



## Food cravings in everyday life: An EMA study on snack-related thoughts, cravings, and consumption



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### ABSTRACT

Food craving refers to an intense desire to consume a specific food and is regularly experienced by the majority of individuals. Yet, there are interindividual differences in the frequency and intensity of food craving experiences, which is often referred to as trait food craving. The characteristics and consequences of trait and state food craving have mainly been investigated in questionnaire-based and laboratory studies, which may not reflect individuals' behavior in daily life. In the present study, sixty-one participants completed the Food Cravings Questionnaire-Trait-reduced (FCQ-T-r) as measure of trait food craving, followed by seven days of Ecological Momentary Assessment (EMA), during which they reported snack-related thoughts, craving intensity, and snack consumption at five times per day. Results showed that 86 percent of reported snacks were high-caloric, with chocolate-containing foods being the most often reported snacks. Individuals with high FCQ-T-r scores (high trait food cravers, HCs) thought more often about high-calorie than low-calorie snacks whereas no differences were found in individuals with low FCQ-T-r scores (low trait food cravers, LCs). Further, the relationship between craving intensity and snack-related thoughts was stronger in HCs than in LCs. Higher craving intensity was associated with more consumption of snacks and again this relationship was stronger in HCs than in LCs. Finally, more snack-related thoughts were related to more frequent consumption of snacks, independent of trait food craving. Thus, HCs are more prone to think about high-calorie snacks in their daily lives and to consume more snack foods when they experience intense cravings, which might be indicative of a heightened responding towards high-calorie foods. Thus, trait-level differences as well as snack-related thoughts should be targeted in dietary interventions.

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## 1. Introduction

In today's obesogenic environment, sugary and fat-rich snack foods are often consumed at quantities that go beyond homeostatic needs (Cleobury & Tapper, 2014; McKiernan, Houchins, & Mattes, 2008), pointing to the relevance of non-homeostatic determinants of food intake (Lowe & Butryn, 2007). One of these determinants is the experience of food craving, which refers to an intense desire to consume a specific food (White, Whisenhunt, Williamson, Greenway, & Netemeyer, 2002) and which can occur in the absence of hunger (Pelchat & Schaefer, 2000). Food cravings are prevalent in societies characterized by abundant food

environments (Pelchat, 1997; Weingarten & Elston, 1991) and craved foods are usually high in sugar and fat, with chocolate being the most frequently craved food in Western societies (Rozin, Levine, & Stoess, 1991). Food cravings are quite specific in that they can be satisfied only by the craved—or very similar—food (Bruinsma & Taren, 1999). As food cravings have been associated with past dieting failures (Meule, Westenhöfer, & Kübler, 2011) and prospectively predict increased food intake and weight gain (Boswell & Kober, 2016; Meule, Richard, & Platte, 2017), knowledge about the characteristics of food cravings is relevant for health behaviors in various fields.

Food cravings are multidimensional experiences with cognitive, motivational, and behavioral facets (Cepeda-Benito, Gleaves, Williams, & Erath, 2000). According to the elaborated intrusion theory of desire, craving is a result of a cognitive elaboration of intrusive thoughts about a desired object (Kavanagh, Andrade, & May, 2005; May, Andrade, Panabokke, & Kavanagh, 2004),

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highlighting the role of food-related thoughts as a prerequisite for the emergence of food cravings. Thus, food cravings are not necessarily triggered by the presence of food stimuli, but can also occur spontaneously through mental imagery of the craved foods (Hallam, Boswell, DeVito, & Kober, 2016). These thoughts can also trigger consumption of the craved food, particularly when cravings are intense (Appelhans, French, Pagoto, & Sherwood, 2016; Hofmann & Van Dillen, 2012; Papies, Stroebe, & Aarts, 2007). There are also marked and stable interindividual differences in the frequency and intensity of food craving experiences, suggesting that some individuals think more frequently, crave more intensely and—as a consequence—likely consume more snack foods than others. Recent theorizing refers to such differences as tonic or *trait food craving* (Boswell & Kober, 2016; Hallam et al., 2016). Importantly, whereas state food craving is exclusively experienced as transient state in a particular moment, trait food craving refers to the experience of food cravings in general.

Laboratory and questionnaire-based studies revealed that individuals with elevated levels of trait food craving (i.e., high trait food cravers) seem to have a preference for high-calorie foods and are more susceptible to experience food cravings spontaneously or when confronted with external food cues. For instance, relative to low trait food cravers, high trait food cravers displayed an implicit approach tendency towards high-calorie foods (Brockmeyer, Hahn, Reetz, Schmidt, & Friederich, 2015) and showed more reward-related brain activity during food picture viewing (Ulrich, Steigleder, & Grön, 2016). High trait food cravers also reported higher craving intensity when they were asked to imagine their favorite food (Tiggemann & Kemps, 2005) or were exposed to pictures of palatable foods (Meule, Hermann, & Kübler, 2014; Meule, Skirde, Freund, Vögele, & Kübler, 2012). Similarly, high trait chocolate cravers displayed more positive implicit attitudes towards chocolate (Richard, Meule, Friese, & Blechert, *in revision*), higher reward-related brain activations during thoughts about chocolate (Miedl, Blechert, Meule, Richard, & Wilhelm, *submitted*), and had difficulties disengaging their attention from chocolate cues (Kemps & Tiggemann, 2009).

Although experiencing a food craving does not always result in subsequent food intake, previous studies reported positive associations between state (Meule & Hormes, 2015) and trait food craving (e.g., Martin, O'Neil, Tollefson, Greenway, & White, 2008) with consumption of the craved food in the laboratory. However, various situational and individual factors can affect whether craved foods are actually consumed (Hill, 2007). For example, the moderating effect of trait food craving on the relationship between state food craving and subsequent consumption has received little attention. Thus, further research is needed on how closely state cravings, thoughts about foods, and food consumption are interrelated as a function of trait food craving in everyday life.

Previous studies on the assessment of food cravings in everyday life, however, used paper-and-pencil methods such as the craving record sheet (Hill, Weaver, & Blundell, 1991). Here, participants entered craving episodes by hand each time they had felt an urge to consume a specific type of food regardless of consumption. It was found that momentary cravings co-occurred with thoughts about craved foods or the presence of these foods. Moreover, these cravings were often followed by consumption (Hill & Heaton-Brown, 1994). In a more recent study, both trait-level and state-level cravings were associated with consumption (Forman, Hoffman, Juarascio, Butryn, & Herbert, 2013), demonstrating the behavioral consequences of food cravings as well as the presence of interindividual differences. Similarly, total energy intake was higher in female trait food cravers than in non-cravers in a study using a three-day food record (Lafay et al.,

2001), which mainly resulted from consumption of between-meal snack foods.

Although these studies provided useful information about food cravings in naturalistic settings, findings are limited by shortcomings of paper-and-pencil measurements, such as low compliance rates and under-reporting of craving episodes (Berkman, Giuliani, & Pruitt, 2014), decreases in compliance across the study period (Massey & Hill, 2012), or backfilling of past events (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2003). Smartphone-based Ecological Momentary Assessment (EMA) in daily life may solve most of these limitations by including electronic prompting and, thus, appear suitable to address transient phenomena (i.e., state food cravings). In addition, hierarchical linear modeling was used in the current study to acknowledge both between-person (here: trait food craving) and within-person information (here: associations between craving intensity, snack-related thoughts, and consumption). Specifically, participants completed the Food Cravings Questionnaire-Trait-reduced (FCQ-T-r), followed by seven days of EMA by use of signal-contingent sampling. At five times per day, they indicated the amount of thoughts about snacks, craving intensity, and snack consumption via their smartphone devices.

The current study had three aims for characterizing food cravings in everyday life. A first aim was to examine the type of snack foods that participants craved most frequently. Based on previous questionnaire-based studies (Rozin et al., 1991; Weingarten & Elston, 1991), it was expected that the majority of craved snacks would be high-caloric and that the most frequently craved food category would be chocolate. A second aim was to expand the conceptual understanding of food cravings outside the laboratory. Specifically, the interrelations between thoughts about snacks, craving intensity, and snack consumption were examined (arrows A, B, and C in Fig. 1A). Given that a cognitive elaboration of food-related thoughts is essential for the emergence of food craving (Kavanagh et al., 2005), it was hypothesized that episodes with more snack-related thoughts would be characterized by higher craving intensity. As food cravings usually involve high-calorie foods, it was expected that the relationship between thoughts about snacks and craving intensity would be particularly pronounced when energy-dense snack foods were thought about. As thoughts about food and more intense food cravings are associated with higher intake of the craved food (Forman et al., 2013; Hill & Heaton-Brown, 1994; Meule & Hormes, 2015), it was further expected that higher craving intensity (arrow B in Fig. 1A) and more thoughts about snacks (arrow C in Fig. 1A) would result in higher snack consumption. A third aim was to examine associations between trait food craving and type of craved snacks, thoughts about snacks, craving intensity, and consumption of snacks (solid gray arrows in Fig. 1A), which would be indicative of the ecological validity of the concept of trait food craving. Based on previous laboratory and questionnaire-based studies (Brockmeyer et al., 2015; Martin et al., 2008; Meule, Hermann, et al., 2014; Richard et al., *in revision*), it was expected that individuals with high scores on the FCQ-T-r (i.e., high trait food cravers) would report more frequent thoughts about high-calorie snacks, crave more intensely, and also consume more snack foods than low trait food cravers. Finally, it was explored whether trait food craving moderated associations between thoughts about snacks, craving intensity, and consumption of snacks (dashed gray arrows in Fig. 1A). Specifically, it was assumed that the relationships between craving intensity, thoughts about snacks, and snack consumption may be more pronounced in high trait food cravers than in low trait food cravers.

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