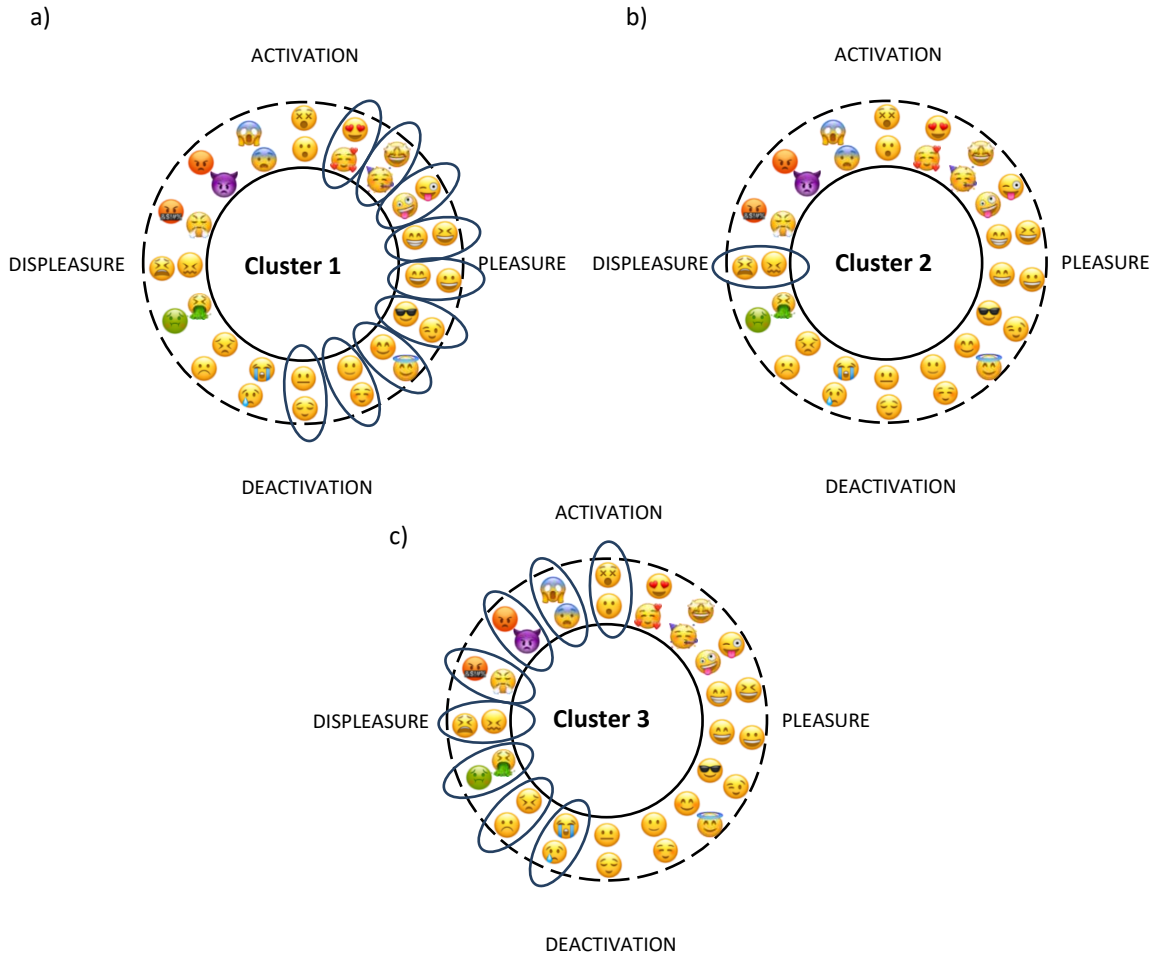


Figure 7.3 Characterization of a) cluster 1, b) cluster 2 and c) cluster 3 in using emoji pairs to describe tasted grapefruit juice samples; Circled emoji pairs indicate emoji pairs with a mean rating ≥2.5 (5-point categorical scale).

7.1.2.2 Differences between clusters in discriminant ability (liking and emotions) for tasted grapefruit juice samples

To examine the differences among the cluster in discriminant ability along affective variables, separated ANOVA were conducted on each cluster. Both C1 (Table 7.3) and C2 (Table 7.4) discriminated between tasted grapefruit juice samples (0, 40, 80 and 160 g/L) in liking (p=0.002, respectively) and emoji pairs but C3 (Table 7.5) did not discriminate between samples in liking (p=0.081), but only in emoji pairs. Considering the emoji pairs, C1 significantly discriminated the samples only according to positive emoji pairs (🤩🥰, 😜🤪, 😆😁, 😀😁, 😍🥰, 😇😊, ☺️🙂, 😉😎), while C2 (🤩🥰, 😆😁, 😀😁, 😍🥰, 😇😊, ☺️🙂 , 😉😎, ☹️😣 , 😫😖) and C3 (😜🤪, 😆😁, 😀😁, ☺️🙂, 🤢🤮) discriminated the samples both according to positive and negative emoji pairs.

In all clusters there were emoji pairs that discriminated better than liking: e.g., for C1 only one emoji pair (😀😁) discriminated better than liking between the 40 and 80 g/L samples indicating that the 80 g/L ample scored higher in the emoji pair than 40 g/L sample. For C2 no differences in liking were found between samples 80 g/L and 160 g/L, but emoji pairs 😍🥰 (p=0.000), 😇😊 (p=0.001), 😆😁 (p=0.005) and 😉😎 (p=0.007) reported higher mean ratings for sample 160 g/L compared to 80 g/L indicating a higher positive emotional response (preference) for the sweetest sample. For C3, only emoji pairs (and not liking) were discriminating between samples, discriminating between the sweetest (160 g/L) and the least sweet (0 g/L) sample. The emoji pairs 😜🤪 (p=0.021), 😆😁 (p=0.003), 😀😁 (p=0.033), ☺️🙂 (p=0.009) showed higher mean ratings for 160 g/L and a higher mean rating of 🤢🤮 (p=0.027) for 0 g/L indicating a more positive emotional response (preference) for the sweetest sample (160 g/L) and a strong dislike (disgusted emotions) for the least sweet samples (0 g/L). Furthermore, the emoji pair 😆😁 discriminated between the equally liked samples 80 g/L and 160 g/L indicating a more positive emotional response (preference) for the sweeter sample. In summary, these results demonstrate individual differences in hedonic and emotional responses between clusters to discriminate between samples and support the idea that emotions help to better understand affective responses to food products beyond liking.

Table 7.3 Cluster 1 (C1): Discriminating ability of liking and emoji pairs showing F-value, p-value, mean liking and mean ratings of emoji pairs for each grapefruit sample (0, 40, 80, 160 g/L). ANOVA was applied with Tukey's HSD as post-hoc test; letters display significant pairwise comparisons for grapefruit juice samples; in bold = significant p-values and mean values in the same row with different letters are significantly different at $p<0.05$; in grey = emoji pairs discriminating between samples despite similar liking.

	F-value	p-value	0 g/L	40 g/L	80 g/L	160 g/L
Liking	5.0	**0.002**	**53.7 a**	61.7 ab	**68.8 b**	**68.2 b**
😵😮	0.6	0.608	2.4	2.4	2.2	2.1
🥳🥰	5.5	**0.001**	**2.4 a**	2.9 ab	**3.4 b**	**3.3 b**
😜🤪	3.8	**0.011**	**2.5 a**	3.2 ab	**3.3 b**	3.1 ab
😆😁	5.7	**0.001**	**2.6 a**	3.0 ab	**3.5 b**	**3.3 b**
😀😁	9.9	**<0.0001**	**2.5 a**	**3.1 ab**	**3.7 c**	**3.4 bc**
😍🥰	7.2	**0.000**	**2.4 a**	3.0 ab	**3.5 b**	**3.3 b**
😇😊	5.5	**0.001**	**2.6 a**	3.1 ab	**3.4 b**	**3.4 b**
☺️🙂	3.0	**0.034**	**2.8 a**	3.2 ab	**3.4 b**	3.3 ab
😉😎	5.3	**0.002**	**2.4 a**	2.9 ab	**3.4 b**	**3.2 b**

	0.1	0.986	2.7	2.8	2.8	2.7
	0.2	0.929	2.1	2.1	1.9	2.0
	0.8	0.515	2.2	2.3	1.9	2.2
	1.1	0.371	2.4	2.1	1.9	2.3
	0.8	0.493	1.9	2.1	1.7	2.0
	0.7	0.569	1.9	2.0	1.7	1.9
	0.6	0.595	1.8	2.0	1.7	2.0
	1.1	0.336	2.6	2.3	2.1	2.4

Table 7.4 Cluster 2 (C2): Discriminating ability of liking and emoji pairs showing F-value, p-value, mean liking and mean ratings of emoji pairs for each grapefruit sample (0, 40, 80, 160 g/L). ANOVA was applied with Tukey's HSD as post-hoc test; letters display significant pairwise comparisons for grapefruit juice samples; in bold = significant p-values and mean values in the same row with different letters are significantly different at $p<0.05$; in grey = emoji pairs discriminating between samples despite similar liking.

	F-value	p-value	0 g/L	40 g/L	80 g/L	160 g/L
Liking	5.1	**0.002**	**25.7 a**	33.2 ab	35.0 ab	**46.1 b**
	1.4	0.252	2.3	1.8	1.9	1.8
	3.8	**0.011**	**1.1 a**	1.3 ab	1.3 ab	**1.6 b**
	0.4	0.766	1.4	1.4	1.5	1.5
	4.5	**0.005**	**1.2 a**	1.3 ab	**1.3 a**	**1.7 b**
	4.8	**0.003**	**1.2 a**	**1.4 a**	1.4 ab	**1.8 b**
	6.4	**0.000**	**1.1 a**	**1.3 a**	**1.2 a**	**1.7 b**
	5.8	**0.001**	**1.2 a**	**1.3 a**	**1.3 a**	**1.7 b**
	3.8	**0.011**	**1.3 a**	1.5 ab	1.4 ab	**1.8 b**
	4.2	**0.007**	**1.2 a**	1.3 ab	**1.2 a**	**1.6 b**
	1.6	0.183	1.6	1.9	1.9	2.1
	1.9	0.130	1.4	1.1	1.3	1.1
	2.7	**0.046**	**2.6 b**	2.4 ab	2.4 ab	**1.8 a**
	3.0	**0.031**	**3.0 b**	2.7 ab	2.7 ab	**2.1 a**
	2.3	0.084	2.7	2.3	2.4	1.9
	2.0	0.115	1.4	1.2	1.3	1.1
	1.6	0.202	1.4	1.3	1.2	1.1
	0.7	0.564	1.9	1.8	1.8	1.6

Table 7.5 Cluster 3 (C3): Discriminating ability of liking and emoji pairs showing F-value, p-value, mean liking and mean ratings of emoji pairs for each grapefruit sample (0, 40, 80, 160 g/L). ANOVA was applied with Tukey's HSD as post-hoc test; letters display significant pairwise comparisons for grapefruit juice samples; in bold = significant p-values and mean values in the same row with different letters are significantly different at p<0.05; in grey = emoji pairs discriminating between samples despite similar liking.

	F-value	p-value	0 g/L	40 g/L	80 g/L	160 g/L
Liking	2.3	0.081	17.6	20.3	21.2	26.9
😵😮	1.9	0.129	3.5	3.5	3.3	3.0
🤩🥳	0.7	0.541	1.1	1.1	1.1	1.2
😜🤪	3.3	**0.021**	**1.1 a**	1.3 ab	1.2 ab	**1.5 b**
😆😄	4.7	**0.003**	**1.1 a**	1.2 ab	**1.2 a**	**1.5 b**
😀😄	3.0	**0.033**	**1.1 a**	1.2 ab	1.3 ab	**1.4 b**
😍🥰	0.8	0.504	1.1	1.1	1.1	1.2
😇😊	1.9	0.128	1.1	1.2	1.2	1.4
☺️🙂	4.0	**0.009**	**1.1 a**	1.3 ab	1.3 ab	**1.5 b**
😉😎	0.8	0.494	1.1	1.2	1.3	1.3
😔😐	0.6	0.636	2.0	2.0	1.9	2.2
😢😭	1.3	0.293	3.1	3.2	3.0	2.7
☹️😣	1.6	0.183	3.8	3.6	3.7	3.4
😫😖	1.2	0.311	4.1	3.8	3.8	3.6
🤢🤮	3.1	**0.027**	**4.4 b**	4.0 ab	4.1 ab	**3.7 a**
🤬😤	2.4	0.070	3.7	3.5	3.5	3.1
😡😈	1.3	0.268	3.6	3.3	3.3	3.1
😱😨	0.5	0.718	3.3	3.4	3.1	3.1

The interaction effect between clusters and samples showed that there is a significant difference in C1 for the emoji pair 🤩🥳 (p=0.007), which is rated more frequently with increasing sucrose concentration, while for C2 and C3 this effect was not shown. There was also a significant difference in C1 for the emoji pairs 😆😄 (p=0.033), 😀😄 (p=0.001), 😇😊 (p=0.028), 😉😎 (p=0.006), which were rated more frequently with increasing sucrose concentration, which was not shown for C2 and C3. In C1, the emoji pair 😀😄 was rated more frequently for 80 g/L than 40 g/L, while mean liking did not increase. Additionally, a significant difference for C1 and C2 was shown for the emoji pair 😍🥰 (p<0.0001), which was rated more frequently with increasing sucrose concentration, which was not shown for C3.

Table 7.6 Interaction effect between mean liking, emoji pair ratings, direction in PCA dimensions (F1-3) between clusters (C1, C2, C3) across tasted grapefruit juice samples. In bold p-values <0.05 and mean values in the same row with different letters are significantly different at p<0.05; in grey = emoji pairs discriminating despite similar liking.

			C1				C2				C3			
F-value		**p-value**	**0 g/L**	**40 g/L**	**80 g/L**	**160 g/L**	**0 g/L**	**40 g/L**	**80 g/L**	**160 g/L**	**0 g/L**	**40 g/L**	**80 g/L**	**160 g/L**
Liking	1.1	0.351	53.7 de	61.7 ef	68.8 f	68.2 f	25.7 ab	33.2 bc	35.0 bc	46.1 cd	17.6 a	20.3 ab	21.2 ab	26.9 ab
😵😮	0.5	0.772	2.4 ab	2.4 ab	2.2 ab	2.1 a	2.3 ab	1.8 a	1.9 a	1.8 a	3.5 c	3.5 c	3.3 c	3.0 bc
🤩🥰	3.0	**0.007**	**2.4 b**	**2.9 bc**	**3.4 c**	**3.3 c**	1.1 a	1.3 a	1.3 a	1.6 a	1.1 a	1.1 a	1.1 a	1.2 a
😜🤪	1.8	0.106	2.5 b	3.2 c	3.4 c	3.1 bc	1.4 a	1.4 a	1.5 a	1.5 a	1.1 a	1.3 a	1.2 a	1.5 a
😆😄	2.3	**0.033**	**2.6 c**	**3.0 cd**	**3.5 d**	**3.3 d**	1.2 ab	1.3 ab	1.3 ab	**1.7 b**	1.1 a	1.2 ab	1.2 ab	1.5 ab
😀😁	3.9	**0.001**	**2.5 c**	**3.1 d**	**3.7 e**	**3.4 de**	1.2 ab	1.4 ab	1.4 ab	**1.8 b**	1.1 a	1.2 a	1.3 ab	1.4 ab
😍🥰	4.8	**<0.0001**	**2.4 c**	**3.0 d**	**3.5 d**	**3.3 d**	1.1 a	1.3 ab	1.2 ab	**1.7 b**	1.1 a	1.1 a	1.1 a	1.2 ab
😇😊	2.4	**0.028**	**2.6 c**	**3.1 cd**	**3.4 d**	**3.4 d**	1.2 ab	1.3 ab	1.3 ab	**1.7 b**	1.1 a	1.2 ab	1.2 ab	1.4 ab
☺️🙂	1.1	0.377	2.8 c	3.2 cd	3.4 d	3.3 cd	1.3 ab	1.5 ab	1.4 ab	1.8 b	1.1 a	1.3 ab	1.3 ab	1.5 ab
😉😎	3.0	**0.006**	**2.4 b**	**2.9 bc**	**3.4 c**	**3.2 c**	1.2 a	1.3 a	1.2 a	1.6 a	1.1 a	1.2 a	1.3 a	1.3 a
😔😐	0.6	0.759	2.7 bcd	2.8 cd	2.8 d	2.7 bcd	1.6 a	1.9 a	1.9 a	2.1 abcd	2.0 ab	2.0 abc	1.9 a	2.2 abcd
😢😭	0.7	0.675	2.1 bc	2.1 bc	1.9 abc	2.0 bc	1.4 ab	1.1 a	1.3 ab	1.1 a	3.1 d	3.2 d	3.0 d	2.7 cd
☹️😣	1.3	0.273	2.2 a	2.3 a	1.9 a	2.2 a	2.6 ab	2.4 a	2.4 a	1.8 a	3.8 c	3.6 c	3.7 c	3.4 bc
😫😖	1.2	0.322	2.4 ab	2.1 ab	1.9 a	2.3 ab	3.0 bc	2.7 ab	2.7 ab	2.1 ab	4.1 d	3.8 cd	3.8 cd	3.6 cd
🤢🤮	1.6	0.133	1.9 ab	2.1 ab	1.7 a	2.0 ab	2.7 b	2.3 ab	2.4 ab	1.9 ab	4.4 c	4.0 c	4.1 c	3.7 c
😡😤	1.3	0.257	1.9 ab	2.0 b	1.7 ab	1.9 ab	1.4 ab	1.2 a	1.3 ab	1.1 a	3.7 c	3.5 c	3.5 c	3.1 c
😡😈	0.9	0.480	1.8 ab	2.0 b	1.7 ab	2.0 b	1.4 ab	1.3 ab	1.2 ab	1.1 a	3.6 c	3.1 c	3.3 c	3.1 c
😱😨	0.4	0.852	2.6 bcd	2.3 ab	2.1 ab	2.4 abc	1.9 ab	1.8 ab	1.8 ab	1.6 a	3.3 d	3.4 d	3.1 cd	3.1 cd
F1-PCA	2.5	**0.021**	**1.7 ef**	**2.6 fg**	**3.6 g**	**3.1 g**	**-0.9 bc**	**-0.3 cd**	**-0.4 cd**	**0.6 de**	-2.8 a	-2.4 a	-2.4 a	-1.7 ab
F2-PCA	1.3	0.245	0.2 b	0.9 b	1.0 b	1.1 b	-1.8 a	-1.9 a	-2.0 a	-1.9 a	0.7 b	0.7 b	0.5 b	0.3 b
F3-PCA	1.1	0.350	0.1 a	-0.1 a	-0.2 a	-0.2 a	0.2 a	0.3 a	0.3 a	0.2 a	-0.1 a	-0.1 a	-0.2 a	0.1 a

7.1.2.3 Differences in sensory responsiveness to basic tastes and PROP status between clusters

ANOVA showed that clusters differ in perceived intensity of sweetness (p<0.0001) and sourness (p=0.002) across grapefruit juice samples (see Table 7.7), but not bitterness (p=0.068). C1 rated grapefruit juice as sweeter (M=30.5) compared to C2 (M=22.5) and C3 (M=19.3) (p<0.0001). Interestingly, C3 rated sourness higher (M=31.6) than C2 (M=23.7), but there was no significant difference between C1 and the other two clusters. No significant differences between clusters (p=0.877) or between gender (p=0.965) were shown for PROP status (Supplementary Materials Figure S 1).

Table 7.7 Sensory responsiveness of clusters (C1, C2, C3) in response to tasted grapefruit juice samples measured by LMS scale (0-100); letters display significant pairwise comparisons for clusters; in bold = significant p-values and mean values in the same row with different letters are significantly different at p<0.05.

	F-value	p-value	C1	C2	C3
Sweet	15.8	**<0.0001**	**30.5 a**	**22.5 b**	**19.3 b**
Bitter	2.7	0.068	**32.8 b**	36.4 ab	**37.9 a**
Sour	5.4	**0.005**	27.7 ab	**23.7 b**	**31.6 a**

7.1.2.4 Validation of personality trait questionnaires with Norwegian children

An overview of the personality trait questionnaires, internal consistency (Cronbach's alpha), differences between genders levels of personality traits are reported in Table 7.8.

Table 7.8 Summary table of personality traits (food neophobia, sensation seeking, sensitivity to reward and punishment, curiosity trait) including subscales (BIS=Behavioral Inhibition System Subscale, REW=Reward responsiveness, DRIVE=Drive, FUN=Fun seeking, JE=Joyous exploration, SC=Social curiosity), median, minimum and maximum score, Cronbach's α, gender differences, classification of subjects.

Personality trait	Subscales	Median	Min. - max. score	Cronbach's α	Gender differences	Classification of subjects
Food neophobia	-	22	9-36	α=0.80	no	Low Medium High
Sensation seeking	-	23	7-35	α=0.85	no	Low Medium High
Sensitivity to reward & punishment (BIS/BAS)	BIS REW DRIVE FUN	17 21 12 15	5-25 5-25 4-20 4-20	α=0.82 α=0.90 α=0.87 α=0.77	no	Low Medium High
Curiosity trait	JE SC	44	12-60	α=0.86 α=0.85	no	Low Medium High

Food neophobia: The internal consistency of the Italian Child Food Neophobia Scale (ICFNS) was satisfactory (Cronbach's α=0.80, n=8) and comparable to those found in previous research assessing children's food neophobia, e.g., α=0.71 (Laureati, Bergamaschi, et al., 2015) and α=0.76 (Proserpio et al., 2020). Factor patterns after Varimax rotation (number of factors = 1)

are reported in Table 7.9. All items showed a positive correlation on the first factor pattern (36.31% of explained variance), meaning that they are consistent in measuring food neophobia. No gender differences were found between girls and boys in food neophobia (p=0.079), which is in line with Proserpio et al. (2019) comparing food neophobia in 9-12-y.o. children between 5 European countries (Finland, Italy, Spain, Sweden and UK). However, Laureati, Bertoli, et al. (2015) found that in Italian 6-9-y.o. children, boys were more food neophobic than girls.

Table 7.9 The Italian Child Food Neophobia Scale (ICFNS): Factor patterns after Varimax rotation (number of factors = 1); values in bold correspond for each variable to the factor for which the squared cosine is the largest; (R) indicates the neophilic items for which the score was reversed.

Items	D1	Cronbach's α
FN 1 (R)	**0.65**	0.80
FN 2	**0.73**	
FN 3	**0.64**	
FN 4 (R)	**0.59**	
FN 5 (R)	**0.52**	
FN 6	**0.51**	
FN 7	**0.54**	
FN 8 (R)	**0.61**	

Sensation seeking: The internal consistency of the Brief Sensation Seeking Scale (BSSS) was satisfactory (Cronbach's α=0.85, n=7). The internal consistency of α=0.85 was even higher when comparing to previous research by Primi et al. (2011) validating the BSSS scale with 14-20-y.o. school students yielding a Cronbach's α=0.73 (8 items). Factor patterns, total BSSS mean sores and individual item scores are reported in Table 7.10. All items showed a positive correlation on the first factor pattern (45.19% of explained variance), meaning that they are consistent in measuring sensation seeking. No gender differences were found between girls and boys in sensation seeking (p=0.438), which aligns with Primi et al. (2011).

Table 7.10 Brief Sensation Seeking Scale (BSSS): Factor patterns (BSSS 4 was not asked in the questionnaire); factor patterns after Varimax rotation (number of factors = 1); values in bold correspond for each variable to the factor for which the squared cosine is the largest.

Items	D1	Cronbach's α
BSSS 1	**0.72**	0.85
BSSS 2	**0.51**	
BSSS 3	**0.79**	
BSSS 4	-	
BSSS 5	**0.52**	
BSSS 6	**0.70**	
BSSS 7	**0.63**	
BSSS 8	**0.78**	

BIS/BAS scale: Factor patterns after Varimax rotation, total BIS/BAS mean sores and individual item scores are reported in Table 7.11. Two items of the BIS subscale (BIS 5 and BIS 7) were removed to obtain a satisfactory internal consistency (Cronbach's α=0.92, n=18). All BIS subscale items (n=5) showed a positive correlation on the third factor pattern (D3, 13.1% of explained variance) and a satisfactory internal consistency (α=0.82), meaning that they are consistent in measuring the behavior inhibition system. The internal consistency of the BAS subscales REW and FUN was satisfactory (α=0.90), however, the two subscales (except FUN 1) loaded both on the first factor pattern (D1, 14.83% of explained variance). All DRIVE subscale items (n=4) showed a positive correlation on the second factor pattern (D2, DRIVE: 14.83% of explained variance) and a satisfactory internal consistency (α=0.80), meaning that it is consistent in measuring the drive to pursuit desired goals. No gender differences were found between girls and boys in neither of the subscales: BIS (p=0.077), REW (p=0.949), DRIVE (p=0.687) and FUN (p=0.156).

Table 7.11 The Behavioral Inhibition & Behavioral Activation Scale (BIS/BAS): BIS subscale (BIS 5 (R) and BIS 7 (R) were removed) and BAS subscales (REW = Reward responsiveness, DRIVE = Drive and FUN = Fun seeking): Factor patterns after Varimax rotation (number of factors = 4); values in bold correspond for each variable to the factor for which the squared cosine is the largest.

Items	D1	D2	D3	Cronbach's α
BIS 1	0.45	0.08	**0.61**	0.82
BIS 2	0.17	0.17	**0.71**	
BIS 3	0.25	0.16	**0.57**	
BIS 4	0.26	0.22	**0.45**	
BIS 5 (R)	-	-	-	
BIS 6	0.35	0.26	**0.66**	
BIS 7 (R)	-	-	-	
REW 1	**0.70**	0.28	0.70	0.90
REW 2	**0.74**	0.25	0.74	
REW 3	**0.76**	0.11	0.76	
REW 4	**0.64**	-0.05	0.64	
REW 5	**0.73**	0.27	0.73	
FUN 1	0.35	**0.55**	0.35	
FUN 2	**0.56**	0.22	0.56	
FUN 3	**0.74**	0.16	0.74	
FUN 4	**0.53**	0.44	0.53	
DRIVE 1	0.16	**0.80**	0.16	0.80
DRIVE 2	0.18	**0.71**	0.18	
DRIVE 3	0.31	**0.56**	0.31	
DRIVE 4	0.093	**0.47**	0.09	

Curiosity trait scale: The internal consistency of the Curiosity trait subscales Joyous exploration (JE) and Social curiosity (SC) was satisfactory (JE: α=0.86, n=6; SC: α=0.85, n=6). Factor patterns are reported in Table 7.12. All items of the JE subscale showed a positive correlation on the first factor pattern (D1, 26.85% of explained variance) and items of the SC subscale showed a positive correlation on the second factor pattern (D2, 24.64% of explained variance, meaning that both subscales are consistent in measuring joyous exploration and social curiosity. The internal consistencies for each subscale was adequate with coefficients comparable to those found in previous research (JE: α=0.87, n=5; SC: α=0.86, n=5) validating the scale with adults (Kashdan et al., 2018). No gender differences were found between girls and boys for the curiosity trait (p=0.077).

Table 7.12 Curiosity trait scale (subscales: Joyous exploration (JE) and Social curiosity (SC)): Factor pattern after Varimax rotation (number of factors = 2); values in bold correspond for each variable to the factor for which the squared cosine is the largest.

Items	D1	D2	Cronbach's α
JE 1	**0.72**	0.16	0.86
JE 2	**0.68**	0.25	
JE 3	**0.63**	0.20	
JE 4	**0.74**	0.14	
JE 5	**0.79**	0.12	
JE 11	**0.56**	0.21	
SC 6	0.24	**0.50**	0.85
SC 7	0.41	**0.60**	
SC 8	0.09	**0.80**	
SC 9	0.14	**0.74**	
SC 10	0.30	**0.65**	

7.1.2.5 Differences in personality trait questionnaires between clusters

Differences between clusters were found in reward responsiveness for the FUN subscale (χ^2 (4, n=148) =10.33; p=0.035). C1 was shown to have lower number of medium fun seekers, whereas C2 had a higher number of medium fun seekers compared to the other levels of fun seekers (see Figure 7.4).

There were no significant differences between clusters and levels of personality traits when analyzed for food neophobia (χ^2 (4, n=148)=6.74, p=0.151), sensation seeking (χ^2 (4, n=148)= 3.00, p=0.557), BIS subscale (5 items, χ^2 (4, n=148)= 2.20, p=0.699), REW subscale (χ^2 (4, n=148)= 2.10, p=0.718), DRIVE subscale (χ^2 (4, n=148)= 1.33, p=0.856) and curiosity trait (p=0.186). Observed frequencies for each cluster (C1, C2, C3) and level of personality trait (low, medium, high) for all personality trait questionnaires are reported in Supplementary Materials Table S 16 and visualized in the Supplementary Materials Figure S 2a-g).

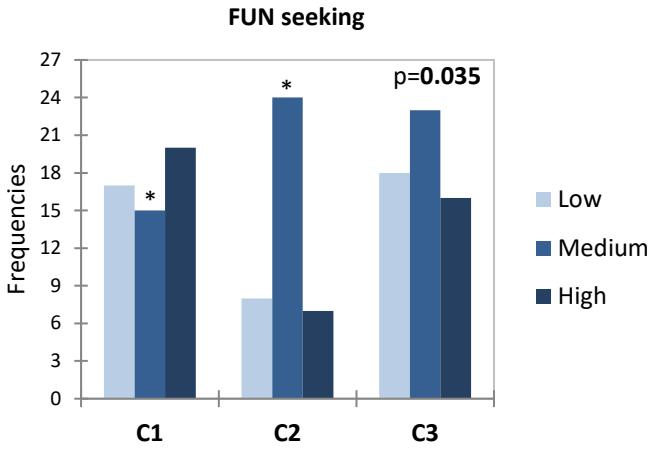


Figure 7.4 Observed frequencies for each cluster (C1, C2, C3) and level of FUN seekers (low, medium, high) of the BAS subscale. * highlights significant levels $p<0.05$.

7.2 Discussion

Study 7b investigated individual differences in emotional responses to foods by clustering children according to their patterns of emotional responses and by testing the clusters for differences in PROP status, sensory responsiveness to basic tastes and personality traits (food neophobia, sensation seeking, sensitivity to reward and punishment, and curiosity trait). Children were classified into three clusters according to their emotional patterns in Principal Component Analysis. The three clusters were found to differ in liking, responsiveness to sweet, sour, and sensitivity to reward (FUN subscale).

7.2.1 Relationship between liking, emotional responses, and sensory responsiveness to basic tastes

In a study by Gallo et al. (2017), children tended to pick positive emoji when referencing their favorite foods (high liking), and negative emoji when referencing their least favorite foods (low liking). Da Cruz et al. (2021) showed that fermented milk samples with the highest overall liking were correlated with positive emoji, while the least liked samples were associated with negative emoji, which is consistent with further findings when children evaluated food products in terms of liking and emotions using emoji (Schouteten et al., 2018; Swaney-Stueve et al., 2018), supporting the strong link between liking and emotional valence (pleasantness/unpleasantness). However, in this study this link was only shown for C1 and C2 and not C3, who did not discriminate in liking between the samples.

Furthermore, in this study it was shown that added sucrose concentrations influence liking and emotions: with increasing sucrose concentrations, ratings of liking and positive emotions increased, while ratings of negative emotions decreased. This is consistent with a study that tested if grapefruit juice with added sucrose would increase pleasantness in children and adults (Capaldi & Privitera, 2008). They found that sweet taste of sucrose increased liking of grapefruit juice, which is consistent with the findings of the present study. This may be explained by the fact that sucrose is a strong suppressor of bitter and sour (Green et al., 2010), thereby enhancing the pleasantness of grapefruit juice. Adding sucrose (or food products with sweet sensory properties e.g., apples, grapes, bananas) may be an effective strategy to increase liking for beverages or other food categories with unpleasant sensory properties, often characteristic of fruits and vegetables. However, despite the benefit of actively suppressing undesirable basic tastes, attention should be paid to the amount of added sucrose as high ingestion of sugar leads to adverse health effects (WHO, 2015). Yet, by adding sweetness to disliked foods can act as one of the initiators to overcome the barriers to taste and consume foods with disliked sensory properties and to accept them. Through mere exposure and by gradually decreasing again the degree of sweetness, children will potentially learn to like the product that they did not like initially.

7.2.2 Clusters are characterized by liking and emotional responses

Three clusters were identified that differed in liking and emotions to discriminate between tasted grapefruit juice samples. Interestingly, the cluster (C3) that reported the highest average scores of negative emoji for all tasted samples, did not only have the lowest mean liking, but also had the highest average score for “surprise”, which could mean a negative surprise for this cluster of children when tasting products characterized by bitterness such as the ones presented here. In contrast, the cluster (C1) with the highest average scores of positive emoji, and which expressed the highest mean liking for the samples also expressed “surprise” to some extent; however, this can be interpreted as positive surprise. Surprise seems to be an important emotion that can be used to describe positive or negative emotional experiences in response to foods and may play an important role in both food acceptance and rejection. While instances of some emotions tend to be rather associated with one valence (e.g., happy is associated with positive valence), some instances of emotions may be associated with positive/negative valence. This seems to be specifically relevant for “surprise”

that has been implemented as pleasant and unpleasant surprise in previous emotion measurement questionnaires related to food/odors (e.g., ScentMove™, Delplanque et al., 2012; Porcherot et al., 2012, 2010). There are some practical implications of the presence of differing valence in "surprise" and a surprise reaction can be beneficial for both the product developer and the consumer. For example, for the consumer, it makes the product more interesting. The product that evokes surprise catches a person's attention increasing a product's recall and recognition, which is especially relevant in new product development to increase the success of a product (Ludden, Schifferstein, & Hekkert, 2008). On the contrary, negative surprise is more likely to result in product rejection and should therefore be avoided.

Large differences in emoji profiles between product likers and dislikers were also found in adults (Jaeger, Vidal, et al., 2017). C2 is characterized by children, who have a rather low mean liking towards the samples and particularly use emoji expressing higher arousal (surprised, angry). An important characteristic of this cluster is that children do not really use any of the emoji pairs to discriminate between the food samples compared to the other two clusters. These are important findings that should be considered when developing products for children as there may be a group of children that respond rather negative and with low arousal towards products. Future research should investigate how products for this group of children could evoke more positive and high activation emotions to increase food acceptance. Furthermore, it should be studied if this is an effect specifically related to grapefruit juice or if this can also be observed for other food product categories.

7.2.3 How does each cluster discriminate between grapefruit juice samples?

Cluster differed in liking and emotions between grapefruit juice samples (0, 40, 80 and 160 g/L). C1 used only positive emotions to discriminate between samples indicating that this cluster does not discriminate according to negative emotions. This may be explained by the higher mean liking and lower ratings of negative emotions for all grapefruit juice samples compared to C2 and C3 that reported lower mean likings. In this cluster, only one emoji pair 😀😁 ("cheerful - serene") discriminated better than liking between the 40 and 80 g/L samples. Moreover, for this cluster there was a tendency that children preferred the second sweetest sample 80 g/L (and not 160 g/L as shown for C2 and C3). This indicates that these children can be satisfied with a lower concentration of sucrose compared to the other clusters.

There was a tendency that C1 had higher mean ratings of positive emoji pairs and lower mean ratings of negative emoji groups. This cluster also perceived the grapefruit juice samples as sweeter compared to C2 and C3, indicating that this cluster requires lower concentrations of sucrose, e.g., in sweetened beverages, to consume them with the same "pleasure". This knowledge is important as it could help to reduce the sugar content of unhealthy beverages/ food products high in sugar targeted at children. This research offers new insights into individual differences in children; individuals more sensitive to sweetness may need lower sucrose concentrations in products to accept and feel positive towards them. However, it should be investigated if this effect also holds true for other beverages/ food products as it was shown that sensory-emotion linkages are category-specific, meaning that sensory properties have a specific emotional significance within a product category, but are different in another product category (Jaeger, Spinelli, Ares, et al., 2018).

While C1 and C2 discriminated samples in liking, C3 did not. Nonetheless, C3 that generally disliked all the samples used emotions to discriminate between the samples. The cluster discriminated mainly between the least sweet sample (0 g/L) and the sweetest (160 g/L) by using both negative (🤢🤮) and positive emoji pairs (😜🤪, 😆😁, 😀😁, ☺️🙂). This cluster was most negative towards the samples and expressed the highest mean rating for the disgusted emoji pair 🤢🤮 ("disgusted - nauseated") compared to C1 and C2. This is not surprising as this cluster tended to perceive the samples also as sourer and less sweet compared to the other clusters. Disgust is a type of rejection in response to products with offensive properties (Rozin & Fallon, 1987), which may be related to sour and bitter taste in the case of grapefruit juice that are both most dominant in the least sweet sample (0 g/L). Sour and bitter are both basic tastes related to food rejection in children (Birch & Fisher, 1998) and emotions of disgust may act as a protective mechanism to avoid potentially dangerous compounds. For example, children (9-14-y.o.) were shown to prefer fruit drinks low in sourness suggesting a negative association between sour taste and children's food liking (Kildegaard, Tønning, & Thybo, 2011).

7.2.4 Cluster differ in sensory responsiveness to basic tastes but not PROP status

Clusters differed in sensory responsiveness to basic tastes of sweet and sour, however, they did not differ in responsiveness to bitter and PROP status. In a recent study by Ervina, Berget,

Nilsen, & Almli (2020) investigating children's (10-11-y.o.) ability to identify basic tastes and their liking towards unfamiliar foods, it was shown that bitterness was the least described basic taste among children. Following, the fact that there were no differences between clusters for neither responsiveness to bitter nor PROP status could mean that children had difficulties to identify bitter taste in the grapefruit juice samples. A study using quinine to measure 9-11-y.o. children's responsiveness to bitterness found that children that were high responsive for bitterness showed a decreased acceptance for grapefruit juice (Hartvig et al., 2014), however this was not confirmed in the current study. Furthermore, PROP does not explicitly measure sensitivity to bitterness, but also other sensory sensations (Tepper, 1998).

Moreover, a study examining the link between PROP taste sensitivity and emotional responses demonstrated that PROP supertasters reported more intense negative emotions (increased responses for anger, tension, and fear) compared to PROP non-tasters and medium tasters (Macht & Mueller, 2007), but this was not shown in the current study.

7.2.5 Cluster differ in BAS fun seeking but not in other personality traits

Personality trait questionnaires showed sufficient internal consistency (Cronbach's α), which enabled the application of the questionnaires with 9-13-y.o. children. For the first time, the sensation seeking scale, BIS/BAS scale and curiosity trait scale were used to explore individual differences in children's food preferences in respect to differences in emotional responses.

Differences between clusters were found in reward responsiveness (FUN subscale). C1 showed a lower number of medium fun seekers, whereas C2 showed a higher number of medium fun seekers that have a desire and tendency to spontaneously approach a potential reward. This cluster (C2) was also the one giving the lowest scores for all the emoji indicating a very limited emotional response (either positive or negative) to the grapefruit products. If these subjects seek more fun in the products, it seems they did not find it in these samples. The lowest ratings could be thus a reaction to disappointment.

Findings showed that higher fun seeking scores were present in obese children (Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006) and that there is a strong association between fun seeking and alcohol use among teenage girls (Loxton & Dawe, 2001) indicating that these individuals are more risk taking. Sensitivity to reward was positively associated with higher preference for sweet taste in adults (Saliba et al., 2009) and children (De Cock et al., 2016,

2015). Especially, 14-16-y.o. girls with higher sensitivity to reward were found to have a higher daily intake of snacks and sugar sweetened beverages (De Cock et al., 2015). However, in this study we did not measure children's daily intake of foods, which did not enable a comparison between studies. Research investigating the relationship between sensitivity to reward and punishment in food behavior is very scarce, especially experimental, and behavioral research which is not primarily based on self-reports. Moreover, it may be that the product itself used in this study had an effect as grapefruit juice may not be a good representative food model to detect individual differences in personality traits. Given the lack of overlap between personality traits studied in this research, it is suggested that there is merit in continued research into the effects of personality traits on emotional responses.

No gender differences were found for personality traits. For the few studies available on gender-related differences in food neophobia in children, research suggested that boys are more neophobic compared to girls (Koivisto Hursti & Sjödén, 1996, 1997; Laureati, Bertoli, et al., 2015), however, we could not show this in the current study. In contrast to our findings, a meta-analysis on gender differences in sensation seeking found that men scored higher than women on measures of sensation-seeking in adults (Cross, Cyrenne, & Brown, 2013) and 9-13-y.o. children (Jensen et al., 2011). The data in the literature on gender-related differences in the personality traits used in this research are scarce, especially data on children.

7.2.6 Familiarity and liking of grapefruit juice samples

All clusters were rather unfamiliar to grapefruit juice yet some differences between clusters in familiarity to grapefruit juice were found. Also, there was a trend that with increasing familiarity, liking and positive emotions increased. Familiarity plays an important role in children's food liking (Cooke, 2007; Cooke & Wardle, 2005) as demonstrated in a study where foods that had been tried less often tended to be less liked and vice versa (Cooke & Wardle, 2005). It would have been expected that children more unfamiliar to grapefruit juice score higher in food neophobia and vice versa, however, this was not demonstrated in this study. Future research should investigate how familiarity of other tasted food samples influence liking and emotional responses.

7.2.7 Conclusions

Findings of Study 7b proved that children can be clustered according to emotional patterns to a model food modified according to sensory properties and that these clusters differ in liking, responsiveness to sweet, sour, and ability to discriminate between food samples and sensitivity to reward (fun seeking). Sensory responsiveness to basic tastes were shown to influence emotional responses to grapefruit juice samples in preadolescents. The findings can be used to not only understand children's food behavior but also to develop novel products targeted at specific clusters of children considering their individual differences in emotions, personality traits and sensory responsiveness by providing target-specific products. In future research it would be interesting to cluster children according to emotional patterns to a broader set of food products.

Part IV General discussion

Chapter 8 General discussion and conclusions

The previous parts and chapters have discussed study-specific findings in detail. In this part, a more general discussion of the main findings and conclusions in respect to the research objectives and aims will be presented in this chapter. Furthermore, the results and their scientific implications and relevance to the industry will be provided. The final section proposes directions for future research based on the findings of the research presented in this PhD thesis.

8.1 Research objectives revisited

The overall objective of this PhD thesis was to investigate the role of emotions, personality traits and sensory sensitivity in preadolescent's food preferences. Obtaining a broader view on different determinants of food choice in preadolescents with a focus on emotions and individual differences help to better understand important factors of food choice and is therefore of interest in healthier food product development targeted at preadolescents. Due to the lack of an age-appropriate emotion measurement tool to measure food-elicited emotions in preadolescents, a new emoji-based self-report measurement tool, the **Emoji Pair Questionnaire**, has been developed, validated, and applied in this PhD thesis.

The first main objective was to develop an emoji-based self-report questionnaire for preadolescents consisting of a food-specific emoji list with identified emotional meaning, and to validate and apply the tool to test its discriminant ability in response to food. A further main objective was to investigate individual differences in emotional responses to foods by clustering children according to patterns of emotional responses and by testing the clusters for differences in personality traits and sensory responsiveness.

8.1.1 Research objective 1: Developing an emoji-based self-report measurement tool to measure food-related emotions in preadolescents

The first research objective in Part II dealt with the development and validation of the emoji-based self-report measurement tool to assess emotions in response to food stimuli in preadolescents. First, food-related emoji were selected, followed by an in-depth exploration of their meaning in the context of food, which led to the development of the emoji-based self-report questionnaire. Its discriminatory ability in respect to emotional responses to foods was

assessed with food names of different food categories and tasted food models and compared to liking measurements, both using a CATA and a rating scale format.

> *SO 1: To **select a list of emoji** that is **appropriate for preadolescents** to describe their emotions elicited by foods recalled in relation to different evoked eating contexts and to explore related **age- and gender differences** in how emoji are selected for each evoked eating context.*

The findings of Study 1 (Chapter 2) identified 46 of 92 emoji that resulted as appropriate to describe emotional response to foods in different eating contexts. Preadolescents used mainly positive emoji, except for the context "Most disliked food", where mainly negative emoji were used. Most food-related emojis resulted from "Most liked food" and "Most disliked food", but the context "Birthday" also added some context-specific emoji. The number of selected emoji varied across evoked eating contexts eliciting different foods. Age and gender significantly affected emoji selection across and within foods elicited by varied eating contexts, with girls and 9-11-y.o. children selecting some emoji more frequently across all contexts, but also within contexts. The results of this study were an important step to reduce the list of emoji to be further evaluated for their meaning in a food-related context.

> *SO 2: To **explore the meaning of emoji** by applying a) a similarity-based method (Study 2: projective mapping) to detect the meaning defined in the interrelationship between emoji (differential dimension meaning), b) descriptive methods (Study 3: CATA with emoji described by emotion words and Study 4: CATA with emotion words described by emoji) to investigate the association of emoji with words (cognitive/conceptual dimension of meaning), and c) a qualitative descriptive method (one-on-one interviews using a modified version of the Repertory Grid Method) to investigate emoji more in-depth. A further specific research objective was to measure **age- and gender differences** in the emotional meaning of food-related emoji.*

Chapter 3 includes findings of Study 2-5 focusing on the meaning of emoji. Results of Study 2 showed that emoji were discriminated along three dimensions interpreted as valence, power, and arousal, which were also found to describe emotion words (Fontaine & Scherer, 2013). In general, negative emoji had more distinct emotional meanings than positive emoji, but

differences in nuances of meaning were found also among positive emoji. It was possible to identify several emoji that were mapped closely to each other, hence, expressing similar emotional meanings. Results of Study 3 and 4 were congruent in linking emoji and emotion words and integrated the findings of Jaeger, Roigard, Jin, Vidal, & Ares (2019) on the meaning of emoji in adults. Positive emoji were described by more words in general, which could be explained by the context dependent use of emoji (Wijeratne et al., 2016), which was clarified in the interviews (Study 5). Girls and older preadolescents (12-13-y.o.) discriminated positive emoji slightly better than boys and younger preadolescents (9-11-y.o.). This could be related to gender differences in children's emotional expression (Chaplin & Aldao, 2013). Girls may be higher in emotional granularity of positive emotions and therefore being able to make finer distinctions between positive emoji. Girls express more positive emotions than boys which further develop with increasing age (Chaplin & Aldao, 2013), confirming the results of Study 1. Girls stated to use more positive emoji compared to boys in the Emoji Usage Questionnaire when merging Studies 1-4, but no significant differences were found when considering Studies 1-4 separately. The slight improvement in discrimination ability reported with age could be due to an improved cognitive development (Eccles, 1999) and ability to distinguish between emotion categories. The findings suggests that girls and older preadolescents (12-13-y.o.) may be higher in emotional granularity (the ability to experience and discriminate emotions), particularly of positive emotions. Hence, when using emoji in self-report emotion measurement tools, age- and gender differences should be considered due to some differences in emoji meaning.

> *SO 3: To **develop the emoji-based self-report questionnaire** based on Studies 1-5 by reducing the number of emoji and grouping emoji of similar emotional meaning to be used to evaluate emotional responses to foods in preadolescents.*

The development of the emoji-based self-report questionnaire was described in Chapter 4. Emoji expressing similar semantic and dimensional meanings were grouped in pairs of two, based on the idea that the grouping of the two emoji with the most similar semantic and dimensional meaning allows to better identify the overall meaning of the emoji pair. A similar approach was conducted by Chrea et al. (2009) with emotion terms to describe subjective emotions induced by odors. Emoji with ambiguous meaning were excluded. The emoji circumplex structure was inspired by previously developed emotion word circumplexes (e.g.,

Yik et al., 2011). Finally, the emoji-based self-report questionnaire which consisted of a reduced list of 17 emoji pairs (n=34 emoji) varying in valence, power, and arousal dimension.

> *SO 4: To compare the emotional meaning of emoji for Italian and Norwegian preadolescents through a **cross-cultural study** by repeating Study 3 (CATA emoji described by emotion words) with Norwegian preadolescents (Study 6).*

Results of Study 6 were described in Chapter 5 and showed that Italian and Norwegian preadolescents were found to describe emoji with overlapping emotional meaning, which was consistent with previous research with adults (Barbieri et al., 2016; Jaeger & Ares, 2017). This is the first study of its kind comparing the semantic meaning of emoji relevant to describe food experiences in preadolescents, which allowed the application of the emoji-based self-report questionnaire developed with Italian preadolescents also with Norwegian preadolescents to describe emotions in response to different food stimuli.

> *SO 5: To **validate and apply the emoji-based self-report questionnaire** with Norwegian preadolescents to **assess its emotional profiles and discriminant ability** in response to food (food names and tasted food models).*

Findings of Study 7a showed that emoji pairs varied between food categories of food names and were able to discriminate between familiar foods despite similar liking. Emoji also discriminated significantly among familiar food products within the food categories fruits, vegetables, and desserts/juices. Vegetable broth samples (spiked with sodium chloride) were neither discriminated in liking nor emotions. Tasted samples (grapefruit juice spiked with sucrose) differed in liking and in associated emoji. The findings support previous research foods using emoji for product discrimination in preadolescents (Gallo, Swaney-Stueve, et al., 2017b; Lima et al., 2019; Schouteten et al., 2019, 2018). The new questionnaire offers a novel approach that can be used both with a CATA or a rating scale format to discriminate between food that can be used across and within food categories and that proved to be effective when differences among products are small, such in the case of familiar food products and in the case of a model food presented with increasing concentration of sucrose.

8.1.2 Research objective 2: Applying the emoji-based self-report questionnaire to cluster preadolescents according to emotional patterns and testing the clusters for differences in personality traits and sensory responsiveness

Part III of this thesis dealt with the role of emotions, personality traits and sensory sensitivity in preadolescents' food preferences. In this part the emoji-based self-report questionnaire (Emoji Pair Rating Scale) was applied to assess preadolescent's emotional responses to tasted food samples of grapefruit juice (spiked with sucrose). Children were clustered based on their emotional responses to grapefruit juice samples and tested for individual differences in personality traits and sensory responsiveness:

> *SO 6: To **investigate individual differences by clustering children according to patterns of emotional responses** and by testing the clusters for differences in **personality traits** (food neophobia, sensation seeking, sensitivity to reward and punishment, curiosity trait), and **sensory responsiveness** (responsiveness to basic tastes and PROP status).*

Children were classified into three clusters according to their emotional patterns. One cluster scored higher in the emoji expressing positive emotions (C1), one in the emoji expressing negative emotions (C3) and one scored lower in all emoji (C2) demonstrating a lower emotional engagement with the products compared to the other clusters. The three clusters were found to differ also in liking, sensitivity to reward (fun seeking), responsiveness to sweet, sour, and ability to discriminate between food samples. Interestingly, the cluster that reported the highest average scores of negative emoji for all the tasted samples, did not only express the lowest mean liking, but also expressed the highest average score for "surprise", which could mean a negative surprise for this cluster of children. In contrast, the cluster that expressed the highest average scores for positive emoji, and which had the highest mean liking for the samples also expressed "surprise" to some extent, positive in this case. Unexpectedly, clusters did not differ in responsiveness to bitterness, PROP status and other personality traits, hence, more research is needed to investigate the relationship between emotions, sensory sensitivity, and personality traits. Clusters differed in reward responsiveness. Sensitivity to reward was positively associated with higher preference for sweet taste in adults (Saliba et al., 2009) and children (De Cock et al., 2016, 2015), but this was not demonstrated in the current study.

8.2 General conclusions, implications, and future perspectives

Sensory testing of food products is important for the **understanding of how consumers perceive these products**. Nowadays, there is an increasing rise of food products targeted at children, hence, it is essential to understand **what determines their food choices**. Traditional measurements for the evaluation of food products by consumers including adults and children are often limited to the assessment of overall acceptance of the products. However, these methods do not always capture the full picture to understand what drives consumers' food choices. Emotional profiles can give additional information that go beyond hedonic measurements. Yet, methods for the measurement of emotions are scarce, especially age-appropriate methods that can be used with children. Therefore, a new emotion measurement tool was developed, the Emoji Pair Questionnaire, to obtain a broader view on preadolescents' food product choice.

The findings of this PhD thesis demonstrated that this method resulted in distinct emotional profiles, which discriminated between and within food product categories by being a better indicator for food choice for several products compared to the sole use of hedonic measurements. The use of the questionnaire offers a wide application especially in industrial product development and sensory testing in research with children. By obtaining such emotional profiles, **researchers** and the **food industries** can use this information to not only **understand children's food behavior** but also to **develop novel products** targeted at specific clusters of children considering their individual differences in emotions, personality traits and sensory responsiveness by providing target-specific products. The following sections will elaborate on how the current findings can be integrated in each field more specifically.

8.2.1 Scientific implications in sensory- and consumer sciences

Researchers can apply the emoji-based self-report questionnaire to food products in a comparable way as current food-elicited emotion questionnaires. However, the advantage of the emoji-based self-report questionnaire is that it was specifically developed for preadolescents consisting of a food-specific emoji list with identified emotional meaning. Measuring emotions in response to food products was shown to give additional insights that go beyond hedonic measurement thereby **improving common procedures of affective testing in sensory- and consumer research** (Meiselman, 2016; Spinelli & Monteleone, 2018).

Children were not only found to be very familiar with emoji, but they also stated as the main motivations for the application that emoji are fun to use and that they express something they normally cannot describe in words. Following, using emoji could be more intuitive for children leading to **improved understanding of their food preferences** and enhance their engagement in sensory- and consumer tests. It is important to mention that when applying the emoji-based self-report questionnaires with children, rigorous and appropriate instructions to children on how to fill in the questionnaire are required to avoid any misunderstandings (e.g., how to deal with the interpretation of an emoji pair when they express different meanings for a child).

8.2.2 Societal and industry relevance and implications

This PhD dissertation also seeks to be of practical relevance for policy makers (e.g., health and nutrition) and food industry. The Emoji Pair Questionnaire is a general list that can help to understand children's affective responses to foods. The information given by emoji can help to better understand consumer's food preferences to 1) **improve product performance**, 2) assist in the **consumer-led development of new products** (Carr et al., 2015; Vidal, Ares, Machín, & Jaeger, 2015) or 3) can be used in **marketing** (Meiselman, 2016). The tool can be used to better understand the underlying reasons for choosing and consuming specific food products in children.

For the improvement of product performance, the food industry can directly involve children by conducting consumer tests, for example, in public facilities like supermarkets, schools, recreational facilities. They can then apply the Emoji Group Questionnaire to ask preadolescents about specific products. Th tool can be applied to a wide range of food products across food categories but also within food categories. The use of different response formats (e.g., CATA or rating scale) allows flexibility to the food products investigated and can be adapted in terms of difficulty level depending on the children's cognitive development. For instance, the **CATA questionnaire** can be applied to assess products **across different food categories**, while the **rating scale** is more **sensitive to capture more subtle differences**, e.g., products with very similar sensory characteristics. The tool can assist to select the most preferred products eliciting positive emotion. For the evaluation of product performance, the food industry often relies on rather traditional methods, mainly hedonic measurements. But as demonstrated in the current PhD research, even though some products were liked equally, the products differed in their emotional profiles, which are a better indicator of food choice.

For example, plain and fruit yogurt were liked equally, but fruit yogurt elicited more positive emotions compared to the plain yogurt, which is an indication for the preference for the fruit yogurt. Through emotional profiles, the food industry can gain important feedback about their products helping them to optimize their products.

Furthermore, the food industry can use this information to develop healthier and tastier food products tailored for children, which is urgently needed given the steep rise of childhood obesity and related diseases (Wang & Lobstein, 2006; WHO, 2020b). Velázquez, Vidal, Alcaire, Varela, & Ares (2021) investigated 8-13-y.o. children's hedonic sensitivity to sugar reduction in three types of dairy products (vanilla milk desserts, chocolate-flavored milk, and vanilla yogurt) and found that sugar reductions of the samples did not cause significant changes in children's hedonic reaction. The application of the Emoji Pair Questionnaire could give additional understanding on why sugar reduction of the products did not impact their hedonic reaction and following, demonstrate which of the sugar-reduced products are most preferred by children.

In this study, different clusters of children varying in their emoji-emotional patterns were discovered. The food industry can use this information not only to understand children's food behavior but also to develop novel products targeted at specific clusters of children considering their individual differences in emotions, personality traits and sensory responsiveness by providing products tailored to their needs. For instance, one of the clusters (C1) was found to express high liking and positive emotions for the two sweetest samples in contrast to cluster (C2), where emotions indicated a clear preference for the sweetest sample. This could be of very important information for the food industry to know that not all children prefer the same level of sweetness to elicit positive emotions. The industry could offer more sugar-reduced options targeted at specific groups of children. Furthermore, this PhD work found that both positive and negative "surprise" constitute an interesting aspect in children's food choice. The food industry could develop products that specifically induce positive "surprise" in children e.g., by adding an unexpected but pleasant taste/odor/flavor, design interesting product packaging eliciting "surprise", or by using popular toys for product marketing.

When attaining emotional profiles of food products by consumers, it is possible to have a more adequate and efficient marketing based upon these profiles. These profiles are not only of great importance for the food industry, but also policy makers can take advantage especially when e.g., promoting healthy and nutritionally balance food products to parents and children.

8.2.3 Future perspectives

In this PhD thesis a novel tool, the Emoji Pair Questionnaire, has been developed, validated, and applied to obtain a better and broad understanding on how children experience food products. Moreover, the current findings contribute to the understanding of the role of individual differences in children's food preferences. However, the choice of research design and methodology impose some limitations, which however encourage directions for future research.

One limitation is related to the **recruitment of children** that participated in the studies. The development of the Emoji Pair Questionnaire was mainly based on school children attending schools from the Florence area (both urban and rural areas) in Italy. Even though a big number of children (n=454) participated in the studies related to the selection of emoji and exploration of their meaning related to food, the current findings may be limited to Italy. Yet, Study 3 (CATA emoji described by emotion words) was replicated with Norwegian children and results showed good agreement in how children describe emoji with words. For future research it would still be interesting to further expand the research on the meaning of emoji in other countries/cultures and across different languages. It may be expected that children of this age group use emoji with overlapping meaning, however, this needs to be confirmed in future studies. Furthermore, it would be interesting to explore the semantic and dimensional meaning of food-related emoji with different age groups, e.g., by comparing younger/older children with preadolescents or by comparing adults with preadolescents. The findings would give critical understanding about the interpretation of emoji and following offer a wide application of the Emoji Pair Questionnaire across different age groups.

Moreover, the Emoji Pair Questionnaire was **validated** with a **selection of familiar foods presented as names and tasted foods models**. One advantage is that food names are easy-to-use in such questionnaires as they do not require any preparation or other logistics. In this research, food names from three food categories (vegetables, fruits, and desserts/juices) and

two different food models (grapefruit juice and vegetable broth) were used, which gave some insightful information about children's emotional responses. In order to know if the results can be replicated, more research is needed with other food categories and food differing in sensory properties beyond basic tastes (e.g., considering the influence of texture, appearance, smell). In addition, future research should also go broader than single food products but work even with whole meals if possible. Results obtained from such measurements could then be compared with actual food consumption.

In addition, the **context** in which the studies were conducted play an important role. As elaborated by Piqueras-Fiszman & Jaeger (2014b), the consumption context influences one's mood and mindset and results in an array of emotions and feelings that affect food choices and modulate the enjoyment of the consumption experience and one's satisfaction. In this PhD work, the data were collected in schools during school teaching, and this could influence how children responded when evaluating emotions in response to food. Consequently, it would be of crucial to investigate children's emotional responses to foods in a real context (e.g., at the school canteen, home, restaurant, friend's place, supermarkets, recreational facilities).

A further suggestion for future research is the **comparison** of the newly developed Emoji Pair Questionnaire **with other existing explicit tools** (e.g., CATA questionnaires using emoji by Gallo et al. (2017b) and Schouteten et al. (2019), the K-state emoji scale by Deubler, Swaney-Stueve, Jepsen, & Su-Fern, 2020, or word-based questionnaires e.g., Pelsmaeker et al. (2013)) to test if the Emoji Pair Questionnaire outperforms these tools in terms of discriminative ability, efficiency, and user-friendliness when used with preadolescents.

Another point is that the Emoji Pair Questionnaire is a self-report questionnaire and following, exclusively **explicit emotions** are captured. This means that the participants are conscious about and aware of the questions asked. However, emotions in a real-life consumption situation also occur below the level of consciousness and therefore additional measurements such as **implicit measurements** are needed to capture a more complete spectrum of emotions. They can be used with subjects without them being explicitly aware of the relation between the measurement and the food eaten, and without having the explicit power over his/her reaction (Köster & Mojet, 2015). For example, it would be worthwhile to assess

emotional responses to foods with **physiological measures** of the autonomic nervous system (ANS) (Kreibig, 2010), brain imaging techniques such as functional MRI neuroscience (Grabenhorst, Rolls, & Bilderbeck, 2008) or other implicit methods such as the Implicit Association Test (IAT) (DeJesus, Gelman, & Lumeng, 2020). The inclusion of physiological measurements and implicit tests could help to give additional information that cannot be captured by explicit measurements solely (such as self-report questionnaires). Instead, they complement explicit measurement methods to obtain a broader understanding of one's food choices. Previous research showed that when measuring ANS, responses of heart rate and skin conductance differ across various food odors or sensory attributes like taste and sight (de Wijk, Kooijman, Verhoeven, Holthuysen, & de Graaf, 2012; He et al., 2014; Kreibig, 2010). In this PhD work, it was shown that food names and tasted food models elicited emotions of different degree of e.g., arousal and it would be worthwhile to assess arousal with implicit measurements (e.g., high/low heartbeat, blood pressure etc.) and how implicitly assessed arousal responses to foods are linked with actual food choice behavior in preadolescents. Also, the Emoji Pair Questionnaire is a one-point measure in time. Yet, actual consumption of food is more than just a single bite or sip and therefore more **dynamic measurements** that capture changes over time like the Temporal Dominance of Emotions (TDE) are required to provide a fuller emotional profile of a consumption episode (Jager et al., 2014).

Finally, given the global challenges such as the increase of overweight in children (WHO, 2021), it is without any doubt of great significance to understand the drivers of children's food preferences and choice as they shape their eating behaviors, which can track into adulthood (De Cosmi et al., 2017; Harris, 2008; Ventura & Worobey, 2013). To gain deeper insights into the underlying factors of food choice and preferences, there is certainly a need for **multidisciplinary approaches** by combining different fields including nutrition, psychology, food sciences, and marketing.

Bringing everything together, this doctoral thesis has introduced a promising method, the Emoji Pair Questionnaire, to obtain a better and more global understanding in how preadolescents experience food by using emotions and exploring the role of individual differences in food preferences.

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Appendix

Table S 1 Emoji Usage Questionnaire (EUQ) of Study 1 (selection of food-related emoji). Total frequencies (%) and frequencies divided by genders (girls and boys) and school level (elementary: 9-11-y.o. and secondary: 12-13-y.o.) of Familiarity, Frequency of usage, Social use, Motivation, Valence of emojis, and Enjoyment in using emojis. Depending on data analysis p-values refer to Kruskal Wallis (*) or Chi-square test. In bold p-values <0.05.

	Question	Domain	Scale Categories/Items	Frequency (%)						
					Gender			School level		
				Total (n=96)	Girls (n=109)	Boys (n=92)	p-value	elementary (n=55)	secondary (n=41)	*p*-value
1	Did you know what emoji were before participating in this study?	Familiarity	I use them regularly	68	63	71	0.437*	56	83	**0.006***
			I use them occasionally	26	29	24		35	15	
			I had used them but only once	2	3	2		4	0	
			I had heard of them but had never used them	4	5	3		5	2	
			I never heard of them	0	0	0		0	0	
2	How often do you usually use emoji?	Frequency of usage	every day	24	29	20	0.714*	20	29	**0.007***
			a few times a week	42	27	53		33	54	
			a couple of times a month or less	20	29	13		25	12	
			never	14	15	14		22	5	
3	To whom do you send emoji?	Social use	friends	75	71	78	0.404	58	98	**<0.0001**
			siblings	32	27	36	0.323	27	39	0.223
			parents	55	59	53	0.571	45	68	**0.026**
			relatives	57	59	56	0.831	56	59	0.831
			teachers	7	10	5	0.423	2	15	**0.017**
			other	18	22	15	0.347	16	20	0.689
4	Why do you use emoji?	Motivation	they are fun	70	61	76	0.104	75	63	0.240
			I can use emoji instead of words	42	46	38	0.422	47	34	0.197
			they make my text messages more understandable	45	44	45	0.880	38	54	0.131
			to save time when sending messages	25	27	24	0.721	27	22	0.551
			they highlight a part of the message	23	32	16	0.077	22	24	0.767
			they express something I normally can't describe in words, e.g., how I feel	45	49	42	0.497	38	54	0.131
			they are quick to use	26	29	24	0.534	27	24	0.750
5	Do you use more emoji with positive or negative meaning?	Valence	positive	72	76	69	0.482	69	76	0.482
			negative	4	7	2	0.182	5	2	0.465
			almost the same	17	12	20	0.310	13	22	0.230
			I don't know	7	5	9	0.432	13	0	0.018
6	How much do you like using emoji?	Enjoyment	a lot	65	71		0.255*	71	56	0.164*
			fairly	25	22			20	32	
			so and so	7	5			5	10	
			a bit	2	2			2	2	
			by no means	1	0			2	0	

Table S 2 Emoji Usage Questionnaire (EUQ) of Study 2 (projective mapping). Total frequencies (%) and frequencies divided by genders (girls and boys) and school level (elementary: 9-11-y.o. and secondary: 12-13-y.o.) of Familiarity, Frequency of usage, Social use, Motivation, Valence of emojis, and Enjoyment in using emojis. Depending on data analysis p-values refer to Kruskal Wallis (*) or Chi-square test. In bold p-values <0.05.

	Question	Domain	Scale Categories/Items	Frequency (%)						
					Gender			School level		
				Total (n=162)	Girls (n=87)	Boys (n=75)	p-value	elementary (n=75)	secondary (n=87)	p-value
1	Did you know what emoji were before participating in this study?	Familiarity	I use them regularly	71	68	76	0.271*	60	82	**0.001***
			I use them occasionally	23	27	18		30	17	
			I had used them but only once	2	1	3		4	0	
			I had heard of them but had never used them	1	1	0		1	0	
			I never heard of them	3	3	3		5	1	
2	How often do you usually use emoji?	Frequency of usage	every day	56	57	55	0.963*	32	77	**<0.0001***
			a few times a week	29	24	33		40	18	
			a couple of times a month or less	10	15	5		19	4	
			never	5	4	7		9	1	
3	To whom do you send emoji?	Social use	friends	84	83	85	0.656	68	98	**<0.0001**
			siblings	35	31	39	0.308	28	40	0.103
			parents	54	54	55	0.935	45	62	**0.033**
			relatives	54	55	52	0.686	48	59	0.176
			teachers	2	5	0	0.060	3	2	0.880
			other	22	21	24	0.613	27	18	0.206
4	Why do you use emoji?	Motivation	they are fun	49	45	55	0.212	68	33	**<0.0001**
			I can use emoji instead of words	41	38	44	0.433	39	43	0.618
			they make my text messages more understandable	51	43	61	**0.017**	36	64	**0.000**
			to save time when sending messages	23	14	33	**0.003**	21	24	0.672
			they highlight a part of the message	30	31	28	0.673	24	34	0.145
			they express something I normally can't describe in words, e.g., how I feel	56	56	55	0.833	44	66	**0.006**
			they are quick to use	25	17	33	**0.018**	25	24	0.860
5	Do you use more emoji with positive or negative meaning?	Valence	positive	78	83	72	0.131*	78	78	0.850*
			negative	1	1	1		1	1	
			almost the same	13	8	19		12	14	
			I don't know	8	8	8		9	7	
6	How much do you like using emoji?	Enjoyment	a lot	63	67	60	0.573*	80	50	**0.000***
			fairly	32	26	39		19	44	
			so and so	4	6	1		3	5	
			a bit							
			by no means							

Table S 3 Emoji Usage Questionnaire (EUQ) of Study 3 (emoji described by emotion words) with 11-13-y.o. children. Total frequencies (%) and frequencies divided by genders (girls and boys) of Familiarity, Frequency of usage, Social use, Motivation, Valence of emojis, and Enjoyment in using emojis. Depending on data analysis p-values refer to Kruskal Wallis (*) or Chi-square test; in bold p-values <0.05.

	Question	Domain	Scale Categories/Items	Frequency (%)			
				Gender			
				Total (n=92)	Girls (n=52)	Boys (n=40)	p-value
1	Did you know what emoji were before participating in this study?	Familiarity	I use them regularly	77	65	92	**0.003***
			I use them occasionally	20	31	5	
			I had used them but only once	0	0	0	
			I had heard of them but had never used them	1	0	3	
			I never heard of them	2	4	0	
2	How often do you usually use emoji?	Frequency of usage	every day	66	56	80	**0.009***
			a few times a week	27	32	20	
			a couple of times a month or less	6	10	0	
			never	1	2	0	
3	To whom do you send emoji?	Social use	friends	97	94	100	0.122
			siblings	47	37	60	**0.025**
			parents	59	46	75	**0.005**
			relatives	50	40	63	**0.035**
			teachers	1	0	3	0.252
			other	26	27	25	0.835
4	Why do you use emoji?	Motivation	they are fun	53	60	45	0.164
			I can use emoji instead of words	39	33	48	0.149
			they make my text messages more understandable	62	60	65	0.598
			to save time when sending messages	15	13	18	0.593
			they highlight a part of the message	28	29	28	0.887
			they express something I normally can't describe in words, e.g., how I feel	57	56	58	0.868
			they are quick to use	22	29	13	0.060
5	Do you use more emoji with positive or negative meaning?	Valence	positive	55	62	45	0.131*
			negative	1	2	0	
			almost the same	29	23	38	
			I don't know	15	13	17	
6	How much do you like using emoji?	Enjoyment	a lot	62	56	70	0.123*
			fairly	32	34	28	
			so and so	4	6	2	
			a bit	1	2	0	
			by no means	1	2	0	

Table S 4 Emoji Usage Questionnaire (EUQ) of Study 4 (emotion word described by emoji). Total frequencies (%) and frequencies divided by genders (girls and boys) and school level (elementary: 9-10-y.o. and secondary: 10-13-y.o.) of Familiarity, Frequency of usage, Social use, Motivation, Valence of emojis, and Enjoyment in using emojis. Depending on data analysis p-values refer to Kruskal Wallis (*) or Chi-square test to test differences between gender. In bold p-values <0.05.

	Question	Domain	Scale Categories/Items	Frequency (%)					
					Gender			School level	
				Total (n=85)	Girls (n=46)	Boys (n=39)	p-value	elementary (n=21)	secondary (n=64)
1	Did you know what emoji were before participating in this study?	Familiarity	I use them regularly	66	72	59	0.263	38	75
			I use them occasionally	25	20	31		52	16
			I had used them but only once	4	2	5		5	3
			I had heard of them but had never used them	2	2	3		0	3
			I never heard of them	3	4	2		5	3
2	How often do you usually use emoji?	Frequency of usage	every day	68	69	67	0.804	43	77
			a few times a week	24	22	26		38	19
			a couple of times a month or less	7	9	5		19	3
			never	1	0	2		0	1
3	To whom do you send emoji?	Social use	friends	84	85	82	0.735	62	91
			siblings	40	41	38	0.790	33	42
			parents	64	67	59	0.422	62	64
			relatives	67	70	64	0.593	57	70
			teachers	4	2	5	0.462	0	5
			other	22	15	31	0.086	19	23
4	Why do you use emoji?	Motivation	they are fun	59	48	72	**0.025**	71	55
			I can use emoji instead of words	44	43	44	0.992	33	47
			they make my text messages more understandable	45	57	31	**0.017**	19	53
			to save time when sending messages	22	20	26	0.503	24	22
			they highlight a part of the message	35	39	31	0.422	19	41
			they express something I normally can't describe in words, e.g., how I feel	53	65	38	**0.014**	43	56
			they are quick to use	33	30	36	0.593	24	36
			other	8	11	5	0.337	0	11
5	Do you use more emoji with positive or negative meaning?	Valence	positive	65	70	59	0.311	67	64
			negative	1	2	0		0	2
			almost the same	25	19	31		24	25
			I don't know	9	9	10		9	9
6	How much do you like using emoji?	Enjoyment	a lot	67	74	59	0.140	76	64
			fairly	27	22	33		19	30
			so and so	4	4	3		5	3
			a bit	1	0	3		0	2
			by no means	1	0	2		0	1

Table S 5 Emoji Usage Questionnaire (EUQ) of Studies 1-4 (n=435 children): Familiarity; Frequency of usage; Social use; Motivation; Valence of emoji; Enjoyment in using emoji. Total frequencies (%) and frequencies divided by genders (girls and boys) and age considering school level (primary: 9-10-y.o. and secondary: 10-13-y.o.). Depending on data analysis p-values refer to Kruskal Wallis (*) or Chi-square test. In bold p-values <0.05.

	Question	Domain	Scale Categories/Items	Frequency (%)						
					Gender			School level		
				Total (n=435)	Girls (n=226)	Boys (n=209)	p-value	elementary (n=151)	secondary (n=284)	p-value
1	Did you know what emoji were before participating in this study?	Familiarity	I use them regularly	71	67	75	0.104*	56	79	**<0.0001***
			I use them occasionally	23	27	20		34	17	
			I had used them but only once	2	1	2		4	1	
			I had heard of them but had never used them	2	2	2		3	1	
			I never heard of them	2	3	1		3	2	
2	How often do you usually use emoji?	Frequency of usage	every day	54	55	53	0.872*	29	67	**<0.0001***
			a few times a week	30	26	34		37	26	
			a couple of times a month or less	11	15	6		21	5	
			never	5	4	7		13	2	
3	To whom do you send emoji?	Social use	friends	85	84	86	0.560	64	96	**<0.0001**
			siblings	38	34	42	0.068	28	43	**0.004**
			parents	57	56	59	0.514	48	62	**0.003**
			relatives	56	55	57	0.658	52	58	0.220
			teachers	3	4	3	0.526	2	4	0.223
			other	22	21	23	0.664	22	22	0.937
4	Why do you use emoji?	Motivation	they are fun	57	52	62	**0.036**	71	49	**<0.0001**
			I can use emoji instead of words	41	39	43	0.436	41	41	0.978
			they make my text messages more understandable	51	50	52	0.589	34	60	**<0,0001**
			to save time when sending messages	22	17	26	**0.022**	24	20	0.410
			they highlight a part of the message	29	32	25	0.111	23	32	**0.021**
			they express something I normally can't describe in words, e.g., how I feel	53	57	49	0.102	42	59	**0.001**
			they are quick to use	26	25	27	0.553	26	26	0.959
			Other [4]	10	11	8	0.415	0	11	0.112
5		Valence	positive	69	74	64	**0.023***	73	67	0.261*
			negative	2	3	1		3	1	

[4] The response option „other“ in the Motivation domain was not asked in Study 1 and Study 2. Following the number of children was: total (n=177), girls (n=98), boys (n=79), elementary (n=21) and secondary (n=156) school level.

	Do you use more emoji with positive or negative meaning?		almost the same	19	14	26		14	23	
			I don't know	10	9	11		11	9	
6	How much do you like using emoji?	Enjoyment	a lot	64	66	62	0.403*	75	58	**0.001***
			fairly	29	27	32		19	35	
			so and so	5	5	4		4	5	
			a bit	1	1	1		1	1	
			by no means	1	1	1		1	1	

Table S 6 Cross-cultural comparison of the Emoji Usage Questionnaire (EUQ) comparing Study 6 with Norwegian (n=109) and Study 3 with Italian (n=92) children. Frequencies (%) divided by country (Norway and Italy) and gender for Norwegian children (girls and boys) for Familiarity, Frequency of usage, Social use, Motivation, Valence of emoji, Enjoyment in using emoji. Depending on data analysis p-values refer to Kruskal Wallis (*) or Chi-square test. In bold p-values <0.05.

	Question	Domain	Scale Categories/Items	Frequency (%)					
				Total			Gender (Norwegian children)		
				Norway (n=109)	Italy (n=92)	p-value	Girls (n=51)	Boys (n=58)	p-value
1	Did you know what emoji were before participating in this study?	Familiarity	I use them regularly	49	77	**<0.0001***	65	35	**0.002***
			I use them occasionally	40	20		29	50	
			I had used them but only once	4	0		0	7	
			I had heard of them but had never used them	3	1		2	3	
			I never heard of them	4	2		4	5	
2	How often do you usually use emoji?	Frequency of usage	every day	46	66	**<0.0001***	72	22	**<0.0001***
			a few times a week	37	27		18	54	
			a couple of times a month or less	13	6		8	17	
			never	4	1		2	7	
3	To whom do you send emoji?	Social use	friends	94	97	0.304	98	90	0.075
			siblings	44	47	0.701	61	29	**0.001**
			parents	62	59	0.594	69	57	0.207
			relatives	40	50	0.171	49	33	0.084
			teachers	14	1	**0.001**	25	3	**0.001**
			other	29	26	0.606	31	28	0.665
4	Why do you use emoji?	Motivation	they are fun	39	53	0.050	29	48	**0.044**
			I can use emoji instead of words	34	39	0.446	33	34	0.899
			they make my text messages more understandable	46	62	**0.023**	59	34	**0.011**
			to save time when sending messages	20	15	0.360	18	22	0.536
			they highlight a part of the message	13	28	**0.006**	20	7	**0.048**
			they express something I normally can't describe in words, e.g., how I feel	31	57	**0.000**	45	19	**0.003**
			they are quick to use	20	22	0.787	24	17	0.414
			other	12	11	0.815	12	12	0.961
5	Do you use more emoji with positive or negative meaning?	Valence	positive	70	55	**0.018***	63	77	0.161*
			negative	2	1		2	1	
			almost the same	19	29		27	11	
			I don't know	9	15		8	11	
6	How much do you like using emoji?	Enjoyment	a lot	32	62	**<0.0001***	49	18	**<0.0001***
			fairly	43	32		37	47	
			so and so	22	4		14	30	
			a bit	1	1		0	2	
			by no means	2	1		0	3	

Table S 7 Study 3: Frequency of use (%) for each of the 46 emoji by each of the 30 CATA terms. In the last row additional words provided by children are reported. Frequencies 40-59% are marked in light blue, 60-79% in blue and 80-100% in dark blue. Different letters (in brackets) indicate a significant difference according to Sheskin post-hoc test ($p<0.05$). Additional words (grouped by their meaning) were mentioned by ≥ 10% of children in the open-ended response option. Emotion words are divided by dimensions of I Pleasant Activation, II Activated Pleasure, III Pleasure, IV Deactivated Pleasure, V Pleasant Deactivation, VI Deactivation, VII Unpleasant Deactivation, VIII Deactivated Displeasure, IX Displeasure, X Activated Displeasure, XI Unpleasant Activation, XII Activation (Sick, Monteleone et al. 2020; Yik, Russell, & Steiger, 2011).

Dimension	Emotion word	😀	😃	😄	😁	😆	🙂	😉	😊	😇	🥰	😍	🤩	😘	☺️	😋	😛	😜	🤪	😝	🤑	🤗	😌	😚
I	energetic	25 cdefg	35 efgh	26 defg	37 fghi	38 fghi	4 abc	11 abcd	8 abcd	11 abcd	7 abcd	14 abcde	**54 hi**	10 abcd	1 a	24 bcdefg	25 cdefg	**41 ghi**	**57 i**	**41 ghi**	39 fghi	15 abcde	7 abcd	5 abcd
II	enthusiastic	33 efghi	**40 ghi**	25 cdefgh	**42 hi**	**40 ghi**	9 abcd	20 abcdefg	21 abcdefg	25 cdefgh	21 abcdefg	34 efghi	**48 i**	20 abcdefg	13 abcde	22 bcdefgh	29 defghi	32 efghi	36 fghi	37 fghi	26 cdefgh	33 efghi	7 abc	16 abcdef
	amused	**41 hijklm**	37 ghijkl	**45 ijklm**	**60 m**	**47 jklm**	20 abcdefgh	32 efghijkl	20 abcdefgh	23 bcdefghi	10 abcde	10 abcde	**42 ijklm**	19 abcdefg	15 abcdefg	24 cdefghi	**53 lm**	**51 klm**	**53 lm**	**52 klm**	28 defghij	33 fghijkl	11 abcdef	8 abcd
	cheerful	**50 efghi**	**55 fghi**	**71 i**	**64 hi**	**64 hi**	35 cdefg	**40 cdefgh**	**52 fghi**	**44 cdefgh**	**42 cdefgh**	32 cdef	**49 defghi**	36 cdefg	26 bcde	**51 efghi**	**42 cdefgh**	**59 ghi**	**58 ghi**	**57 fghi**	**42 cdefgh**	**48 defghi**	21 abc	24 abcd
III	happy	**66 efg**	**78 g**	**75 fg**	**70 efg**	**66 efg**	**61 efg**	**49 cdef**	**64 efg**	**55 cdefg**	**61 efg**	**59 defg**	**64 efg**	**46 cde**	**46 cde**	**59 defg**	**58 defg**	**59 defg**	**60 defg**	**63 efg**	**51 cdefg**	**54 cdefg**	33 cd	29 bc
	satisfied	22 cdef	24 defg	19 abcdef	27 defgh	14 abcde	22 cdef	27 defgh	24 defg	36 fgh	20 abcdef	16 abcdef	36 fgh	15 abcde	21 bcdef	27 defgh	15 abcde	21 bcdef	9 abcd	19 abcdef	**46 h**	26 defgh	29 efgh	26 defgh
	cuddled	10 ab	9 ab	7 ab	9 ab	3ab	4 ab	4 ab	27 def	13 abcd	**58 g**	33 ef	7 ab	35 f	39 f	8 ab	1 a	1 a	2 a	7 ab	2 a	26 cdef	19 bcde	14 abcd
	gratified	17 cdef	20 def	17 cdef	20 def	7 abcd	11 abcde	10 abcde	24 ef	30 f	15 abcdef	12 abcde	30 f	16 bcdef	17 cdef	10 abcde	1 ab	7 abcd	5 abcd	7 abcd	20 def	20 def	15 abcdef	13 abcde
IV	confident	32 fghi	27 efgh	28 efgh	34 ghi	19 abcdefg	17 abcdefg	**40 hi**	24 defgh	32 fghi	20 bcdefg	14 abcdef	20 bcdefg	21 cdefg	26 efgh	11 abcde	16 abcdefg	32 fghi	16 abcdefg	20 bcdefg	20 bcdefg	20 bcdefg	35 ghi	5 abcd
	at ease	26 cde	35 cde	34 cde	23 bcde	17 abcd	35 cde	35 cde	37 de	37 de	33 cde	15 abc	24 bcde	34 cde	34 cde	25 cde	23 bcde	29 cde	25 cde	24 bcde	20 abcd	35 cde	36 cde	20 abcd
	reassured	13 abcdefgh	16 bcdefgh	23 fgh	21 efgh	4 abcd	9 abcdef	16 bcdefgh	28 h	16 bcdefgh	20 defgh	7 abcde	10 abcdef	16 bcdefgh	26 gh	12 abcdefg	7 abcde	9 abcdef	5 abcde	8 abcdef	14 abcdefgh	19 cdefgh	23 fgh	5 abcde
V	relaxed	24 defghijk	23 cdefghijk	28 fghijk	23 cdefghijk	7 abcd	29 ghijk	21 bcdefghijk	19 abcdefghij	39 k	30 hijk	11 abcdefg	8 abcde	21 bcdefghijk	32 ijk	13 abcdefghi	9 abcde	10 abcdef	7 abcd	12 abcdefgh	16 abcdefghij	26 efghijk	39 k	39 jk
	calm	30 efgh	29 efgh	27 defgh	26 cdefg	11 abcde	39 fgh	29 efgh	**44 gh**	**47 h**	38 fgh	12 abcde	4 ab	29 efgh	**40 fgh**	15 abcde	16 abcde	12 abcde	5 ab	8 abcd	5 ab	30 efgh	**44 gh**	22 bcdef
	serene	**54 hij**	**44 efghij**	**55 ij**	**45 efghij**	32 defgh	**49 efghij**	36 defghi	**47 efghij**	**60 j**	**44 efghij**	33 defghi	26 bcde	38 defghij	39 defghij	33 defghi	36 defghi	38 defghi	19 abcd	29 defg	32 defgh	50 fghij	**52 ghij**	27 cdef
	carefree	16 abcdefg	15 abcdefg	19 abcdefg	17 abcdefg	19 abcdefg	17 abcdefg	20 bcdefg	14 abcdefg	26 fg	27 fg	16 abcdefg	15 abcdefg	12 abcdefg	17 abcdefg	16 abcdefg	14 abcdefg	24 defg	27 fg	19 abcdefg	16 abcdefg	16 abcdefg	22 cdefg	30 g
VI	indifferent	7 ab	3 a	4 a	1 a	7 ab	19 b	1 a	2 a	2 a	3 a	0 a	0 a	5 ab	3 a	3 a	4 a	1 a	3 a	3 a	4 a	4 a	8 ab	3 a
	quiet	27 efghij	21 bcdefghij	23 cdefghij	29fghij	11 abcdef	35 ijk	22 cdefghij	32 ghijk	**50 k**	26 defghij	15 abcdefgh	10 abcde	26 defghij	32 ghijk	16 abcdefghi	15 abcdefgh	21 bcdefghij	10 abcde	13 abcdefg	10 abcde	30 ghij	39 jk	24 defghij
VII	bored	2 ab	0 a	0 a	0 a	1 a	1 a	0 a	0 a	0 a	1 a	0 a	0 a	1 a	1 a	1 a	0 a	0 a	0 a	0 a	0 a	1 a	2 ab	4 ab
VIII	sad	2 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	1 a	0 a	0 a	2 a
	melancholic	2 ab	0 a	1 a	2 ab	0 a	1 a	0 a	0 a	0 a	1 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	2 ab
IX	unhappy	2 ab	0 a	1 ab	0 a	0 a	1 ab	0 a	1 ab	0 a	1 ab	0 a	1 ab	0 a	1 ab	1 ab	1 ab	0 a	0 a	0 a	2 ab	0 a	0 a	0 a
	dissatisfied	1 a	1 a	0 a	1 a	1 a	1 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	1 a	1 a	1 a	0 a	1 a	0 a	0 a	0 a	2 a
	disappointed	1 a	1 a	1 a	1 a	0 a	1 a	0 a	0 a	1 a	2 a	0 a	0 a	0 a	1 a	0 a	0 a	1 a	0 a	0 a	1 a	0 a	1 a	2 a
X	guilty	2 a	0 a	1 a	2 a	0 a	0 a	1 a	1 a	1 a	1 a	1 a	0 a	0 a	1 a	2 a	0 a	0 a	0 a	0 a	1 a	1 a	1 a	0 a
XI	annoyed	1 a	0 a	0 a	1 a	1 a	2 ab	0 a	0 a	0 a	1 a	0 a	0 a	0 a	1 a	1 a	1 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a
	disgusted	3 ab	0 a	0 a	0 a	0 a	0 a	0 a	1 ab	0 a	1 ab	0 a	0 a	0 a	1 ab	1 ab	0 a	0 a	0 a	3 ab	0 a	0 a	0 a	1 ab
	angry	3 ab	0 a	1 a	1 a	1 a	1 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
	worried	3 abc	0 a	0 a	1 ab	1 ab	3 abc	0 a	0 a	0 a	2 ab	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 ab	0 a	0 a
XII	surprised	28 defghi	32 efghi	21 bcdefgh	19abcdef	15 abcde	4 abc	9 abcd	10 abcd	8 abc	13 abcde	15 abcde	37 fghi	8 abc	4 abc	15 abcde	11 abcd	11 abcd	23 cdefghi	20 abcdefg	15 abcde	17 abcdef	3 abc	13 abcde
	curious	8 ab	8 ab	4 ab	5 ab	5 ab	3 ab	4 ab	5 ab	5 ab	4 ab	4 ab	5 ab	1 a	3 ab	7 ab	7 ab	5 ab	7 ab	3 ab	3 ab	5 ab	2 ab	14 b
	Additional words	-	-	-	-	-	-	-	-	I am good / I feel like an angel (11%)	in love (35%)	in love (63%)	-	in love (17%)	-	gluttonous (14%), hungry (10%)	-	-	crazy (23%)	-	rich (26%)	-	-	-

Table S 7. Continued (Study 3)

Dimension	Emotion word	🥰	😎	😐	🤢	🤮	🥵	😵	🤯	☹️	😮	😨	😰	😢	😭	😱	😖	😣	😫	😤	😡	😠	🤬	😈
I	energetic	**52 hi**	26 defg	0 a	0 a	0 a	4 ab	1 a	10 abcd	0 a	2 a	1 a	0 a	0 a	0 a	2 a	1 a	0 a	0 a	4 abc	14 abcde	9 abcd	19 abcdef	10 abcd
II	enthusiastic	**49 i**	20 abcdefg	0 a	0 a	1 ab	1 ab	3 ab	7 abc	0 a	5 abc	0 a	1 ab	0 a	0 a	3 ab	0 a	2 ab	0 a	1 ab	0 a	0 a	0 a	0 a
	amused	**49 jklm**	30 efghijk	0 a	0 a	0 a	0 a	0 a	1 ab	0 a	3 abc	0 a	0 a	0 a	1 ab	0 a	0 a	0 a	0 a	1 ab	0 a	0 a	1 ab	0 a
	cheerful	**70 i**	35 cdefg	0 a	0 a	0 a	0 a	0 a	1 ab	0 a	1 ab	0 a	0 a	0 a	1 ab	2 ab	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
III	happy	**70 efg**	**49 cdef**	0 a	0 a	0 a	0 a	1 a	0 a	0 a	3 ab	0 a	0 a	0 a	2 ab	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
	satisfied	26 defgh	**44 gh**	0 a	1 ab	0 a	0 a	1 ab	1 ab	1 ab	3 abc	0 a	0 a	1 ab	0 a	1 ab	1 ab	1 ab	0 a	0 a	0 a	0 a	0 a	1 ab
	cuddled	11 abc	3 ab	0 a	1 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
	gratified	16 bcdef	12 abcde	3 abc	0 a	0 a	2 abc	1 ab	0 a	0 a	1 ab	1 ab	0 a	0 a	2 abc	0 a	0 a	0 a	1 ab	0 a	0 a	1 ab	1 ab	0 a
IV	confident	17 abcdefg	50 i	2 abc	0 a	1 ab	1 ab	0 a	0 a	0 a	3 abc	1 ab	0 a	0 a	0 a	0 a	0 a	0 a	0 a	3 abc	3 abc	3 abc	2 abc	1 ab
	at ease	26 cde	**44 e**	1 a	0 a	0 a	1 a	1 a	0 a	0 a	3 ab	0 a	0 a	0 a	1 a	0 a	0 a	1 a	0 a	1 a	1 a	1 a	0 a	1 a
	reassured	10 abcdef	11 abcdefg	3 abc	0 a	0 a	0 a	0 a	1 ab	1 ab	3 abc	1 ab	1 ab	2 ab	0 a	0 a	0 a	0 a	1 ab	1 ab	0 a	0 a	0 a	1 ab
V	relaxed	13 abcdefghi	34 jk	5 abcd	0 a	0 a	2 ab	0 a	1 a	2 ab	4 abc	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
	calm	7 abc	27 defgh	15 abcde	0 a	1 a	4 ab	1 a	0 a	3 ab	8 abcd	0 a	0 a	2 ab	0 a	1 a	0 a	1 a	1 a	2 ab	0 a	0 a	0 a	0 a
	serene	38 defghij	38 defghij	3 ab	0 a	0 a	0 a	0 a	0 a	2 a	4 abc	0 a	0 a	0 a	1 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
	carefree	25 efg	24 defg	12 abcdefg	2 ab	0 a	2 ab	2 ab	7 abcde	5 abcd	4 abc	9 abcdef	9 abcdef	2 ab	4 abc	3 abc	3 abc	2 ab	7 abcde	2 ab	0 a	1 ab	2 ab	0 a
VI	indifferent	0 a	10 ab	**58 c**	1 a	2 a	8 ab	4 a	4 a	9 ab	7 ab	7 ab	2 a	3 a	3 a	3 a	5 ab	10 ab	7 ab	8 ab	3 a	4 a	4 a	7 ab
	quiet	17 abcdefghi	33 hijk	8 abcd	0 a	0 a	1 a	0 a	0 a	2 ab	4 abc	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a
VII	bored	0 a	0 a	13 bc	3 ab	3 ab	8 abc	13 bc	4 ab	16 c	2 ab	5 abc	2 ab	10 abc	3 ab	2 ab	11 abc	8 abc	16 c	10 abc	5 abc	7 abc	4 ab	7 abc
VIII	sad	0 a	0 a	8 a	7 a	8 a	12 a	10 a	5 a	**69 cd**	2 a	15 a	37 b	**75 d**	**86 d**	16 a	**44 b**	**52 bc**	**48 b**	5 a	9 a	7 a	7 a	10 a
	melancholic	0 a	0 a	11 abcd	13 abcdef	5 abc	10 abcd	10 abcd	4 abc	21 cdefgh	3 ab	23 defghi	28 efghij	38 ij	34 hij	19 bcdefgh	30 ghij	29 fghij	**40 j**	12 abcde	15 abcdefg	21 cdefgh	12 abcde	23 defghi
IX	unhappy	0 a	0 a	15 abcd	16 abcd	13 abc	15 abcd	14 abc	14 abc	**54 ghij**	3 ab	21 bcde	37 efgh	**61 ij**	**66 j**	13 abc	**46 fghi**	**49 ghij**	**55 hij**	19 abcde	35 defg	37 efgh	24 cde	28 cdef
	dissatisfied	1 a	1 a	16 abcde	14 abcd	12 ab	19 abcde	13 abc	13 abc	**46 f**	3 a	26 bcde	28 bcdef	25 bcde	25 bcde	12 ab	34 ef	33 def	35 ef	29 bcdef	33 def	30 bcdef	35 ef	32 cdef
	disappointed	0 a	0 a	17 abcde	7 ab	8 ab	10 abc	13 abcd	10 abc	**51 h**	9 ab	24 bcdef	34 efgh	**47 gh**	39 fgh	10 abc	36 efgh	**46 gh**	**40 fgh**	29 defg	33 efgh	25 bcdef	28 cdefg	30 defg
X	guilty	0 a	0 a	9 ab	5 a	2 a	10 abc	13 abc	7 a	25 cde	7 a	23 bcd	35 def	32 def	35 def	15 abc	33 def	**47 f**	**40 ef**	3 a	3 a	3 a	2 a	13 abc
XI	annoyed	0 a	0 a	11 abcd	24 cdef	22 cdef	24 cdef	15 abcd	24 cdef	11 abcd	5 abc	13 abcd	15 abcd	9 abcd	8 abcd	8 abcd	**40 fg**	26 def	21 bcde	**50 g**	38 efg	**47 g**	**53 g**	37 efg
	disgusted	0 a	0 a	7 ab	**87 d**	**84 d**	7 ab	9 ab	7 ab	3 ab	2 ab	4 ab	7 ab	4 ab	3 ab	4 ab	**44 c**	12 ab	15 ab	17 b	11 ab	11 ab	16 ab	14 ab
	angry	0 a	0 a	1 a	0 a	5 ab	3 ab	7 ab	10 ab	2 ab	1 a	1 a	0 a	0 a	2 ab	2 ab	21 b	7 ab	5 ab	**74 c**	**95 d**	**84 cd**	**91 cd**	**86 cd**
	worried	0 a	1 ab	16 abcde	14 abcd	9 abc	32 defgh	**40 ghij**	32 defgh	19 abcdef	33 defgh	**57 j**	**53 ij**	22 cdefg	20 bcdef	**48 hij**	32 defgh	35 efghi	37 fghi	5 abc	5 abc	7 abc	5 abc	8 abc
XII	surprised	23 cdefghi	7 abc	5 abc	1 ab	2 ab	4 abc	**40 hij**	39 ghij	0 a	**73 k**	**42 ij**	8 abc	2 ab	0 a	**58 jk**	2 ab	4 abc	7 abc	2 ab	1 ab	2 ab	3 abc	1 ab
	curious	1 a	5 ab	4 ab	1 a	2 ab	0 a	7 ab	3 ab	1 a	35 c	3 ab	5 ab	5 ab	1 a	7 ab	0 a	1 a	9 ab	0 a	0 a	1 a	2 ab	2 ab
	Additional word	festive (22%)	feeling cool (11%)	-	urge to vomit/ nauseated (12%)	feeling sick (12%)	tired (27%), feeling hot (20%)	dead/deceased (26%)	-	-	-	-	-	-	-	scared/ frightened (22%)	-	-	-	-	-	-	-	-

Table S 8 Study 4 CATA with emotion words: Frequency of use % for each of the 30 emotion words by each of the 46 CATA items. Frequencies 40-59% are marked in light blue, 60-79% in blue and 80-100% in dark blue. Different letters in brackets indicate a significant difference according to Sheskin post-hoc test $p<0.05$. Emotion words are divided by dimensions of I Pleasant Activation, II Activated Pleasure, III Pleasure, IV Deactivated Pleasure, V Pleasant Deactivation, VI Deactivation, VII Unpleasant Deactivation, VIII Deactivated Displeasure, IX Displeasure, X Activated Displeasure, XI Unpleasant Activation, XII Activation Sick, Monteleone et al. 2020; Yik, Russell, & Steiger, 2011.

	I	II			III				IV			V				VI		VII	VIII		IX			X	XI				XII	
	energetic	enthusiastic	amused	cheerful	happy	satisfied	cuddled	gratified	confident	at ease	reassured	relaxed	calm	serene	carefree	indifferent	quiet	bored	sad	melancholic	unhappy	dissatisfied	disappointed	guilty	annoyed	disgusted	angry	worried	surprised	curious
	13 abcd	31 de	27 cd	**47 ef**	**58 f**	22 bcd	6 ab	17 abcd	9 abc	15 abcd	17 abcd	5 ab	12 abc	22 bcd	12 abc	0 a	15 abcd	0 a	0 a	2 a	1 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	8 ab	4 a
	17 abcde	28 def	32 ef	**41 f**	**61 g**	25 cdef	6 ab	14 abcde	9 abc	18 abcde	14 abcde	8 abc	11 abcd	21 bcde	12 abcd	0 a	7 abc	0 a	0 a	1 a	1 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	9 abc	8 abc
	22 cdef	32 def	39 fg	37 ef	**57 g**	31 def	6 abc	15 abcd	14 abcd	18 abcd	19 bcde	5 abc	7 abc	18 abcd	12 abc	1 ab	8 abc	0 a	0 a	1 ab	1 ab	1 ab	1 ab	0 a	0 a	0 a	0 a	0 a	9 abc	2 ab
	21 cdef	37 fg	35 efg	**46 g**	**65 h**	24 def	6 abcd	18 abcde	14 abcd	15 abcd	17 abcd	4 abc	8 abcd	20 bcdef	12 abcd	0 a	9 abcd	0 a	1 a	0 a	1 a	1 a	0 a	0 a	0 a	0 a	1 a	0 a	6 abcd	2 ab
	19 bc	21 cd	35 de	37 de	**44 e**	15 abc	5 ab	11 abc	8 abc	7 abc	8 abc	0 a	4 ab	13 abc	11 abc	0 a	6 abc	0 a	0 a	2 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	8 abc	2 a
	5 ab	15 abcd	12 abcd	18 abcde	**44 f**	17 abcd	11 abc	17 abcd	20 bcde	31 def	28 cdef	20 bcde	37 ef	31 def	17 abcd	9 abc	**40 f**	5 ab	0 a	1 ab	0 a	0 a	1 ab	0 a	0 a	0 a	0 a	0 a	4 ab	4 ab
	2 abc	9 abcde	14 abcde	17 cde	22 e	13 abcde	4 abcd	12 abcde	22 e	14 abcde	12 abcde	11 abcde	9 abcde	15 bcde	14 abcde	4 abcd	18 de	0 a	0 a	1 ab	0 a	0 a	0 a	0 a	1 ab	0 a	0 a	0 a	6 abcd	4 abcd
	4 ab	13 abc	15 abc	19 bcd	37 d	27 cd	24 cd	26 cd	17 abc	27 cd	27 cd	15 abc	26 cd	37 d	18 abc	0 a	22 cd	0 a	0 a	0 a	1 ab	2 ab	0 a	0 a	0 a	1 ab	0 a	0 a	2 ab	0 a
	5 abc	5 abc	7 abcd	9 abcd	14 bcd	5 abc	6 abcd	9 abcd	6 abcd	4 abc	11 abcd	13 abcd	13 abcd	19 d	11 abcd	0 a	15 cd	1 ab	0 a	0 a	0 a	1 ab	0 a	2 abc	0 a	0 a	0 a	0 a	1 ab	0 a
	2 abc	4 abc	5 abc	7 abc	12 abc	5 abc	**71 d**	14 bc	4 abc	15 c	9 abc	1 ab	7 abc	11 abc	5 abc	0 a	8 abc	0 a	0 a	0 a	0 a	0 a	0 a	1 ab	0 a	0 a	0 a	0 a	2 abc	0 a
	4 a	7 ab	6 ab	11 ab	15 b	4 a	31 c	11 ab	1 a	6 ab	5 ab	0 a	2 a	4 a	8 ab	0 a	4 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	8 ab	0 a
	39 e	35 de	32 de	27 cde	29 de	11 abc	7 ab	21 bcd	4 a	12 abc	4 a	5 ab	2 a	5 ab	12 abc	2 a	2 a	0 a	0 a	1 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	21 bcd	2 a
	4 ab	1 a	5 ab	7 ab	12 b	2 ab	31 c	7 ab	2 ab	7 ab	6 ab	1 a	2 ab	2 ab	5 ab	0 a	4 ab	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a
	4 abc	6 abcd	11 abcde	17 abcdef	20 bcdef	18 abcdef	26 ef	17 abcdef	17 abcdef	21 cdef	22 def	33 f	32 f	33 f	17 abcdef	5 abcd	25 ef	0 a	0 a	2 ab	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	2 ab	0 a
	8 a	8 a	24 cd	22 bcd	27 d	13 abc	9 ab	8 a	7 a	9 ab	11 abc	2 a	7 a	8 a	6 a	0 a	6 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	5 a	6 a
	9 ab	11 abc	21 bcd	27 d	24 cd	8 ab	7 a	2 a	5 a	8 ab	5 a	5 a	2 a	9 ab	8 ab	1 a	5 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	2 a	1 a
	20 cde	19 bcde	27 e	29 e	26 de	9 abc	6 abc	4 a	6 abc	7 abc	7 abc	1 a	2 a	6 abc	12 abcd	0 a	8 abc	0 a	0 a	1 a	0 a	1 a	0 a	0 a	1 a	0 a	0 a	0 a	4 a	5 ab
	32 cd	24 bc	**40 d**	29 cd	24 bc	4 a	5 a	5 a	2 a	5 a	4 a	0 a	4 a	6 a	11 ab	2 a	5 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	2 a	0 a	0 a	0 a	7 a	5 a
	21 bc	21 bc	25 c	25 c	24 c	8 ab	7 a	6 a	2 a	4 a	5 a	0 a	2 a	8 ab	7 a	1 a	5 a	0 a	0 a	1 a	0 a	0 a	0 a	1 a	0 a	2 a	0 a	1 a	2 a	2 a
	12 b	9 ab	8 ab	8 ab	9 ab	4 ab	4 ab	8 ab	4 ab	4 ab	2 ab	0 a	2 ab	1 a	2 ab	1 a	0 a	0 a	0 a	1 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	1 a	2 ab	1 a
	9 abcd	14 abcd	14 abcd	18 cd	25 d	20 cd	25 d	19 cd	14 abcd	19 cd	20 cd	8 abc	12 abcd	17 bcd	11 abcd	1 ab	11 abcd	0 a	0 a	0 a	1 ab	1 ab	0 a	0 a	0 a	0 a	0 a	0 a	9 abcd	6 abc
	5 abc	8 abcde	9 abcde	15 abcde	14 abcde	20 bcdef	8 abcde	21 cdefg	26 efg	25 defg	25 defg	39 fg	39 fg	37 fg	20 bcdef	8 abcde	**40 g**	1 ab	0 a	0 a	0 a	1 ab	1 ab	1 ab	0 a	0 a	0 a	0 a	2 abc	6 abcd
	1 ab	4 abc	5 abc	1 ab	6 abc	5 abc	13 bc	4 abc	0 a	8 abc	1 ab	27 d	12 abc	8 abc	15 cd	5 abc	9 abc	5 abc	0 a	1 ab	0 a	1 ab	0 a	0 a	0 a	0 a	0 a	0 a	2 ab	4 abc

Table S 8. Continued (Study 4)

	I	II			III				IV			V				VI		VII	VIII		IX			X	XI				XII	
	energetic	enthusiastic	amused	cheerful	happy	satisfied	cuddled	gratified	confident	at ease	reassured	relaxed	calm	serene	carefree	indifferent	quiet	bored	sad	melancholic	unhappy	dissatisfied	disappointed	guilty	annoyed	disgusted	angry	worried	surprised	curious
🥳	29 cd	29 cd	39 d	28 cd	22 bc	11 ab	4 a	12 ab	5 a	2 a	2 a	2 a	2 a	5 a	9 ab	0 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	4 a	1 a
😎	25 de	5 abc	15 bcde	17 cde	17 cde	13 abcde	6 abc	7 abc	27 e	13 abcde	12 abcd	17 cde	8 abc	13 abcde	12 abcd	5 abc	12 abcd	0 a	0 a	2 abc	0 a	1 ab	0 a	0 a	0 a	0 a	1 ab	1 ab	0 a	4 abc
😐	1 ab	0 a	1 ab	1 ab	1 ab	0 a	2 ab	2 ab	5 ab	1 ab	4 ab	1 ab	9 abc	4 ab	2 ab	**59 d**	8 abc	**47 d**	4 ab	7 abc	4 ab	21 c	8 abc	17 bc	12 abc	5 ab	4 ab	12 abc	2 ab	8 abc
🤢	0 a	0 a	1 a	0 a	1 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	5 a	1 a	2 a	2 a	5 a	1 a	4 a	4 a	**79 b**	1 a	0 a	1 a	0 a
🤮	1 a	0 a	2 a	0 a	1 a	0 a	2 a	0 a	2 a	2 a	0 a	0 a	1 a	0 a	0 a	1 a	0 a	4 a	0 a	1 a	1 a	4 a	0 a	1 a	4 a	**75 b**	2 a	0 a	0 a	0 a
🥵	0 a	1 a	4 ab	0 a	1 a	0 a	2 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	2 a	1 a	1 a	2 a	6 ab	4 ab	5 ab	7 ab	7 ab	5 ab	7 ab	13 b	8 ab	6 ab	0 a	0 a
😵	1 a	4 ab	1 a	1 a	1 a	0 a	1 a	2 ab	0 a	0 a	1 a	0 a	0 a	0 a	2 ab	1 a	0 a	9 ab	1 a	1 a	5 ab	6 ab	2 ab	6 ab	5 ab	4 ab	0 a	6 ab	12 b	7 ab
🤯	8 abc	1 ab	4 ab	0 a	2 ab	0 a	2 ab	4 ab	0 a	0 a	2 ab	1 ab	1 ab	2 ab	7 abc	0 a	0 a	8 abc	0 a	7 abc	2 ab	4 ab	2 ab	4 ab	11 abc	6 abc	17 c	12 bc	7 abc	2 ab
☹️	0 a	0 a	1 a	1 a	1 a	0 a	2 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	4 a	0 a	27 bcd	28 cd	28 cd	**42 d**	**41 d**	39 d	26 bcd	14 abc	6 a	2 a	11 ab	1 a	0 a
😮	1 a	4 a	1 a	1 a	1 a	2 a	1 a	4 a	0 a	0 a	1 a	0 a	0 a	1 a	2 a	6 a	0 a	4 a	0 a	2 a	2 a	2 a	4 a	5 a	1 a	1 a	0 a	12 a	**42 b**	**46 b**
😨	0 a	0 a	1 ab	0 a	1 ab	0 a	1 ab	0 a	0 a	0 a	1 ab	0 a	0 a	0 a	5 abc	2 ab	0 a	2 ab	8 abcd	18 cde	14 bcde	20 de	20 de	22 ef	6 abc	0 a	0 a	35 f	12 abcde	6 abc
😰	0 a	0 a	1 a	0 a	1 a	0 a	1 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	5 a	2 a	0 a	1 a	32 cd	24 bc	26 bc	12 ab	24 bc	38 cd	1 a	1 a	1 a	**41 d**	2 a	4 a
😢	0 a	1 a	1 a	0 a	1 a	0 a	1 a	1 a	1 a	0 a	0 a	0 a	0 a	0 a	2 ab	1 a	0 a	7 ab	**46 f**	26 cde	32 ef	17 bcd	32 ef	28 de	0 a	0 a	1 a	12 abc	1 a	0 a
😭	0 a	0 a	1 a	0 a	1 a	1 a	1 a	1 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	**69 e**	22 cd	31 d	8 ab	20 bcd	12 abc	0 a	0 a	1 a	2 a	2 a	0 a
😱	0 a	4 a	1 a	1 a	1 a	4 a	2 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	7 a	5 a	6 a	12 ab	8 a	0 a	5 a	1 a	22 b	37 c	9 a
😖	0 a	0 a	1 a	1 a	1 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	7 abc	4 ab	1 a	8 abc	13 abcd	18 cd	24 d	13 abcd	15 bcd	22 d	15 bcd	17 bcd	4 ab	19 cd	0 a	1 a
😣	0 a	0 a	1 a	0 a	1 a	0 a	1 a	1 a	0 a	0 a	0 a	0 a	0 a	1 a	5 ab	4 a	0 a	13 abcd	19 bcde	20 cde	25 de	19 bcde	28 e	24 cde	12 abcd	9 abc	1 a	13 abcd	0 a	1 a
😫	0 a	0 a	1 a	1 a	1 a	0 a	2 a	1 a	0 a	0 a	0 a	0 a	0 a	1 a	5 ab	2 a	0 a	5 ab	20 cde	26 de	29 e	13 abcd	17 bcde	19 cde	7 abc	5 ab	1 a	13 abcd	0 a	0 a
😤	1 a	0 a	1 a	0 a	1 a	0 a	1 a	0 a	1 a	1 a	1 a	1 a	0 a	0 a	1 a	4 ab	0 a	24 cd	1 a	0 a	11 abc	20 c	15 bc	4 ab	38 e	5 ab	34 de	5 ab	1 a	1 a
😡	0 a	0 a	2 ab	0 a	1 ab	0 a	1 ab	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	2 ab	1 ab	1 ab	12 ab	11 ab	14 b	0 a	34 c	2 ab	**79 d**	4 ab	0 a	0 a
😠	0 a	0 a	1 a	1 a	1 a	0 a	1 a	1 a	2 a	0 a	0 a	0 a	0 a	0 a	0 a	2 a	0 a	9 a	0 a	1 a	9 a	6 a	8 a	2 a	24 b	1 a	26 b	0 a	1 a	0 a
🤬	1 a	0 a	2 a	0 a	1 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	4 a	1 a	0 a	5 a	6 a	7 ab	0 a	19 b	5 a	**77 c**	2 a	1 a	0 a
😈	0 a	2 a	1 a	0 a	1 a	1 a	2 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	2 a	6 a	6 a	4 a	1 a	18 b	1 a	**57 c**	2 a	0 a	0 a

Table S 9 Study 6: Frequency of use (%) for each of the 46 emoji by each of the 30 CATA terms. In the last row additional words provided by children are reported. Frequencies 40-59% are marked in light blue, 60-79% in blue and 80-100% in dark blue. Different letters (in brackets) indicate a significant difference according to Sheskin post-hoc test (p<0.05). Additional words (grouped by their meaning) were mentioned by ≥10% of children in the open-ended response option. Emotion words are divided by dimensions of I Pleasant Activation, II Activated Pleasure, III Pleasure, IV Deactivated Pleasure, V Pleasant Deactivation, VI Deactivation, VII Unpleasant Deactivation, VIII Deactivated Displeasure, IX Displeasure, X Activated Displeasure, XI Unpleasant Activation, XII Activation (Sick, Monteleone et al. 2020; Yik, Russell, & Steiger, 2011).

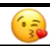
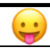
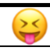
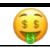
Dimension	Emotion word																							
I	energetic	12 abcdef	16 abcdefg	20 cdefgh	13 abcdef	30 ghij	1 ab	12 abcdef	10 abcde	10 abcde	15 abcdefg	22 efghi	38 ij	15 abcdefg	5 abcd	14 abcdefg	30 ghij	35 hij	**42 j**	28 fghij	21 defghi	17 bcdefg	5 abcd	5 abcd
II	enthusiastic	6 abcd	6 abcd	7 abcd	8 abcde	12 abcdef	2 ab	5 abc	6 abc	5 abc	6 abc	11 abcdef	23 f	11 abcdef	6 abcd	5 abc	9 abcde	17 cdef	20 ef	14 bcdef	11 abcdef	11 abcdef	5 abc	5 abc
	amused	9 abcde	11 abcdef	10 abcdef	8 abcd	16 cdefg	5 abcd	8 abcd	7 abcd	12 abcdef	6 abcd	14 abcdefg	23 efg	8 abcd	5 abcd	7 abcd	10 abcdef	17 defg	24 fg	16 cdefg	12 abcdef	15 bcdefg	6 abcd	17 defg
	cheerful	**76 ef**	**77 ef**	**84 f**	**81 ef**	**73 ef**	**57 cde**	**61 def**	**77 ef**	**59 cdef**	**79 ef**	**74 ef**	**70 ef**	**73 ef**	**68 ef**	**62 def**	**57 cde**	**59 cdef**	**59 cdef**	**56 cde**	**56 cde**	**72 ef**	34 bc	**41 bcd**
III	happy	39 defghi	**50 fghijkl**	**59 ijkl**	**46 efghijkl**	**44 defghijk**	21 abcd	24 bcde	**54 hijkl**	**52 ghijkl**	**66 jkl**	**67 kl**	**57 hijkl**	**58 hijkl**	**43 defghij**	35 cdefgh	28 cdef	27 cdef	42 defghi	35 cdefgh	**40 defghi**	**59 ijkl**	28 cdef	23 abcde
	satisfied	26 bcd	32 cde	34 cde	**42 de**	30 cde	28 cde	32 cde	31 cde	**40 de**	39 cde	37 cde	**47 e**	37 cde	37 cde	**41 de**	18 abc	28 cde	29 cde	27 cde	36 cde	33 cde	29 cde	28 cde
	cuddled	1 a	2 ab	4 ab	3 ab	2 ab	3 ab	2 ab	4 ab	3 ab	7 ab	5 ab	12 b	6 ab	5 ab	6 ab	3 ab	2 ab	5 ab	2 ab	38 c	6 ab	8 ab	9 ab
	gratified	8 abcde	8 abcde	9 abcde	13 abcde	10 abcde	14 bcde	7 abcde	13 abcde	14 bcde	16 cde	17 e	11 abcde	12 abcde	8 abcde	13 abcde	12 abcde	9 abcde	9 abcde	3 abc	13 abcde	10 abcde	17 de	19 e
IV	confident	15 bcd	11 abc	11 abc	13 abc	11 abc	12 abc	28 de	14 abcd	12 abc	14 abcd	13 abc	15 bcd	10 abc	13 abc	9 abc	13 abc	13 abc	16 cd	13 abc	11 abc	10 abc	12 abc	6 abc
	at ease	9 abcdef	13 abcdefgh	15 abcdefgh	9 abcdef	17 bcdefghij	13 abcdefgh	19 efghij	16 abcdefghi	26 ghij	28 hij	24 fghij	17 bcdefghij	17 bcdefghij	21 efghij	19 efghij	11 abcdefg	14 abcdefgh	17 cdefghij	6 abcde	22 fghij	17 cdefghij	26 ghij	32 j
	reassured	6 abc	6 abc	6 abc	7 abc	5 ab	12 abcde	9 abcd	11 abcd	24 ef	15 bcde	8 abcd	8 abcd	11 abcd	20 def	7 abc	6 abc	5 ab	7 abc	4 ab	6 abc	12 abcde	28 f	17 cdef
V	relaxed	6 abc	6 abc	6 abc	5 abc	3 a	14 abcde	14 abcde	17 bcdef	32 g	22 defg	13 abcde	6 abc	10 abcd	27 efg	4 ab	9 abcd	6 abc	5 abc	3 a	7 abc	18 cdefg	32 g	28 fg
	calm	17 cdefghi	11 abcdefg	17 bcdefghi	9 abcdef	6 abcd	27 ghij	22 efghij	19 defghi	29 ij	24 fghij	14 abcdefghi	6 abcde	15 abcdefghi	27 ghij	13 abcdefgh	11 abcdefg	9 abcdef	6 abcd	7 abcde	7 abcde	21 defghij	37 j	22 efghij
	serene	4 ab	9 abcde	6 abc	9 abcde	6 abc	16 bcdefg	12 abcdef	16 bcdefg	26 g	23 fg	11 abcdef	6 abc	9 abcde	22 efg	11 abcdef	9 abcde	9 abcde	5 ab	4 ab	6 abc	18 cdefg	27 g	11 abcdef
	carefree	6 abcde	9 abcdefg	8 abcdef	10 abcdefg	6 abcde	10 abcdefg	8 abcdef	5 abcd	16 defg	15 cdefg	6 abcde	11 abcdefg	10 abcdefg	6 abcde	9 abcdefg	10 abcdefg	13 bcdefg	19 fg	7 abcdef	10 abcdefg	8 abcdef	21 g	9 abcdefg
VI	indifferent	3 a	2 a	2 a	2 a	4 a	4 a	6 a	5 a	3 a	1 a	2 a	5 a	2 a	2 a	3 a	3 a	4 a	2 a	3 a	1 a	1 a	2 a	3 a
	quiet	4 abc	4 abc	3 abc	2 ab	2 ab	24 ef	6 abcd	6 abcd	14 bcde	6 abcd	2 ab	0 a	1 a	14 bcde	4 abc	6 abcd	3 abc	3 abc	2 ab	2 ab	4 abc	17 def	6 abcd
VII	bored	2 a	2 a	0 a	2 a	4 abc	5 abc	1 a	1 a	0 a	1 a	1 a	2 a	1 a	1 a	0 a	2 a	5 abc	3 ab	4 abc	1 a	1 a	2 a	5 abc
VIII	sad	1 ab	1 ab	0 a	2 ab	0 a	2 ab	1 ab	0 a	1 ab	2 ab	0 a	0 a	0 a	0 a	0 a	0 a	1 ab	1 ab	1 ab	1 ab	0 a	2 ab	0 a
	melancholic	0 a	0 a	1 a	0 a	0 a	0 a	1 a	0 a	1 a	2 a	1 a	0 a	0 a	0 a	0 a	1 a	0 a	3 a	0 a	1 a	0 a	0 a	0 a
IX	unhappy	1 a	1 a	1 a	0 a	0 a	3 ab	0 a	0 a	0 a	0 a	1 a	0 a	0 a	1 a	0 a	0 a	0 a	2 a	2 a	1 a	1 a	1 a	0 a
	dissatisfied	1 ab	0 a	0 a	0 a	0 a	2 ab	1 ab	0 a	0 a	0 a	1 ab	1 ab	0 a	2 ab	0 a	0 a	0 a	2 ab	2 ab	0 a	0 a	0 a	0 a
	disappointed	0 a	0 a	0 a	0 a	1 ab	4 abcd	1 ab	0 a	0 a	1 ab	0 a	0 a	0 a	2 abc	0 a	1 ab	0 a	2 abc	1 ab	0 a	0 a	4 abcd	0 a
X	guilty	2 ab	1 a	1 a	2 ab	0 a	1 a	4 abc	0 a	4 abc	0 a	1 a	0 a	0 a	2 ab	1 a	0 a	0 a	2 ab	3 abc	4 abc	1 a	1 a	1 a
XI	annoyed	2 ab	0 a	0 a	0 a	0 a	2 ab	0 a	0 a	0 a	1 a	0 a	0 a	0 a	1 a	2 ab	1 a	1 a	2 ab	2 ab	1 a	0 a	0 a	0 a
	disgusted	1 a	0 a	0 a	1 a	1 a	2 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	1 a	6 ab	0 a	0 a	0 a	1 a
	angry	1 a	1 a	0 a	0 a	0 a	1 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	0 a
	worried	0 a	0 a	0 a	1 a	1 a	1 a	2 a	0 a	1 a	0 a	0 a	0 a	1 a	1 a	1 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a	1 a
XII	surprised	8 ab	12 ab	12 ab	6 ab	18 abc	2 a	4 a	5 a	11 ab	12 ab	15 ab	36 cde	6 ab	6 ab	8 ab	10 ab	7 ab	17 abc	12 ab	16 ab	9 ab	3 a	7 ab
	curious	6 abc	8 abc	2 ab	4 abc	9 abc	3 abc	12 abcd	4 abc	6 abc	4 abc	5 abc	5 abc	6 abc	5 abc	10 abcd	9 abc	8 abc	11 abcd	11 abcd	4 abc	4 abc	3 abc	7 abc
	Additional words	-	-	-	-	-	-	-	-	-	-	in love (12%)	-	-	-	hungry/ tasty (11%)	-	-	crazy (13%)	-	rich (10%)	-	-	-

Table S 9. Continued (Study 6)

Dimension	Emotion word	🥰	😎	😐	🤢	🤮	🥵	😵	🤯	☹️	😮	😨	😰	😢	😭	😱	😖	😣	😫	😤	😡	😠	🤬	😈
I	energetic	35 hij	11 abcde	0 a	1 ab	0 a	12 abcdef	1 ab	11 abcde	0 a	1 ab	1 ab	0 a	0 a	1 ab	7 abcde	2 ab	0 a	0 a	4 abc	2 ab	0 a	5 abcd	2 ab
II	enthusiastic	18 def	8 abcde	0 a	0 a	0 a	4 ab	3 ab	3 ab	0 a	0 a	0 a	0 a	1 a	1 a	4 ab	0 a	0 a	0 a	2 ab	1 a	0 a	1 a	1 a
	amused	28 g	13 abcdef	1 ab	0 a	1 ab	7 abcd	2 abc	6 abcd	1 ab	8 abcd	0 a	1 ab	0 a	1 ab	4 abcd	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 ab
	cheerful	**73 ef**	**58 cde**	3 a	0 a	0 a	18 ab	4 a	5 a	1 a	4 a	0 a	1 a	0 a	3 a	1 a	0 a	0 a	2 a	0 a	0 a	0 a	0 a	1 a
III	happy	**69 l**	30 cdefg	0 a	0 a	0 a	13 abc	2 ab	3 ab	0 a	1 ab	1 ab	0 a	0 a	0 a	1 ab	0 a	0 a	1 ab	0 a	0 a	0 a	0 a	0 a
	satisfied	**47 e**	41 de	0 a	0 a	0 a	6 ab	1 a	3 a	0 a	3 a	0 a	1 a	0 a	0 a	1 a	0 a	0 a	0 a	1 a	0 a	0 a	0 a	0 a
	cuddled	9 ab	9 ab	2 ab	1 a	4 ab	5 ab	2 ab	3 ab	1 a	0 a	0 a	1 a	0 a	0 a	1 a	2 ab	0 a	2 ab	4 ab	3 ab	2 ab	6 ab	3 ab
	gratified	10 abcde	13 abcde	2 ab	0 a	0 a	1 ab	2 ab	3 abc	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	1 ab	1 ab	1 ab	0 a	0 a	0 a	4 abcd
IV	confident	8 abc	33 e	3 abc	1 ab	0 a	4 abc	2 abc	5 abc	1 ab	0 a	1 ab	1 ab	0 a	0 a	0 a	3 abc	0 a	0 a	2 abc	0 a	2 abc	2 abc	4 abc
	at ease	18 defghij	31 ij	2 abc	0 a	0 a	12 abcdefg	2 abc	3 abcd	0 a	0 a	0 a	1 ab	1 ab	1 ab	0 a	0 a	0 a	3 abcd	1 ab	0 a	0 a	0 a	0 a
	reassured	6 abc	15 bcde	5 ab	0 a	0 a	3 ab	1 a	2 a	0 a	1 a	0 a	0 a	2 a	0 a	0 a	0 a	1 a	2 a	1 a	0 a	0 a	2 a	0 a
V	relaxed	10 abcd	30 fg	4 ab	0 a	0 a	6 abc	2 a	3 a	2 a	0 a	1 a	1 a	2 a	1 a	0 a	1 a	0 a	2 a	2 a	0 a	1 a	0 a	1 a
	calm	9 abcdef	28 hij	15 abcdefghi	0 a	0 a	3 abc	6 abcd	3 abc	0 a	3 abc	1 ab	1 ab	2 abc	1 ab	1 ab	1 ab	0 a	0 a	0 a	0 a	0 a	0 a	1 ab
	serene	8 abcd	20 defg	6 abc	0 a	0 a	1 a	2 a	3 ab	0 a	3 ab	2 a	0 a	3 ab	0 a	1 a	0 a	0 a	1 a	2 a	0 a	0 a	0 a	0 a
	carefree	9 abcdefg	17 efg	5 abcd	1 ab	1 ab	2 ab	1 ab	3 abc	0 a	0 a	1 ab	2 ab	0 a	1 ab	0 a	0 a	3 abc	1 ab	0 a	1 ab	0 a	1 ab	0 a
VI	indifferent	4 a	3 a	15 b	1 a	0 a	2 a	2 a	5 a	1 a	3 a	0 a	1 a	1 a	2 a	0 a	1 a	2 a	0 a	0 a	0 a	0 a	1 a	0 a
	quiet	1 a	5 abc	28 f	4 abc	5 abc	4 abc	6 abcd	6 abcd	12 abcde	6 abcd	8 abcd	11 abcd	11 abcd	5 abc	5 abc	3 abc	15 cde	3 abc	1 a	2 ab	3 abc	0 a	3 abc
VII	bored	1 a	2 a	23 d	6 abc	3 ab	5 abc	8 abc	4 abc	14 cd	2 a	2 a	3 ab	5 abc	4 abc	1 a	5 abc	6 abc	13 bcd	7 abc	3 ab	6 abc	5 abc	10 abc
VIII	sad	0 a	0 a	6 abc	5 abc	6 abc	6 abc	7 abc	6 abc	45 e	1 ab	17 bcd	32 de	**76 f**	**84 f**	4 abc	18 cd	**47 e**	**44 e**	6 abc	10 abc	9 abc	8 abc	11 abc
	melancholic	0 a	1 a	2 a	2 a	2 a	0 a	3 a	2 a	3 a	0 a	3 a	1 a	6 ab	10 b	0 a	4 ab	5 ab	6 ab	2 a	3 a	3 a	2 a	3 a
IX	unhappy	1 a	1 a	7 abc	18 bcd	22 cdef	6 abc	14 abcd	7 abc	36 efgh	2 a	19 cd	18 bcd	28 defg	**45 h**	8 abc	21 cde	38 fgh	39 gh	16 abcd	19 cd	21 cde	28 defg	28 defg
	dissatisfied	0 a	0 a	17 abcdef	23 cdefgh	38 hi	10 abcd	17 bcdef	14 abcde	28 efghi	6 abc	16 abcdef	17 abcdef	20 cdefg	29 efghi	9 abcd	28 efghi	26 defghi	29 efghi	31 fghi	35 ghi	32 fghi	39 hi	**42 i**
	disappointed	0 a	0 a	17 bcdefghi	17 bcdefghi	17 cdefghi	7 abcdef	16 abcdefghi	14 abcdefgh	**40 l**	6 abcde	17 bcdefghi	19 defghij	28 hijkl	34 jkl	8 abcdefg	20 efghijk	31 ijkl	34 jkl	36 kl	28 hijkl	24 ghijk	22 fghijk	23 fghijk
X	guilty	0 a	1 a	9 abcd	3 abc	2 ab	3 abc	6 abc	12 bcd	6 abc	3 abc	8 abcd	17 d	8 abcd	6 abc	7 abcd	6 abc	8 abcd	6 abcd	2 ab	6 abc	5 abc	6 abcd	13 cd
XI	annoyed	0 a	0 a	10 abcd	6 abc	14 abcd	9 abcd	7 abcd	17 bcd	15 abcd	3 ab	8 abcd	5 ab	5 ab	13 abcd	2 ab	21 cd	11 abcd	23 d	**51 e**	**49 e**	**56 e**	**62 e**	**47 e**
	disgusted	1 a	0 a	3 ab	**79 e**	**77 e**	9 abc	13 abc	5 ab	9 abc	3 ab	7 abc	7 abc	3 ab	6 abc	8 abc	**42 d**	21 c	17 bc	8 abc	7 abc	8 abc	12 abc	15 abc
	angry	0 a	0 a	3 a	5 ab	5 ab	6 ab	6 ab	22 b	14 ab	0 a	2 a	6 ab	1 a	11 ab	2 a	11 ab	4 a	13 ab	**64 c**	**95 d**	**85 d**	**96 d**	**87 d**
	worried	0 a	1 a	9 abc	12 abc	6 abc	13 abcd	17 bcde	17 cde	8 abc	17 bcde	32 fg	**42 g**	13 abcd	17 cde	27 ef	10 abc	26 def	16 bcde	2 a	4 ab	6 abc	4 ab	4 ab
XII	surprised	25 bcd	2 a	4 a	6 ab	5 a	14 ab	39 de	**65 fg**	1 a	**79 g**	**54 ef**	12 ab	2 a	4 a	**74 g**	6 ab	5 a	5 a	1 a	0 a	1 a	6 a	2 a
	curious	6 abc	2 ab	9 abc	1 ab	0 a	5 abc	7 abc	15 cd	1 ab	22 d	5 abc	3 abc	6 abc	1 ab	13 bcd	4 abc	3 abc	2 ab	0 a	0 a	0 a	0 a	0 a
	Additional word	-	cool (17%)	-	nauseous (18%)	nauseous (15%)	warm/ hot (23%)	dead/ surprised (21%)	surprised/ shocked (12%)	-	-	-	uncomfortable/ stressed (11%)	-	-	-	-	-	-	-	-	-	-	-

Table S 10 Summary table showing semantic meanings (Study 3 & 6) of 46 emoji used to describe food experiences in preadolescents. For both studies, attributes selected by ≥40% of children were displayed, but children's additional emotion words from the open-end response were displayed when selected by ≥10% of children (underlined); n= number of children.

	Cluster	Norway	Italy
	1	**cheerful** (76%)	**happy** (66%), **serene** (54%), **cheerful** (50%), **amused** (41%)
	1	**cheerful** (77%), **happy** (50%)	**happy** (78%), **cheerful** (55%), **serene** (44%), **enthusiastic** (40%)
	1	**cheerful** (84%), **happy** (59%)	**happy** (75%), **cheerful** (71%), **serene** (55%), **amused** (45%)
	1	**cheerful** (81%), **happy** (46%), **satisfied** (42%)	**happy** (70%), **cheerful** (64%), **amused** (60%), **serene** (45%), **enthusiastic** (42%)
	2	**cheerful** (73%), **happy** (44%)	**happy** (66%), **cheerful** (64%), **amused** (47%), **enthusiastic** (40%)
	2	**cheerful** (70%), **happy (57%),** **satisfied** (47%)	**happy** (64%), **energetic** (54%), **cheerful** (49%), **enthusiastic** (48%), **amused** (42%)
	2	**cheerful** (57%)	**happy** (58%), **amused** (53%), **cheerful** (42%)
	2	**cheerful** (59%)	**happy** (59%), **cheerful** (59%), **amused** (51%), **energetic** (41%)
	2	**cheerful** (59%), **happy** (42%), **energetic** (42%), **crazy** (13%)	**happy** (60%), **cheerful** (58%), **energetic** (57%), **amused** (53%), **crazy** (23%)
	2	**cheerful** (56%)	**happy** (63%), **cheerful** (57%), **amused** (52%), **energetic** (41%)
	2	**cheerful** (73%), **happy** (69%), **satisfied** (47%)	**happy** (70%), **cheerful** (70%), **energetic** (52%), **enthusiastic** (49%), **amused** (49%), **festive** (22%)
	3	**cheerful** (57%)	**happy** (61%), **serene** (49%)
	3	**cheerful** (61%)	**happy** (49%), **cheerful** (40%), **confident** (40%)
	3	**cheerful** (77%), **happy** (54%)	**happy** (64%), **cheerful** (52%), **serene** (47%), **calm** (44%)
	3	**cheerful** (59%), **happy** (52%), **satisfied** (40%)	**serene** (60%), **happy** (55%), **quiet** (50%), **calm** (47%), **cheerful** (44%), **I am good/ I feel like an angel** (11%)
	3	**cheerful** (62%), **satisfied** (41%), **hungry/tasty** (11%)	**happy** (59%), **cheerful** (51%), **gluttonous** (14%), **hungry** (10%)
	3	**cheerful** (56%), **happy** (40%), **rich** (10%)	**happy** (51%), **satisfied** (46%), **cheerful** (42%), **rich** (26%)
	3	**cheerful** (72%), **happy** (59%)	**happy** (54%), **serene** (50%), **cheerful** (48%)
	3	**cheerful** (58%), **satisfied** (41%), **feeling cool** (17%)	**confident** (50%), **happy** (49%), **satisfied** (44%), **at ease** (44%), **feeling cool** (11%)
	4	**cheerful** (79%), **happy** (66%)	**happy** (61%), **cuddled** (58%), **serene** (44%), **cheerful** (42%), **in love** (35%)
	4	**cheerful** (74%), **happy** (67%), **in love** (12%)	**happy** (59%), **in love** (63%)
	4	**cheerful** (73%), **happy** (58%)	**happy** (46%), **in love** (17%)
	4	**cheerful** (68%), **happy** (43%)	**happy** (46%), **calm** (40%)
	4	-	**serene** (52%), **calm** (44%)
	4	**cheerful** (41%)	-
	5	**angry** (64%), **annoyed** (51%)	**angry** (74%), **annoyed** (50%)
	5	**angry** (95%), **annoyed** (49%)	**angry** (95%)

	**5**	**angry** (85%), **annoyed** (56%)	**angry** (84%), **annoyed** (47%)
	**5**	**angry** (96%), **annoyed** (62%)	**angry** (91%), **annoyed** (53%)
	**5**	**angry** (87%), **annoyed** (47%), **dissatisfied** (42%)	**angry** (86%)
	**6**	**sad** (45%), **disappointed** (40%)	**sad** (69%), **unhappy** (54%), **disappointed** (51%), **dissatisfied** (46%)
	**6**	**surprised** (54%), **afraid** (44%)	**worried** (57%), **surprised** (42%)
	**6**	**afraid** (57%), **worried** (42%), **uncomfortable/stressed** (11%)	**worried** (53%)
	**6**	**sad** (76%)	**sad** (75%), **unhappy** (61%), **disappointed** (47%)
	**6**	**sad** (84%), **unhappy** (45%)	**sad** (86%), **unhappy** (66%)
	**6**	**disgusted** (42%)	**unhappy** (46%), **sad** (44%), **disgusted** (44%), **annoyed** (40%)
	**6**	**sad** (47%)	**sad** (52%), **unhappy** (49%), **guilty** (47%), **disappointed** (46%)
	**6**	**sad** (44%)	**unhappy** (55%), **sad** (48%), **melancholic** (40%), **disappointed** (40%), **guilty** (40%)
	**7**	-	**indifferent** (58%)
	**7**	**disgusted** (79%), **nauseated** (18%)	**disgusted** (87%), **urge to vomit/nauseated** (12%)
	**7**	**disgusted** (77%), **nauseated** (15%)	**disgusted** (84%), **feeling sick** (12%)
	**7**	**warm/hot** (23%)	**tired** (27%), **feeling hot** (20%)
	**7**	**dead/surprised** (12%)	**surprised** (40%), **worried** (40%), **dead/deceased** (26%)
	**7**	**surprised** (65%)	-
	**7**	**surprised** (79%)	**surprised** (73%)
	**7**	**surprised** (74%)	**surprised** (58%), **worried** (48%), **scared/frightened** (22%)

PROP status (Study 7)

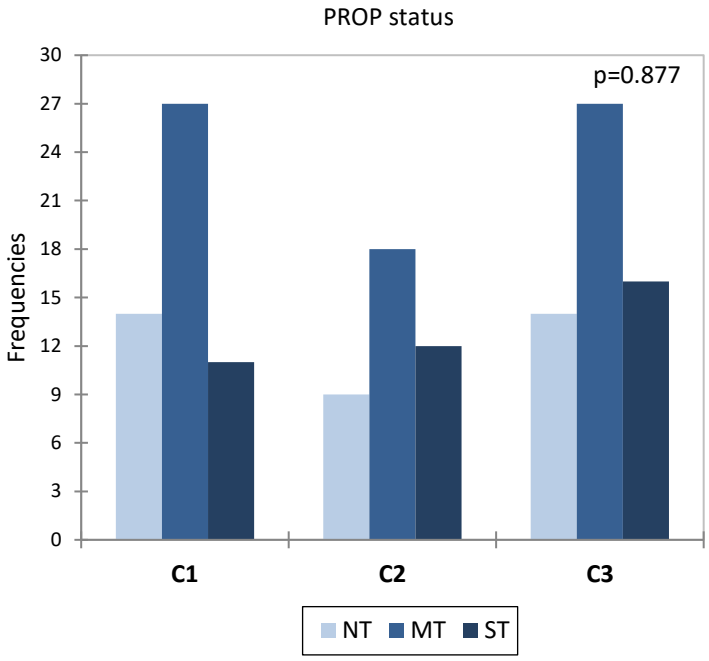


Figure S 1 Observed frequencies of PROP status (NT = non-taster, MT = medium taster, ST = super taster) and clusters (C1, C2, and C3).

Table S 11 Observed frequencies of PROP status (NT = non-taster, MT = medium taster, ST = super taster) and clusters (C1, C2, and C3)

	Cluster	NT	MT	ST	p-value
PROP status	**C1**	14	27	11	0.877
	C2	9	18	12	
	C3	14	27	16	

Personality trait questionnaires (Study 7)

Table S 12 Food neophobia (FN) items with English, Norwegian, and Italian translation. (R) indicates a reversed item.

Items	English	Norwegian	Italian
FN 1 (R)	I often eat new and unusual foods.	Jeg spiser ofte ny og uvant mat.	Mangio spesso cibi nuovi e diversi dal solito.
FN 2	I don't trust new foods.	Jeg stoler ikke på ny mat.	Non mi fido dei cibi nuovi.
FN 3	If a food is new, I don't try it.	Hvis maten er ny for meg, smaker jeg ikke på den.	Se un cibo è nuovo, non lo assagio.
FN 4 (R)	I like to try weird tastes and foods, which are unusual and coming from different countries.	Jeg liker å prøve rare smaker og matvarer som er uvanlige og kommer fra ulike land.	Mi piace provare sapori e cibi strani, diversi dal solito e provenienti da altri Paesi.
FN 5 (R)	When I eat dinner at a friend, I like to try new foods.	Når jeg spiser middag hos en venn, liker jeg å smake ny mat.	Quando sono alla festa di un amico mi piace assagiare cibi nuovi.
FN 6	I am afraid to eat food I have never tried before.	Jeg er redd for å smake på mat jeg ikke har prøvd før.	Ho paura ad assaggiare un cibo che non ho mai mangiato prima.
FN 7	I am very fussy when it's a matter of food.	Jeg er veldig kresen angående mat.	Sono molto schizzinoso/a quando si tratta di mangiare.
FN 8 (R)	I really eat everything!	Jeg spiser hva som helst!	Mangio tutto, ma proprio tutto!

Table S 13 Items Brief Sensation Seeking Scale (BSSS) items with English, Norwegian, and Italian translation

Items	English	Norwegian	Italian
BSSS 1	I would like to explore strange places.	Jeg har lyst til å utforske ukjente steder.	Mi piacerebbe esplorare luoghi sconosciuti.
BSSS 2	I get restless when I spend too much time at home.	Jeg blir utålmodig når jeg tilbringer for mye tid hjemme.	Divento irrequieto/a quando passo troppo tempo a casa.
BSSS 3	I like to do frightening things.	Jeg liker å gjøre skremmende ting.	Mi piace fare cose che in genere spaventano.
BSSS 4	I like wild parties.	-	Mi piacciono le feste in cui si può fare tutto.
BSSS 5	I would like to take off on a trip with no pre-planned routes or timetables.	Jeg har lyst til å dra på tur uten å planlegge rute eller timeplan på forhånd.	Mi piacerebbe partire per un viaggio senza avere itinerari prestabiliti.
BSSS 6	I prefer friends that do exciting and unexpected things.	Jeg foretrekker venner som gjør spennende og uventede ting.	Preferisco amici che siano imprevedibili.
BSSS 7	I would like to try bungee jumping from a bridge.	Jeg har lyst til å prøve å hoppe i strikk fra en bro.	Mi piacerebbe provare il bungee jumping.
BSSS 8	I want to try new and exciting experiences, even if I am not allowed.	Jeg har lyst til å prøve nye og spennende opplevelser, selv om jeg ikke har lov.	Mi piacerebbe fare molte esperienze nuove ed eccitanti, anche se proibite.

Table S 14 Items BIS/BAS scale with English, Norwegian, and Italian translation; BIS = Behavioral Inhibition System, BAS (Behavioral Activation System) subscales: REW = Reward responsivity, DRIVE = Drive, FUN = Fun seeking; (R) indicates reversed item.

Items	English	Norwegian	Italian
BIS 1	Usually when I think something unpleasant will happen to me I become anxious.	Jeg blir som regel engstelig når jeg tror at noe ubehagelig vil skje med meg.	Di solito quando penso che mi succederà qualcosa di spiacevole divento ansioso/a.
BIS 2	The possibility of making mistakes worries me.	Jeg er bekymret for å gjøre feil.	La possibilità di commettere errori mi preoccupa.
BIS 3	Criticisms and reproaches hurt me.	Jeg blir såret av kritikk og anklager.	Le critiche e i rimproveri mi feriscono.
BIS 4	I feel rather worried and excited when I think someone is angry with me.	Jeg er bekymret og opprørt når jeg tenker på at noen er sinte på meg.	Mi sento piuttosto preoccupato/a e emozionato/a quando penso che qualcuno sia arrabbiato con me.
BIS 5 (R)	Even if something unpleasant is about to happen to me, I am rarely afraid or nervous.	Selv om noe ubehagelig skal skje meg snart, er jeg sjelden redd eller nervøs.	Anche se sta per accadermi qualcosa di spiacevole, raramente ho paura o mi sento nervoso/a.
BIS 6	I feel worried when I think I have done something inadequately.	Jeg føler meg bekymret når jeg tenker på at jeg har gjort noe som ikke er godt nok.	Mi sento preoccupato/a quando penso di aver fatto qualcosa in modo inadeguato.
BIS 7 (R)	In comparison with my friends, I have few fears.	Sammenlignet med vennene mine, er jeg lite redd.	In confronto con i miei amici, ho poche paure.
REW 1	When I get something I want, I feel excited and full of energy.	Når jeg får noe jeg har lyst på, føler jeg meg begeistret og full av energi.	Quando ottengo qualcosa che voglio mi sento eccitato/a e pieno/a di energia.
REW 2	When I do something well I like to keep doing it.	Når jeg er god på noe, vil jeg fortsette å gjøre det.	Quando faccio bene qualcosa mi piace continuare a farla.
REW 3	When things are positive for me, my mood is greatly influenced.	Når ting er positivt for meg, blir humøret mitt påvirket i stor grad.	Quando si verificano cose per me positive, il mio stato d'animo ne è molto influenzato.
REW 4	I would be excited to win a race.	Jeg hadde vært begeistret for å vinne et løp.	Mi ecciterebbe vincere una gara.
REW 5	When I have the opportunity of getting something I like, I become immediately enthusiastic.	Når jeg får muligheten til å få noe jeg liker, blir jeg umiddelbart entusiastisk.	Quando ho l'opportunità di ottenere qualcosa che mi piace, sono subito colto dall'entusiasmo.
DRIVE 1	Normally when I want something I do everything I can to get it.	Hvis jeg vil ha noe, er jeg vanligvis villig til å gjøre alt jeg kan for å få det.	Normalmente quando voglio qualcosa faccio tutto quello che posso per ottenerla.
DRIVE 2	I also do the impossible to get the things I want.	Jeg gjør det hva som helst for å få det jeg vil ha.	Faccio anche l'impossibile per ottenere le cose che voglio.
DRIVE 3	When I get the opportunity to get something I want, I act immediately.	Når jeg får muligheten til å få noe jeg vil ha, handler jeg med en gang.	Quando mi capita l'opportunità di ottenere qualcosa che voglio, agisco subito.
DRIVE 4	When I'm trying to get something, I don't worry too much if the methods I use are correct or not.	Når jeg prøver å få noe, bryr jeg meg ikke noe særlig om metodene jeg bruker er riktige eller ikke.	Quando sto cercando di ottenere qualcosa, non mi preoccupo troppo se i metodi che uso sono corretti oppure no.

FUN 1	Often, I only do things because they can be fun.	Jeg gjør ofte ting bare fordi det kan være gøy.	Spesso, faccio delle cose solo perché potrebbero essere divertenti.
FUN 2	I always want new sensations and emotions.	Jeg har alltid lyst på nye opplevelser og følelser.	Ho sempre voglia di nuove sensazioni ed emozioni.
FUN 3	If I think something new is fun, I try it often and willingly.	Hvis jeg synes noe nytt er gøy, prøver jeg det gjerne ofte.	Se penso che una cosa nuova sia divertente, la provo spesso e volentieri.
FUN 4	When I suddenly feel like doing something, I do it.	Når jeg plutselig får lyst til å gjøre noe, gjør jeg det.	Agisco spesso in base all'impulso del momento.

Table S 15 Curiosity trait items with English, Norwegian, and Italian translation; JE = Joyous exploration, SC = Social curiosity.

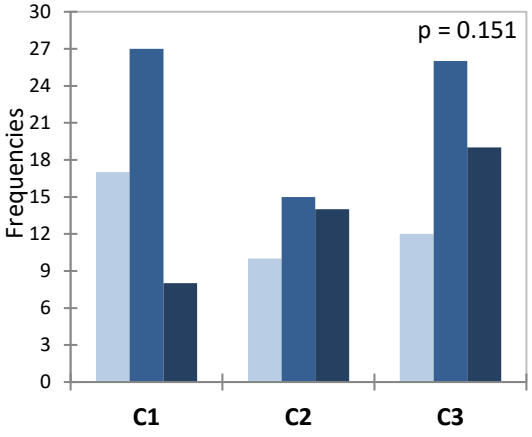
Items	English	Norwegian	Italian
JE 1	I view challenges as an opportunity of growing and learning.	Jeg ser på utfordringer som en mulighet til å vokse og lære.	Considero le situazioni difficili come un'opportunità per crescere e imparare.
JE 2	I am always looking for experiences that challenge how I think about myself and the world.	Jeg liker erfaringer som endrer måten jeg tenker på meg selv og verden.	Sono sempre alla ricerca di esperienze che sfidano il modo in cui penso a me stesso/a e al mondo.
JE 3	I like situations where I have to think in depth about something.	Jeg liker situasjoner hvor jeg må tenke grundig på noe.	Mi piacciono le situazioni in cui è probabile che dovrò ragionare a fondo su qualcosa.
JE 4	I enjoy learning about subjects that are unfamiliar to me.	Jeg liker å lære om temaer som er ukjente for meg.	Mi piace imparare cose che non conosco.
JE 5	I am charmed by learning new things.	Jeg synes det er spennende å lære nye ting.	Trovo affascinante imparare cose nuove.
JE 11	I am curious about trying new foods.	Jeg er nysgjerrig på å smake ny mat.	Sono curioso/a di provare cibi nuovi.
SC 6	I am curious about what other people do.	Jeg er nysgjerrig på hva andre folk gjør.	Mi piace sapere cosa fanno gli altri.
SC 7	I like finding out why people behave the way they do.	Jeg liker å finne ut hvorfor andre oppfører seg som de gjør.	Mi piace scoprire perché le persone si comportano in un certo modo.
SC 8	When other people are having a conversation, I like to find out what it's about.	Når andre har en samtale, liker jeg å finne ut hva den handler om.	Quando altre persone stanno conversando, mi piace scoprire di cosa si tratta.
SC 9	When I am around with other people, I like listening to their conversations.	Jeg liker å høre på samtalene til folk rundt meg.	Quando sono in giro con altre persone, mi piace ascoltare le loro conversazioni
SC 10	When people quarrel, I like to know what's going on.	Når folk krangler, liker jeg å finne ut hva som skjer.	Quando le persone litigano, mi piace sapere cosa sta succedendo.
SC 12	I consider myself as a curious person.	Jeg ser på meg selv som en nysgjerrig person.	Mi considero una persona curiosa.

Personality traits and clusters (Study 7)

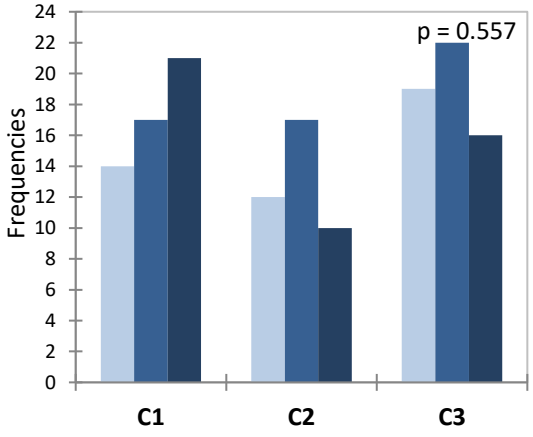
Table S 16 Observed frequencies for each cluster (C1, C2, C3) and level of personality trait (low, medium, high) for personality trait questionnaires food neophobia, sensation seeking, sensitivity to reward and punishment and curiosity trait; p-values from Chi-square test; in bold p-values <0.05.

Scale	Cluster	Low	Medium	High	p-value
Food neophobia	**C1**	17	27	8	0.151
	C2	10	15	14	
	C3	12	26	19	
Sensation seeking	**C1**	14	17	21	0.557
	C2	12	17	10	
	C3	19	22	16	
BIS subscale (5 items)	**C1**	16	19	17	0.699
	C2	11	19	9	
	C3	18	26	13	
REW subscale	**C1**	15	20	17	0.718
	C2	11	20	8	
	C3	17	25	15	
DRIVE subscale	**C1**	15	21	16	0.856
	C2	11	16	12	
	C3	20	18	19	
FUN subscale	**C1**	17	15	20	**0.035**
	C2	8	24	7	
	C3	18	23	16	
Curiosity trait	**C1**	13	20	19	0.186
	C2	7	24	8	
	C3	10	33	14	

a) Food neophobia



b) Sensation seeking



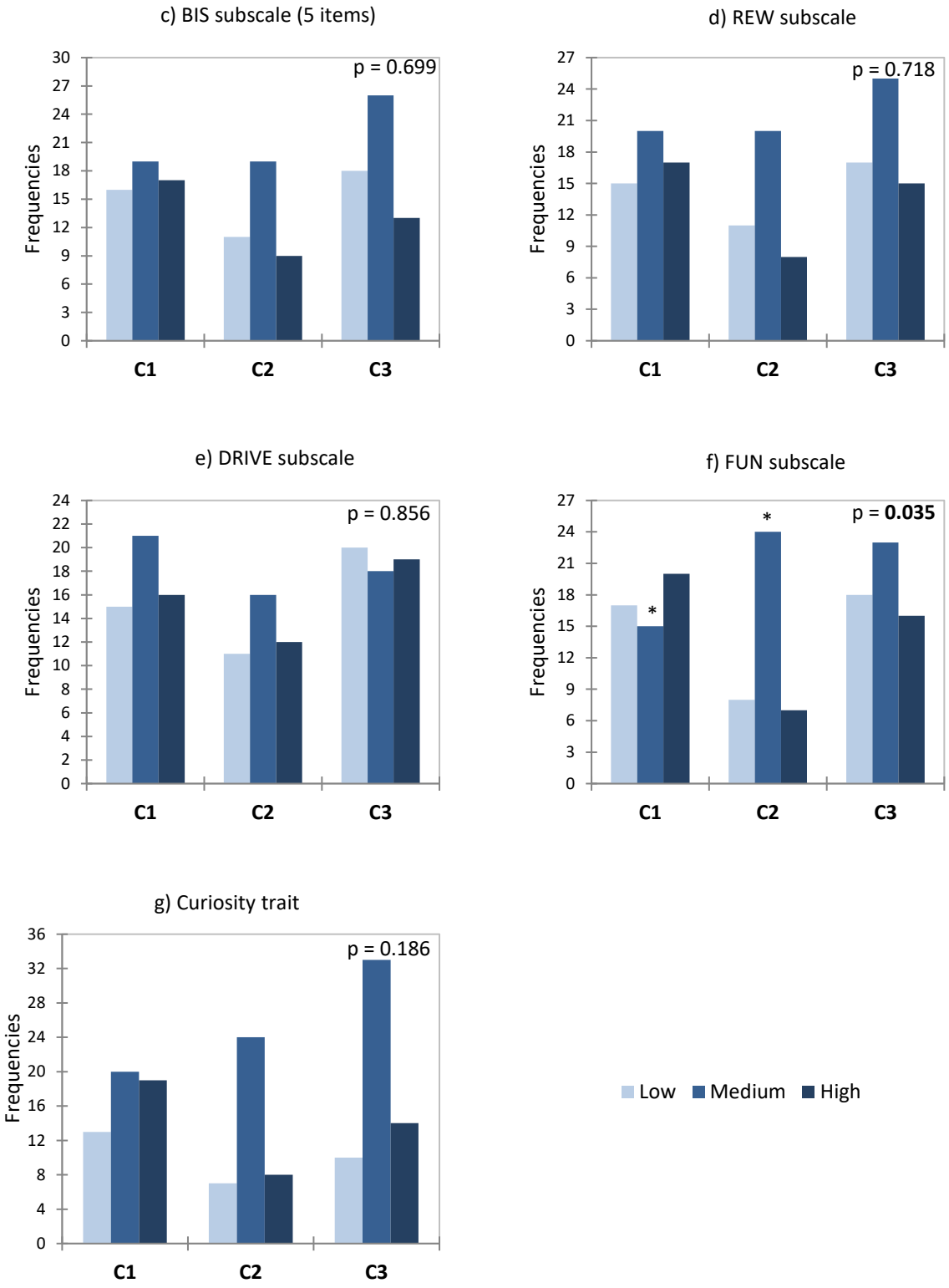


Figure S 2 a-g) Observed frequencies for each cluster (C1, C2, C3) and level of personality trait (low, medium, high) for personality trait questionnaires a) food neophobia, b) sensation seeking, c) BIS subscale and d) REW subscale e) DRIVE subscale, f) FUN subscale and g) curiosity trait. p-values from Chi-square test.

Curriculum vitae

Scientific publications

Sick, J., Monteleone, E., Dinnella, C., Pierguidi, L., & Spinelli, S. (2022). Development of an emoji-based self-report measurement tool to measure emotions elicited by foods in preadolescents. *Food Quality and Preference*, Pre-proof. https://doi.org/10.1016/j.foodqual.2022.104585

Ervina, E., Almli L., V., Berget, I., Spinelli, S., **Sick, J.** & Dinnella, C. (2021). Does responsiveness to basic tastes influence preadolescents' food liking? Investigating taste responsiveness clusters on bitter-sour-sweet and salty-umami model food samples. Nutrients, 13(8), 2721. https://doi.org/10.3390/nu13082721

Sick, J., Monteleone, E., Pierguidi, L., Ares, G., & Spinelli, S. (2020). The Meaning of Emoji to Describe Food Experiences in Preadolescents. Foods, 9(9), 1307. https://doi.org/10.3390/foods9091307

Sick, J., Spinelli, S., Dinnella, C., & Monteleone, E. (2020). Children's selection of emoji to express food-elicited emotions in varied eating contexts. *Food Quality and Preference*, *85*, 103953. https://doi.org/10.1016/j.foodqual.2020.103953

Sick, J., Højer, R., & Olsen, A. (2019). Children's self-reported reasons for accepting and rejecting foods. Nutrients, 11(10), 2455. https://doi.org/10.3390/nu11102455

Olsen, A., **Sick, J.**, C., Møller, P., & Hausner, H. (2019). No choice vs free choice: How serving situations influence pre-school children's vegetable intake. Food Quality and Preference, 72, 172–176. https://doi.org/10.1016/j.foodqual.2018.10.011

Conference contributions

Sick, J., Spinelli, S., Monteleone, E. (2021, 16 - 17 August). The Role of Emotions in Children´s Food Preferences. Creative Tastebuds Symposium 2021, Ebeltoft, Denmark. *Accepted abstract.*

Sick, J., Almli, L. V., Monteleone, E., Dinnella, C., Berget, I., Ervina, E., Spinelli, S. (2021, 9 - 12 August). A novel tool to measure food-elicited emotions in children: the emoji group questionnaire (EGQ). 14th Pangborn Sensory Science Symposium 'Sustainable Sensory Science', online: live and on-demand. *Oral presentation.*

Sick, J., Spinelli, S., Dinnella, C., & Monteleone, E. (2020, 13 - 16 December). Development of an emoji-based self-report measurement tool to measure emotions elicited by foods in preadolescents. 9th European Conference on Sensory and Consumer Research, online: live and on-demand. *Oral presentation.*

Frøst, M.B., Hartmann, A.L., **Sick, J.C.** (2020, 23 - 26 November). Accept of six whole roasted insects in among Danish 11-13 year old children. Insects to Feed the World 2020 Virtual Conference, online. *Oral presentation.*

Sick, J., Spinelli, S., Dinnella, C., & Monteleone, E. (2020, 27 - 28 January). Gender differences in preadolescent's selection of emoji to express emotions elicited by foods. In Regendering Science. For an inclusive research environment; PLOTINA Final Conference. *Accepted abstract.*

Sick, J. (2019, 30 - 31 October). Gli emoji possono misurare le emozioni? Studio esplorativo sul significato degli emoji legati al cibo in soggetti preadolescenti. Workshop SISS Mind in Mouth (MIMO), CiMeC Center for Mind/Brain Sciences in Rovereto, Italy. *Oral presentation.*

Sick, J. (2019, 11 - 13 September). The role of emotions, personality traits and sensory sensitivity in preadolescent's food preferences, 24th Workshop on the Developments in the Italian PhD Research on Food Science Technology and Biotechnology, Florence, Italy. *Poster presentation.*

Sick, J., Spinelli, S., Dinnella, C., Monteleone, E. (2019, 28 July - 1 August). Can emoji measure emotions? An explorative study analyzing the meaning of food-related emoji in preadolescents. 13th Pangborn Sensory Science Symposium, Edinburgh, Scotland. *Poster presentation.*

Sick, J. (2019, 28 July - 1 August). The future of sensory science in the mind of the early career research. 13th Pangborn Sensory Science Symposium, Early Career Research Seminar, Edinburgh, Scotland. *Video abstract (selected among the 15 best videos and presented at the seminar)*.

Hartmann, A.L., **Sick, J.C.**, Frøst, M.B. (2019, 28 July - 1 August). Descriptive analysis by CATA and hedonic response to six whole roasted insects among Danish 11-13-year-old children. 13th Pangborn Sensory Science Symposium, Edinburgh, Scotland. *Oral presentation.*

Sick, J., Højer, R., Olsen, A. (2017, 20 - 24 August). Children's reasons for accepting and rejecting foods. 12th Pangborn Sensory Science Symposium, Providence, Rhode Island, USA. *Oral presentation (presenter: Annemarie Olsen).*

International experience during the PhD

Visiting PhD student at the research institute Nofima Ås, Norwegian Institute of Food, Fisheries and Aquaculture Research, Department of Sensory, Consumer and Innovation, Ås, Norway, 10 August 2020 - 11 February 2021.

Awards and grants

2021	Among the 6 finalists to be awarded the "What for Award" of the First Virtual Workshop on the Developments in the Italian PhD Research on Food Science, Technology and Biotechnology
	BANDO FAI travel grant
2020	Pieter Punter E3S Award, 9th European Conference on Sensory and Consumer Research)
	BANDO FAI travel grant

Active member of scientific societies and working groups

2020 - 2022	E3S Working Group Taste Sensitivity
2019 - 2022	Italian Sensory Science Society (SISS)
	European Sensory Science Society (E3S)
	E3S Early Career Researcher Group