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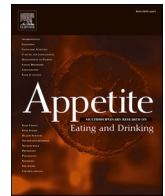To cite this publication, please use the final published version (if applicable).
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The use of ICT devices as part of the solo eating experience

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ABSTRACT

An increasing number of people tend to eat alone due to social changes and an altered attitude towards cooking and eating practices. Anecdotal reports indicate that solo diners tend to use information and communication technology devices, for example, the smartphone, as part of the eating experience. While lab studies suggest that the devices contribute to an increased high-calorie food intake and decreased feeling of satiety, these studies disregard the everyday experience and motivation of solo diners. We conducted an exploratory study to investigate how solo diners use digital devices as part of their daily eating experience. Semi-structured interviews with solo diners (N = 12) were analyzed using thematic analysis in an inductive approach leading to six themes. The themes focus on (1) the perception of a meal; (2) the experience of a solo diner; (3) the purpose of using an information and communication technology device; (4) the perceived influence of the devices; (5) factors decreasing and increasing the use; (6) and the potential to promote healthier food consumption. Our results indicate that the use of digital devices while eating alone can lead to distraction, being unaware of the food texture and the amount that is eaten. The devices can also induce a positive influence by providing entertainment and mitigating negative emotions like loneliness and boredom. The devices have the potential to contribute to healthy eating practices by providing education and by influencing the speed of eating through elements of sound. Although the use of devices might negatively affect eating behavior, their ubiquitous presence also offers the opportunity to reach specific, vulnerable populations.

1. Introduction

The consumption of a meal is not just a basic prerequisite of the body but also a core social element. However, societal changes, such as changing family and work structures and the almost ubiquitous availability of food in urban environments, have led to an increase in the number of meals consumed without the company of others (Fischler, 2011; Mäkelä, 2009; Yates & Warde, 2017). Commensality is often seen as central to a meal and a meal consumed alone is regarded in many cultures as not a proper meal (Fischler, 2011; Kniffin et al., 2015). As a consequence, people who eat alone may experience feelings of sadness and loneliness. Fortunately, they can use information and communication technology (ICT) devices, such as smartphones or computers, during their meal for distraction or to stay in touch with others. However, studies performed in a laboratory environment indicate that using these devices can take away people's attention from the food they eat, leading to decreased feelings of satiety and increased food consumption (Ding et al., 2019; Gonçalves et al., 2019; Oldham-Cooper et al., 2011). Despite several studies investigating the influence of different devices in

a controlled environment, little is known about the role that ICT devices play in everyday eating experiences. Currently, we do not know which devices and applications solo diners tend to use when they eat alone, and why they use these.

In this paper, we report on an explorative study investigating the experience of solo diners in their everyday environment. We conducted interviews with 12 solo diners to investigate their experiences while eating alone, their motivations for using an ICT device, as well as the potential of such devices to contribute to healthy eating practices. In the following section, we will first outline the current discourse around the rise of solo diners, followed by an outline of the known influence of ICT devices in this context.

1.1. Commensality versus eating alone

Commensality refers to eating in a social context, including family members, friends and co-workers (Fischler, 2011). The term normally implies the consumption of 2–3 meals per day in the company of other people according to a strict ritual (Poulain, 2002). However, despite the

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important contribution of the presence of others to the enjoyment of a meal, more and more people tend to eat alone in a social and public context. A study in the UK indicates that every third meal is eaten alone. Often these meals are purchased from stores or restaurants, require little or no preparation and are eaten at an enhanced speed (Yates & Warde, 2017). The rise of solo diners is often explained with a rise of single-unit households. However, studies indicate that a heterogeneous group of people eat alone, including elderly people, widows and widowers, shift workers and family members with different daily schedules (Shahar et al., 2003; Vesnaver et al., 2016; Yates & Warde, 2017). The already mentioned study in the UK indicated that people who live alone tend to eat the majority of their meals alone (74%) and that there is a small difference in sex with more men than women eating alone when they live in a single-unit household. People who are self-employed, working fulltime or are unemployed are slightly less likely to eat with others compared to people who work part-time or are retired (Yates & Warde, 2017). These findings suggest that the group of solo diners is rather heterogenous. It furthermore seems that eating alone can be influenced by a temporal factor: Among the three main meals of a day, breakfast is the most common meal that people tend to eat alone each day, followed by lunch and dinner (Sobal & Nelson, 2003; Statista, 2014; Yates & Warde, 2017).

Reasons for the increase of eating alone are manifold, including the fact that more people live alone, work schedules are flexible and people may work in shifts (Nea et al., 2018; Sobal & Nelson, 2003). In addition, 'eating out' in cafes and restaurants has been accepted as a new standard and the social stigma and normative pressure which often associated people eating alone as having no family and friends has decreased (Danesi, 2012; Koponen & Mustonen, 2020; Paddock et al., 2017).

The social component of eating a meal has a significant influence on behavior (Higgs & Thomas, 2016) and eating alone has been associated with negative effects on the individual, such as a poor diet, and an increased risk of loneliness and depression (Kimura et al., 2012; Kuroda et al., 2015). Nonetheless, studies indicate a positive effect of eating alone if the situation is a self-chosen one, which evokes feelings of relaxation and contentment (Takeda & Melby, 2017; Thomas & Emond, 2017). People seem to appreciate that they can do 'things their way', have practical advantages such as less cleaning up, and are able to engage in other activities at the same time, such as reading (Pliner & Bell, 2009; Takeda & Melby, 2017). However, when people eat alone, they seem less likely to eat a variety of food items. They also seem to have irregular eating patterns, and consume more food faster and generally have a higher energy intake (Hetherington et al., 2006; Yates & Warde, 2017).

1.2. The use of ICT devices in the context of eating

ICT devices can have a positive effect on the eating experience by providing reliable food-related information and sharing personal experience with others, for example by taking part in online groups that discuss specific diet-related topics, such as intolerance to gluten or losing weight (Masson et al., 2018). Interaction on social media platforms to share one's food choices has also been reported to provide peer education and support and contribute to critical reflection on one's eating practices (Watanabe-Ito et al., 2020). The devices can also help maintain dietary changes, for example by reducing the intake of sodium as part of a healthier diet (Ipjian & Johnston, 2017).

However, ICT devices can also induce a negative impact on the eating experience. The presence of non-food related stimuli, including TV or auditory stimuli, seems to stimulate food intake significantly (Bellisle et al., 2004; Higgs & Woodward, 2009). This may be caused by drawing attention away from the food and creating a level of distraction that, in turn, appears to contribute to enhanced snack consumption (Chapman et al., 2012; Gonçalves et al., 2019; Hetherington et al., 2006; Higgs, 2015; Oldham-Cooper et al., 2011). A Korean study investigating smartphone addiction and food consumption in adolescents found a lower consumption of fruit, milk and yoghurt, a higher percentage of meal skipping and a significantly higher body mass index (BMI) among participants with high smartphone addiction (Kim et al., 2017).

Yet hardly any research has investigated the reasons for using the devices as part of an everyday eating experience. A qualitative study focusing on adolescents indicates that the devices used while waiting for food or while eating decrease boredom and kill time, as they are used for entertainment and relaxation purposes (Toh et al., 2019). It also seems that a person's age and the context of use influence the motivation to use the devices while eating. For example, the use of mobile phones in a restaurant seems to be more accepted among younger people than among the elderly. It is also more likely to be tolerated in a public context, such as a restaurant, than in a private setting for family dinners (Rainie & Zickuhr, 2015). News articles suggest that the rise of solo dining in restaurants and the associated decline of stigma while eating alone might be related to the increased use of smartphones, which may evoke the impression that the solo diner is actually not alone (Freedom du Lac, 2011; Luckhurst, 2015). Using smartphones while eating in a public space can provide a sense of belonging and a welcome distraction.

1.3. Present study

Despite these anecdotal reports, the stated rise of solo diners and the high penetration of ICT devices in everyday life, there is a lack of studies examining the solo diner's motivation to use these devices. In addition, we lack insight into how they are used and the specific contexts in which they are used. Therefore, we conducted an explorative, qualitative study that focused on how and why solo diners use ICT devices as part of their eating experience. We conducted semi-structured interviews with solo diners about their experience and analyzed the interview transcripts with thematic analysis (Braun & Clarke, 2006).

2. Method

2.1. Participants

We used a nonprobability, convenience sample for this study (Frey, 2018). To determine the ideal sample size in qualitative studies researchers commonly refer to rules of thumb, statistical models or numerical guidelines. In the context of inductive exploratory studies such as ours, it has also been pointed out that determining an a priori sample size is contradictory to the explorative nature of these studies (Saunders et al., 2018). Another way to justify an ideal number of participants involved in qualitative studies is to reach the point where additional data collection reveals no new insights (Griffin & Hauser, 1993), a concept referred to as 'saturation'. Despite its common use to justify the number of participants in a study, the term is used inconsistently in qualitative research and may involve different approaches including theoretical saturation, inductive thematic saturation, a priori thematic saturation, and data saturation (Saunders et al., 2018). In the context of this study, we focus on data saturation, which takes place during data collection and describes the point at which the interviewer repeatedly hears similar responses (Grady, 1998). We chose this approach because the point of saturation depends on a range of elements, including the study design, the nature of the topic, and the quality of the data collected (Morse, 2000). We decided to stop interviewing after two participants did not provide new insights anymore.

Participants were eligible to participate in the study if they were 18 years of age or older and regularly or occasionally used an ICT device while eating a main meal alone. The recruitment was done by posting announcements for the study on personal and group pages on Facebook. In addition, we emailed the invitation to friends and colleagues who lived alone, and we asked them to share the invitation with friends, students and colleagues. Interested participants received more information about the purpose of the study and duration of the interview by email prior to the interview. Participants provided informed written

consent as part of the study. Each participant was offered 10 euros after the completion of the interview in accordance with the university regulations. This study was approved by the Human Research Ethics Committee of Delft University of Technology in the Netherlands.

Eventually, twelve people took part in the study. Eight participants were female and seven lived alone. Ages ranged from 25 to 62 (Mean 35.3 years, SD 9.6). Participants lived in Austria (n = 1), Germany (n = 7), the Netherlands (n = 2) and New Zealand (n = 2). Most participants were employed full-time (n = 6), some part-time (n = 2) and one was self-employed. Interviews took place between May 2020 and August 2020 and lasted between 25 and 70 min. Interviews were conducted online in English or German depending on the participant's preference.

2.2. Procedure

We developed an interview guide that included questions focusing on situational factors that have been reported to influence consumer behavior (Belk, 1975). The semi-structured interview guide contained six open-ended demographically oriented questions, twenty-two open-ended main questions, and eight prompts that were asked if the participant's response did not cover the topic of interest. The questions focused on the topics of (1) activity patterns and food choices during the day; (2) Covid-19 effects on food and ICT use patterns; (3) participants' attitude towards eating alone; (4) physical and social surroundings influencing the use of ICT devices; (5) the time of day at which they tended to use devices; (6) their general and situation-specific motivations to use the devices; and (7) a potential scenario where ICT devices could contribute to healthy eating practices (see Appendix A).

Interviews were conducted in the form of online video calls by the first author and audio recorded with the participant's consent. Each participant was interviewed once.

2.3. Data analysis

The interviews were transcribed in full, non-verbatim for the analysis. Data were anonymized following the Irish Qualitative Data Archive (IQDA) 'Anonymisation Guidelines' to remove any identifiable data from the data set. Ten of the twelve participants provided consent to include the transcripts as part of an open data depository (https://doi.org/10.4121/13664522). Interviews were analyzed using thematic analysis in an inductive manner using the six steps outlined by Braun and Clarke (2006). First, we familiarized ourselves with the data by reading the transcripts multiple times. The first author then generated initial codes using the software Atlas.ti. The generated codes were then clustered to find themes and subthemes. Subsequently, the themes were reviewed, defined and named. The developed themes, sub-themes, codes and corresponding quotes were reviewed by the first and second author and further refined to clarify the meaning of the themes, so that they reflected the response patterns within the dataset (see Table 1 for an example).

3. Results

The responses during the interviews were clustered into six main themes including: (1) the perception of a meal; (2) the experience of a solo diner; (3) the purpose of using an ICT device; (4) the perceived influence of the devices; (5) factors decreasing and increasing the use; (6) and the potential to promote healthier food consumption. We will outline the different themes in the following sections in detail.

3.1. The perception of a meal

The first theme relates to the experience of a meal, including the general perception of a meal and the perception of a commensal meal. The perceived value, associated feelings and perception of a meal often influenced if and how ICT devices were used as part of the eating experience.

The general perception of the main meal was that eating food was either a pleasurable experience or a necessity reinforced by hunger feelings. Participants who appreciated food described eating a meal as a joyful experience and a moment to be cherished and celebrated, contributing to feelings of relaxation, happiness and comfort. The mealtime, especially lunch and dinner during the week and breakfast at the weekend, was described as a moment to have a break, in particular in the context of work. Eating a meal was seen as a time to socialize and share with others, an opportunity for some bidirectional communication. In contrast, a meal could also be perceived as a necessity required to 'fuel the body'. From this perspective, the mealtime was often described as spare time during which other activities could be performed, such as organizing work-related tasks and responding to online messages.

The participants appreciated the prospect of a commensal meal. Eating out was described as a situation that would involve others, such as friends, co-workers or the partner. Commensal meals were valued because they offer bidirectional conversation rather than the passive consumption of information accessed through ICT devices. Conversations with other people were also perceived as challenging, diverse and tailored to the individual situation. The use of ICT devices in the context of commensal meals was generally perceived as negative. The perception of others using an ICT device while in a group was considered 'sad' as the person seemed unable to enjoy the company and the meal. In order to avoid the use of ICT devices, participants described that they had to turn the screen towards the table to avoid using it or put it away completely. During lunch, ICT devices were tolerated to be present when they were needed for work and as long as they were not used constantly. However, commensal meals were also mentioned to have negative influences. Because the company can distract from the meal, the meal will last longer, leading to overeating, which can ultimately result in weight gain.

3.2. The solo dining experience

This theme describes the overall experience of eating alone in a private and public context and the perception of others eating alone.

The overall experience of eating by oneself was divided into three main aspects: Eating alone was seen as a negative, neutral or positive experience. Eating alone was experienced as neutral or positive about equally often, whereas it was experienced as negative only incidentally.

Table 1
Coding example.

Theme	Sub-theme	Code	Corresponding quote
The influence of ICT devices on the eating experience Definition: This theme describes the perceived influence of the different ICT devices on the eating experiences. The influence can include positive and negative elements.	Distraction	Negative perception of distraction Positive perception of distraction	Yeah, it is a negative influence I would say, because I don't really focus on eating and sometimes I eat faster or so. Or I am not really fully aware of how I eat. But quite often my break will be a distraction slash entertainment […]

Participants who referred to eating alone as something positive described the experience as a moment that they fully enjoyed. They explored new recipes and valued the moments as quality time for themselves, based on the freedom to eat foods they liked and an emphasis on food quality.

> I really enjoy the time. So that's part of my 'ME time'. Other people might do … they might not like to cook, they might watch a TV show to relax. So for me, it's also relaxation … to prepare a delicious dish and then eat it. I like to eat alone. But I also like to eat in groups. So both. Participant 04.

The neutral experience, on the other hand, connected a feeling of hunger with the logical consequence of having to eat. A negative eating experience was associated with being bored and feeling lonely. The context of eating alone in public was described by some participants as uncomfortable and potentially evoking the image to be seen as alone.

The impression of other people eating alone in a private context (at home) was described as a normal thing. The use of ICT devices in a public space while eating alone was considered understandable and explained with the increased use of ICT devices in everyday situations. Solo diners in a public context were also seen as having a busy schedule, unable to take a proper break or using their lunch break to communicate with friends and family. Negative attitudes toward others who ate alone suggested that solo diners were hiding behind the ICT device to avoid potentially negative emotions and that they were lonely people in general.

3.3. Purpose of using an ICT device

During the day, participants used different ICT devices for different purposes. This theme describes the six main purposes for which ICT devices were used: entertainment, managing one's identity, seeking and managing information, relationship management, and as an eating experience enhancer. The different purposes included both active and passive use of devices. For example, the smartphone could be used to call friends or to have some 'background noise' in the form of playing music, listening to a podcast or watching a TV show. The kind of device influenced in some instances what kind of application was used. This choice was often influenced by the time of day, if it was a weekday or the weekend, the context of use (private, work, public) and the mood of the participant. For example, the smartphone was used as the primary device during breakfast and when going out for a meal. The TV, the laptop or a tablet were often used during lunch and dinner, sometimes even simultaneously, for example when watching a TV show on the laptop and checking messages on the phone.

The purpose of entertainment included the use of applications that allowed to listen to audio files and watch a show or movie while cooking and eating. The type of audio included music, the news, podcasts and audiobooks. Audio-visual content included the news, videos, and live TV shows.

The purpose of identity management encompassed applications used for 'self-enhancement' and 'self-improvement' purposes. Self-enhancement referred to the motivation to use the devices to feel good about oneself and maintain a certain level of self-esteem. For example, the smartphone made it possible to take pictures of the cooking process or food plates and participants shared them with friends and social media platforms or reflected on their experiences later on. Sharing images on social media allowed participants to be admired for their cooking skills and the choice of a meal. Using the devices for 'self-improvement' purposes concerns the inner drive to improve and refine certain food-related skills. For instance, the participants used the devices to increase their knowledge of the seasonality of foods, to look up recipes and find cooking instructions.

The purpose of information management entailed different applications that made it possible to look up specific information and manage it accordingly. This was done in the context of personal and work-related tasks. Activities in the personal context included planning a vacation, reading, shopping online or searching for Covid-19 related news. Work-related tasks involved checking and replying to emails and Slack messages, checking appointments, and planning the workday.

Applications used for relationship management purposes enabled unidirectional and bidirectional communication. Tasks performed included reading and replying to online messages, being on social platforms, and making video and voice calls. The applications were used to share one's activities, including cooking and eating, making appointments, and taking part in people's lives through social media.

> […] My motivation is to feel as if you know what happened to all the friends that day, because sometimes you don't communicate as often as you used to […] To say that I am still informed without having to communicate. Without having to text again in the evening. Participant 05.

The different devices were also used to enhance the eating experience. This was either done because the devices provided a feeling of relaxation or because they compensated for negative emotions that arose out of the eating context, such as feelings of boredom, loneliness, and not knowing what else to do.

> It is, I think, it is for not feeling 100% alone. […] I think it is to choose to look at it or not and to engage and there are always enough friends that are always able to reply. You know I have that sense of security that I am not fully alone […] Participant 01.

The ICT devices were described as a way to put up a barrier and avoid any potential feelings of discomfort or loneliness by hiding behind the device.

3.4. The perceived influence of ICT devices on the eating experience

The fourth theme describes how the participants perceived the use of the ICT devices as part of the eating experience, including the general influence on the meal consumption and induced distraction.

The influence on the meal can be characterized as positive, negative or neutral and can involve specific changes in the process of eating, affecting the quantity, quality, speed and eating routine. Some participants mentioned that the devices did not influence the eating experience in any way.

A positive influence was associated with the ability to share the eating experience online with others and to create a relaxed and comfortable eating context. A negative impact occurred when the mealtime was no longer perceived as a break. This negative influence involved doing additional tasks while eating, due to real or perceived-time pressure and regarding the meal time as some kind of 'spare time'. As a consequence, the participant would feel stressed from doing multiple things at once and would find it difficult to relax. Additional negative influences came from the shared eating experience, such as hearing the sound of someone eat or the feeling of being watched when eating and skyping. The type of content accessed with the device could also have a negative influence on the eating experience, such as films that required a lot of attention. The use of social media could be negative when receiving unwanted feedback and being judged for one's food choices, getting lost while scrolling through content, and losing track of time.

Some participants mentioned eating faster while using the devices. They also mentioned eating more and feeling less satiated after the meal. However, a few other participants mentioned eating slower. Participants also indicated that using the devices during cooking affected the speed of meal preparation, as the devices sometimes required both hands to interact with them.

Distraction was mentioned as a major consequence of the use of an ICT device, which could be experienced as positive or negative depending on the circumstances. Distraction was beneficial in avoiding negative feelings or in providing entertainment while eating. Negative

effects included the lack of attention to the food, such as not registering and processing the food properly or forgetting what was eaten. In addition, some participants perceived a lower post-meal concentration level when using ICT devices while eating. The distracting effect seemed strongly linked to the cognitive load required by the devices. For example, using multiple devices simultaneously was found to be more distracting than using just one device.

3.5. Factors that decrease and increase the use of ICT devices

This theme describes factors that enhanced and decreased the likelihood of using an ICT device during a meal. Such factors include the need for the device, awareness of influence, and situational factors.

The factor need for the device refers to the practical and emotional needs that the device can fulfill. For instance, due to the uncertainty surrounding the Covid-19 situation, participants used their devices to retrieve updates in the news and on social media. People who longed for interpersonal connection used devices for distraction and compensation for negative emotions, including feelings of loneliness.

I think everyone has a usually strong longing for connection but it doesn't appear naturally, so you don't talk to other people probably, so you use the device to distract yourself and to stuff your longing for connection by feeding yourself information. And that is the strange thing … for me it feels like it is a substitute for what people actually long for. Participant 08.

Specific times and locations could increase this longing. For instance, the winter season was associated with reduced social connection and a lack of external stimulation due to spending less time outside. In contrast, on weekday mornings, people were often in a hurry and did not want to be distracted.

Participants mentioned their awareness of the influence of ICT devices after observing others or themselves during their eating moments, which led to reflection on their behavior patterns. Replying to emails and using social media would often grab attention and make it hard to leave the application. The appreciation of a meal as a time to pause and disconnect urged them to avoid the device and develop a different usage pattern.

The high penetration rate of ICT devices and the almost ubiquitous access to a stable WIFI network facilitate constant use of devices during everyday life, both for work and leisure. The situational factors, along with the characteristics of the device, affect how much it will be used. For example, a smartphone lying on the table in plain sight will likely be used frequently. Also, sitting comfortably on a sofa can increase phone usage, especially if it can be operated with one hand, whereas being outside on the balcony reduces its use. Being in a restaurant may provide distraction from using the phone, and it may stimulate reaching out to others.

3.6. ICT devices and the potential to promote healthier food consumption

This theme describes how participants saw the use of ICT devices in the context of promoting healthier eating behavior. Some participants expressed clear doubts about the use of ICT devices to facilitate healthy eating in any way. Others saw potential and provided recommendations based on self-reflection on their own behavior and speculated on the use of applications. The possible options included providing education, complementing the eating experience and reaching certain populations.

ICT devices were considered suitable for providing general information about healthy eating; the quality of food items; the health benefits of certain foods; the seasonality of specific foods, which could encourage their purchase; the fact that healthy food does not have to be expensive; and the perceived link between eating healthy and being happy. Some educational efforts focused on providing cooking instructions that were easy to follow and that promoted the right kind of food and amount of ingredients. The ICT devices would allow quick and easy access to this kind of information, and would make it possible to tailor this information to user needs.

I think the digital device can give you information quickly about food that you might otherwise have to tediously search for in a book or get through parents or grandparents. Participant 05.

During the eating process, the devices could influence the speed of eating in concealed or overt form. The devices could support a kind of meditation that guided the user through the eating process and enhanced the focus on the food and its qualities. Such an application should not create a distraction and should complement the eating experience rather than overlap it. Using music or sound patterns in the background could influence the speed of eating by either increasing it or slowing it down.

I do believe that it is possible, because background music has certain tones, and certain kinds of music and certain volume levels that are already used in department stores and that can influence the purchasing behavior. And I think that this could certainly be possible in some form in the context of eating behavior. It may not have been explored yet, but I could imagine something like that. Participant 02.

Some participants expressed concern that certain populations might be adversely affected by the devices, like children or people who have grown up with digital devices and have not learned to appreciate food as part of their upbringing. On the other hand, the devices could also enable educators to reach populations that are currently resistant to messages of healthy eating messages and thus encourage participation in weight loss programs. ICT devices in this context could enable participants to access relevant information when they feel like it.

4. Discussion

Studies suggest that the number of times that people eat a meal on their own is steadily increasing. The use of ICT devices as part of a meal can influence the way the food is perceived and consumed. In this explorative study, we investigated how and why solo diners used ICT device as part of their daily lives.

4.1. Effect of ICT devices on food consumption

The positive influence that ICT devices have on eating experiences relates to the mental rather than the physical well-being of the individual. Similar to previous studies, we found that the devices facilitate connecting with others while eating (Koponen & Mustonen, 2020), they contribute to a feeling of relaxation (Takeda & Melby, 2017), and alleviate negative emotions, including feelings of boredom and loneliness (Mahapatra, 2019; Toh et al., 2019). These positive qualities potentially contribute also to the appreciation of food as a source of pleasure rather than a bodily necessity.

The devices enabled a sense of commensality by digitally sharing the eating experience with others. The use of digital technology in this context has been referred to as 'digital commensality' and 'computational commensality', a topic that has gained increasing research interest in recent years. The terms encompass the everyday use of technology while eating to (1) share the eating experience with others; (2) create artificial dining companions; (3) analyze food intake and flavor perception or; (4) add a digital layer to the multisensory food experience (Niewiadomski et al., 2019; Spence, Mancini, & Huisman, 2019). However, digital and computational commensality also faces challenges, such as developing culturally appropriate solutions. Food items and food rituals can be an essential part of a society's identity and not every culture is open to enabling 'playing with food' through technology.

The negative influence of ICT devices can affect the mental wellbeing as well as the physical condition of individuals. ICT devices were

reported to influence the amount of food eaten, the perceived quality of food and often enhanced the speed of eating. Participants also reported paying no attention to the food before and during oral processing. This often resulted in a lack of satiety and overeating, even to the point of feeling unwell afterwards. Our qualitative results, therefore, confirm laboratory-based studies indicating that the use of ICT devices affects feelings of hunger and awareness of the food eaten (Ding et al., 2019; Oldham-Cooper et al., 2011).

The negative influence that ICT devices have on the eating process was strongly related to the creation of distraction. Although this distracting effect was often well appreciated, there appears to be a tipping point at which distraction can evoke behavior patterns that are difficult to control. Our results also suggest that the more someone had to concentrate on the content on a screen, the more likely that person was to be distracted from the food. For example, participants mentioned that using multiple devices at once or having to read text on a screen evoked a high level of distraction. This is in line with research investigating mindless eating in the context of using multiple screen devices (McAlister & Kononova, 2020) and showing that various activities performed while eating can distract from hunger pangs and the eating process (Ogden et al., 2013). A theoretical model that offers a possible explanation for such a behavior is the 'Limited Capacity Model', which suggests that humans only have access to a specific amount of cognitive resources. When an event requires more cognitive resources than is available, it leads to a cognitive overload that affects efficient information processing (Lang, 2000). From this perspective, it is reasonable to assume that the more cognitive resources have to be allocated to encode, store and retrieve the provided content on the ICT device, the more cognitive resources are diverted away from processing the food properly. For example, reading a text and using a smartphone can lead to an increased intake of calories and lipids (Gonçalves et al., 2019). However, the type of content displayed may moderate this effect: whereas boring TV content encourages eating unhealthy foods, engaging TV shows seem to promote healthy eating (Chapman et al., 2014). Future studies are required to investigate these effects further.

4.2. Implications for design interventions

As part of the study, we asked participants how ICT devices can be used to promote healthy eating patterns. Some participants saw a clear mismatch in the current use of ICT devices and the ambition to promote healthy eating. This discrepancy was connected to the devices' highly distracting influence on one's own eating experience. To mitigate such an influence in a future scenario, devices could limit access to its content to reduce the likelihood of getting lost in ICT use, for example, by turning itself off.

Despite this criticism, the majority of participants saw opportunities in using the devices to disseminate food-relevant information and to nudge users to eat more slowly and in a more mindful way. Indeed, music is capable of modulating eating duration, influence perceived food qualities and even food choice, which can help promote healthy eating behavior (Mathiesen et al., 2020; Spence, Reinoso-Carvalho et al., 2019).

Sound offers a rich playground for designers. Creative as well as commercial projects have explored how sound could be a core ingredient in the food experience and have created playful interactions to allow some form of 'sonic seasoning' (Spence, 2020). Examples include the Michelin star restaurant 'The Fat Duck' (UK) that provides specific soundscapes to complement seafood dishes (TLC Southeast Asia, 2016), providing a carefully crafted set of classical music to accompany chocolate testing (Chocolats Symphoniques, 2016), or offering sound clips to emphasize sweet or bitter taste characteristics during a beer tasting (Stella Artois, 2016). Most of these explorations use commercial ICT devices, but designers have also created new digital technology, for example in the form of an ice cream cone that enables users to create different sounds while eating (Wang et al., 2019). These explorations

offer new insights into the role of sound as part of food experiences, but seem to focus on creating a rich experience rather than a healthy one. In some cases, listening to music while eating has led to higher food intakes (Stroebele & de Castro, 2006) and newspaper reports indicate that restaurants like Hard Rock Café use this effect to make customers eat more and leave faster (Buckley, 2012). The choice of sound should thus be considered with care to avoid negative influences.

Participants also mentioned specific groups that could benefit from ICT devices, such as overweight people. Countless digital applications are available that can help change eating habits, such as MyFitnessPal (MyFitnessPal, 2021), a digital food diary that allows users to scan the barcode of food items to reveal nutritional value and suggest serving sizes, or 'WW Weight Watchers reimagined' that supports weight loss through food tracking, recipe provision, 24/7 live coaching and community interaction (Weigthwatchers, 2021). Such applications can increase motivation, desire and ability to change food-related behaviors and thus contribute to healthy eating patterns (West et al., 2017). Design research projects have also explored how to encapsulate health information in a playful interaction, including the development of -analog and digital games (Bomfim & Wallace, 2018; Skouw et al., 2020) and integrating digital technology in the kitchen environment to provide nutritional information while cooking (Chi et al., 2008). However, it is doubtful whether the use of devices alone can increase the amount of food-related knowledge and improve eating behavior in the long run. To be effective, these interventions are likely to be combined with more 'hands-on' approaches, for example cooking classes for children to educate consumers about food and cooking techniques from an early age.

4.3. Limitations

The results of this study need to be interpreted in regards to our participant sample. We used a convenience sample, starting with the people in our network, and in addition used a snowball procedure to obtain more participants. This may have limited variability in the responses. It should also be taken into account that we only interviewed participants once as part of this study. Using complimentary methods, including food diaries, video data, behavior observations, or the use of multiple data collection moments, can help participants reflect and re-evaluate their experience and associated emotions during the eating experience and can reveal additional insights.

Furthermore, in this explorative study, we included adults who either lived in Central and Western Europe or grew up in this region and have a similar eating pattern. Including participants from different social, cultural or age groups could reveal additional factors relevant to the context of eating alone and using ICT devices. In this respect, for example, children and teenagers who have interacted with ICT devices from a young age may be particularly interesting. They have grown up with digital devices being omnipresent, even during meals, and they are vulnerable to developing addictive ICT usage patterns to offset negative emotions such as loneliness (Mahapatra, 2019). While they might perceive the use as non-problematic, their parents may view it as excessive and implement rules to limit its use (Toh et al., 2019). Another age group that requires more study concerns the elderly. Research in Japan suggests that eating alone can lead to depressive symptoms and affect the quality of life in this population (Kimura et al., 2012; Kuroda et al., 2015). Future studies should investigate the lived experience of these two groups as they were not part of our sample. Since one of the mentioned populations has been raised in the presence of ICT devices and the other has not, there are likely to be large differences in the kind of devices used (e.g., TV, smartphone or feature phone), the frequencies with which they are used, as well as the content that is accessed (e.g., social media, entertainment or educational content).

It is noteworthy that none of our participants mentioned eating out regularly. Probably, most of our participants do not go out for a meal when they are on their own. Cultural factors may play a role here. For

example, in Japan eating out alone in public is a common phenomenon. However, the general perception of a solo diner is a male single, as women fear being perceived as lazy when eating alone in a public space (Takeda & Melby, 2017).

5. Conclusion

The lived experience of solo diners and the role that ICT devices play as part of the eating experience is complex. Solo diners seem to use a number of different devices, depending on the context, purpose of use, mood and perception of convenience. The various applications that the ICT device can access can help to improve the eating experience, mitigate potential negative emotions arising out of the context, perform secondary tasks due to the 'free' time while eating a meal and maintain one's social identity and social network. However, the devices also create distraction, which affects food perception, often leading to more and faster eating. Nonetheless, the devices can also contribute to healthy eating behavior, by providing food education, supporting mindful eating and by facilitating access to vulnerable populations, such as children and teenagers.

Declaration of competing interest

None.

Acknowledgements

Appendix A

Demographic
1. Could you please state your name and what your current occupation is?
2. Are you working? Or are you studying?
3. What is your age?
4. Where do you currently live?
5. Do you live alone or with others?
   Prompt: If so with whom?
6. How long have you been living there?

Food and daily structure
   Question 8–15 were repeated for the topic lunch and dinner
7. When do you normally get up?
   Prompt: Is that on the weekend similar?
8. Do you eat breakfast on an average day during the week?
   Prompt: Would you say that this is the same on the weekend?
9. What would you normally eat for breakfast?
   Prompt: And on the weekend?
10. Where would you normally eat your breakfast?
11. Do you tend to eat your breakfast alone or with others?
    Prompt: If so, with whom?
12. Would you prepare your breakfast or buy it somewhere?
13. How often do you eat your breakfast alone?
14. Are there any activities that you do while eating your breakfast alone?
15. Would you use a digital device while preparing or eating breakfast?
    Prompt: What kind tasks would you do when you use the device?

Covid19 effect
16. Looking back at the peak time of the lockdown due to Covid19: Do you feel that your eating habit and use of ICT
    devices changed during that time?
    Prompt: If yes, what did you do that you normally would not?

Attitude towards eating alone
17. How do you feel when you eat alone?
18. What do you think about people who eat their meal alone in a public space and use a digital device?
19. What do you think about people who eat their meal alone at home and use a digital device?

Physical and social surrounding
20. Are there any specific places where you tend to use a digital device while eating alone?

Temporal perspective
21. Are there certain times of a day, week or the year during which you are likely to use your device while eating alone?

Task definition and antecedent states
22. Could you explain what your motivation is to use a digital device while eating a meal?
23. Do you feel the digital device contributed to the experience?
24. Do you feel that your motivation to use a specific device depends on the situation?
25. Do you think that there are certain situations in which the use of a digital device while eating makes the eating
    experience more enjoyable?
    Prompt: In your context? In the context of other people?
26. Do you think that there are certain situations in which the device impacts on the eating experience of people eating
    alone?
    Prompt: In your context? In the context of other people?

(continued)

Future scenario
27. From your perspective, how could a digital device be used to contribute to a healthy eating habit among people eating alone?
28. From your perspective, what do you think are the current issues with using a digital device while eating alone?

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