



Pleasantness, familiarity, and identification of spice odors are interrelated and enhanced by consumption of herbs and food neophilia



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ABSTRACT

The primary dimension of odor is pleasantness, which is associated with a multitude of factors. We investigated how the pleasantness, familiarity, and identification of spice odors were associated with each other and with the use of the respective spice, overall use of herbs, and level of food neophobia. A total of 126 adults (93 women, 33 men; age 25–61 years, mean 39 years) rated the odors from 12 spices (oregano, anise, rosemary, mint, caraway, sage, thyme, cinnamon, fennel, marjoram, garlic, and clove) for pleasantness and familiarity, and completed a multiple-choice odor identification. Data on the use of specific spices, overall use of herbs, and Food Neophobia Scale score were collected using an online questionnaire. Familiar odors were mostly rated as pleasant (except garlic), whereas unfamiliar odors were rated as neutral ($r = 0.63$). We observed consistent and often significant trends that suggested the odor pleasantness and familiarity were positively associated with the correct odor identification, consumption of the respective spice, overall use of herbs, and food neophilia. Our results suggest that knowledge acquisition through repetitive exposure to spice odor with active attention may gradually increase the odor pleasantness within the framework set by the chemical characteristics of the aroma compound.

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1. Introduction

Olfaction (the sense of smell) is a central sensory modality guiding food preferences. The principal information that olfaction conveys is the hedonic value (valence, pleasantness) of an odor (Stevenson & Mahmut, 2013; Yeshurun & Sobel, 2010). Humans are poor at naming odors, but it is usually easy to tell whether we like an odor or not. However, the hedonic value of an odor is subjective and changeable. It is modified by various environmental factors, including cognitive inputs. In addition, it has been shown that for some odorants, such as androstenone, genetic variation in the olfactory receptor for the odorant can account for some variation in

liking for the respective odor (Keller, Zhuang, Chi, Vosshall, & Matsunami, 2007). However, twin studies have observed that the total effects of environmental factors are usually higher than the total effects of genetic factors on the pleasantness of odors (Finkel, Pedersen, & Larsson, 2001, pp. P226–P233; Knaapila et al., 2008, 2012). Thus, genetic factors may set the limits within which the environmental factors can modulate the hedonic value of an odor.

Rouby, Pouliot, and Bensafi (2009) organized the modulators of odor hedonics into three categories, (1) the stimulus itself (intensity and frequency of exposure), (2) the individual perceiver (e.g., sex, hormonal status, emotional state, physiological state, and sensory-specific satiety), and (3) the context in which the two are put in contact (experimental task, semantic knowledge, and cultural background). The authors recommended that all three categories of modulators should be considered, in addition to the route of stimulation (i.e., orthonasal/retronasal route), when planning sensory studies on foods.

Many studies have shown that the rated pleasantness and

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familiarity of odors are correlated, at least among neutral and pleasant odors (Delplanque et al., 2008; Distel et al., 1999; Ferdenzi et al., 2013; Royet et al., 1999; Sulmont, Issanchou, & Köster, 2002). However, it is not completely understood how this association evolves: whether people tend to continually expose themselves to odors that they find pleasant at the first exposures, or whether they gradually start to like odors as they become more familiar (providing the odor source produces no adverse effects). Recently, Schloss, Goldberger, Palmer, and Levitan (2015) proposed that the hedonic value of an odor is based on the sum statistics of the valences of previous experiences related to that odor. The authors pointed out that the model they used (ecological valence theory) applies only to familiar odors. However, they speculated that preference for a truly novel odor should be neutral.

Another factor associated with odor preferences in food is food neophobia (for a review see Demattè, Endrizzi, & Flavia Gasperi, 2014). Food neophobia is defined as reluctance to eat and/or avoidance of novel foods (Pliner & Hobden, 1992). Food neophobic children had less variety in their diet than did food neophilic children (Falciglia, Couch, Gribble, Pabst, & Frank, 2000) and food neophobia correlated negatively with the use frequency of several food categories in young adults (Knaapila et al., 2011). In a laboratory experiment, Raudenbush, Schroth, Reilley, and Frank (1998) demonstrated that food neophobics sniffed odor samples less vigorously than did food neophilics. Limited sniffing exploratory behavior, together with fewer contacts with new foods, can be assumed to limit exposure to food odors. Therefore, it can be hypothesized that food neophilics perceive food odors as less familiar and less pleasant than do food neophilics. Indeed, Raudenbush et al. (1998) observed that on average, food neophobics rated the sampled odors as less pleasant than did food neophilics. Furthermore, Demattè et al. (2013) showed that odor identification abilities of the neophobic participants were poorer than those of the non-neophobics. Based on the observation of Raudenbush and Frank (1999) that food neophobics responded more negatively to *unfamiliar* foods than did neophilics (but that both groups responded similarly to *familiar* foods), we analogously hypothesized that food neophobics differ from neophilics in their responses to unfamiliar (but not familiar) food odors.

Dried herbs and other odorous spices provide a versatile selection of natural odor stimuli to study human responses to (food) odors. Therefore, we tested our hypotheses using spices. We established our hypotheses on the previous findings that the rated pleasantness of an odor correlates with the familiarity of the odor, and both are associated with correct identification of the odor. First, we hypothesized that the habitual consumption of the spice (reflecting exposure to the odor source) is associated with both pleasantness, familiarity, and correct identification of the spice odor. Second, on a more general level, we hypothesized that the more frequently a person uses herbs in cooking and baking, the higher she/he scores in the identification of spice odors. Third, we hypothesized that the level of food neophobia (or neophilia) is associated with responses to the spice odors, particularly in the case of odors that are rated, on average, as *unfamiliar*.

The present study aimed to test the hypotheses above listed in adults, to advance understanding of the relationships among overall and specific consumption of herbs/spices, responses to spice odors (pleasantness, familiarity, and identification), and food neophobia/neophilia.

2. Methods

2.1. Overview

This cross-sectional study consisted of two consecutive parts.

First, an online survey and second, a laboratory study. Initially, we sent an invitation by email to 2379 adults (who were previously enrolled in a large family study unrelated to eating) to take part in the online survey that included questions related to olfaction, spices, eating, and demographics (detailed below). The survey was completed by 814 individuals (34.2% of the invited). Then, we invited the respondents who indicated a potential interest in a research visit ($n = 618$) to participate in the laboratory study. This part of the research included a visit to a sensory laboratory to assess a set of olfactory stimuli for pleasantness, familiarity, and identity, and complete a short questionnaire (detailed below).

Here, we analyzed the data from all the 126 individuals who completed the laboratory part of the study, including eight persons for whom the online survey data were not available. Instead, the data from the respondents of the online survey who did not participate in the laboratory part ($N = 696$) were excluded from the present analyses, together with some variables unrelated to the present topic (to be reported elsewhere).

Ethical aspects of the study protocol were evaluated and accepted by the Ethical Committee of the University of Turku. The participants of the study had the freedom to cancel their participation at any time. In the laboratory study, we collected a written informed consent from each participant prior to starting their data collection. We rewarded each participant in the laboratory study for her/his time and efforts with a movie voucher.

2.2. Participants

We recruited the participants from the adults involved in the intensive follow-up group of the Steps to the healthy development and well-being of children (STEPS) study. The STEPS is an on-going longitudinal cohort study on children and their parents in Southwest Finland. The detailed cohort profile of the STEPS study, including ethical considerations, has been reported by Lagström et al. (2013). All participants lived in Finland and were Finnish-speaking (we communicated with them in Finnish only). Therefore, even if we did not ask their ethnicity, it is likely that most, if not all, participants were Caucasian and of Finnish descent.

A total of 126 individuals, 93 women (73.8%) and 33 men (26.2%), completed the laboratory study. Age of the participants ranged from 25 to 61 years. The mean age was 38.7 years ($SD = 5.1$) and the median was 38.0 years. The women were, on average, slightly younger than the men (mean ages 38.0 and 40.7 years, respectively; $t(124) = -2.63$, $p = 0.010$). Additional demographics, collected using the online survey, were available for 118 (93.7%) of the 126 participants in the laboratory study (Table 1).

2.3. Online survey

2.3.1. Procedure

An invitation to the online survey was emailed to all Finnish-speaking adults of the STEPS follow-up group for whom a valid email address was available, who had not refused to be contacted and to whom no other surveys were recently sent by the STEPS researchers. For practical reasons, no invitation was sent by mail and all communication was in Finnish only. It was possible to complete the survey during three months from the day the invitations were emailed (March 5th, 2014). After a little over a month from the first invitation, a reminder email message was sent.

The online survey was created using Webropol 2.0 online survey software (Webropol, Helsinki, Finland). In addition to collecting information on demographics and dietary orientation (reported above), we used the online survey to measure the participants' use of spices and level of food neophobia/neophilia (detailed below).

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