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Human Affective Response to Cooking Fire Odor

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Abstract

The attraction of men to barbecue grills seems spread cross-culturally, but it has never been approached scientifically. The barbecue grill might be viewed as the urban version of a campfire. The control of fire has shaped human evolution substantially by providing warmth, light, scaring away predators and enabling cooking. However, aside from the direct threat of the heat, fire represents a potential hazard due to toxic chemical compounds in fire smoke. In this study, the affective emotional response to olfactory stimuli of cooking fire smoke flavors is tested for the first time. In addition to the descriptive approach, we hypothesized that women should avoid fire as a potential hazard rather than men, considering the theory of unequal parental investment. Thus, fire odor should evoke stronger repellent feelings in women. Via the method “Emotion and Odor Scale” 105 normosmic young adults rated their emotions evoked by odor stimuli. Five different fire odor samples were presented in the form of “Sniffin’ Sticks”. Participants responded towards fire smoke odors with positive feelings and women responded to a particular odor with increased feelings of well-being. However, women showed ambivalent emotions, as they felt more disgusted by two smoke odors. Men reported stronger attraction to fire than women. These findings support the idea that women have evolved olfactory functions, which lead to more sensitive affective response to fire. Our study emphasizes the complexity of human affective response to fire in accordance with its critical role in human evolution.

Keywords: fire, olfaction, affect, gender, Emotion and Odor Scale, Sniffin’ Sticks

Human Affective Response to Cooking Fire Odor

Media spread the notion that barbecue grilling is typically male, however this is rather based on personal observations than on scientific facts. The barbecue grill might be viewed as the modern version of a campfire in the urban area and similar behavior as in our evolutionary past could be evoked by the perception of the situation. In this study we posed the question, if we can measure scientifically that men are attracted by barbecue grills more than women, and made a first step towards probing the causes for this behavior. The fire, the grilled food, the meat, and the social situation could represent evolutionary triggers. We tested gender-related differences in the olfactory perception of fragrances occurring at barbecue events. Two theses were established, each elucidated the affective response to a particular odor source, meat (Rennisch, Ramesmayer, Schaman, & Grammer) and cooking fire (this study).

The ability to control fire is an exceptional human trait and is considered as having shaped our evolution crucially. Fire has presented several benefits like warmth, light and cooking (James et al., 1989). Humans are the only living species that are adapted to a heat-processed diet, as much as they cannot survive on exclusively raw food, especially in the wilderness (Wrangham & Carmody, 2010). Cooking advances the nutritive value substantially by softening fibers its chewing and digesting would be time and energy intensive, and furthermore it makes food safer by inactivating microorganisms and denaturing toxins (Stahl et al., 1984; Wrangham & Carmody, 2010).

It is difficult to draw conclusions at what time hominids started to regularly use fire. Regarding archeological data, earliest claims date about 2.5 to 1.5 mya in Africa and hearths can be ascertained from the middle Pleistocene on (about 800 mya) (Goren-Inbar et al., 2004;

James et al., 1989). Hominid findings suggest two significant increases of brain size in human evolution. According to the expensive tissue hypothesis the first major increase at the transition from *Australopithecus* to habilines at about 2 mya is the consequence of an increased meat consumption, which contain high-value proteins, and the second increase at about 0.6 mya (*Homo erectus* to *H. heidelbergensis*) represents the consequence of cooking (Aiello & Wheeler, 1995). Hence hominids would have learned to use fire relatively late in human evolution and fire would have had low impact on human biology (Wrangham & Carmody, 2010). However, anatomical changes from about 1.9 mya on, at the transition from late australopithecines or early *Homo* to *H. erectus*, such as the increase in brain size, reductions of masticatory and gastrointestinal anatomy as well as reduced inter-birth intervals suggest significant biological adaptations towards an easy digestible diet with massively enhanced energetic gain that could rather be explained by cooking (Dunsworth, 2010; Wrangham & Carmody, 2010). It should be mentioned that this “cooking hypothesis” has challenged the social brain hypothesis just insofar, as it explains where the huge amount of extra energy could stem from, which allowed an enhancement of costly brain material without having enhanced metabolic rates compared to other primates (Wrangham, 2009).

In their comprehensive work about human adaptation to fire Wrangham and Carmody argue that fire use can explain various aspects of the unique human life style (Wrangham & Carmody, 2010). First, fire use might have been a prerequisite for an obligate terrestrial lifestyle in order to expel predators, especially when sleeping on the ground. That would be another argument that speaks for the ability of *H. erectus* to master fire, as the hominid is suggested to represent the first obligate biped and to have had reduced arboreal skills. Second, fire use could have implemented adaptations which lead to the unique human life history

pattern, e.g. routinely high fertility, short interbirth intervals, early weaning, and senescence, to mention the most important. Third, fire use can solve the problem of heat loss due to reduced body hair, which gives an advantage over parasites (Pagel & Bodmer, 2003) and facilitates long distance running in consequence (Wheeler, 1992). Fourth, the “control of fire hypothesis” is compatible with all theories that are build upon or profit from a save, nutrient-rich and constantly available diet to explain human exceptional longevity, such as the “grandmother hypothesis” (Hawkes et al., 1998), the “embodied capital model” (Kaplan, Hill, Lancaster, & Hurtado, 2000), the “mutation accumulation theory” (Medawar, 1952) as well as the “antagonistic pleiotropy model” (Williams, 2001). Mastering fire also demands cognitive and social capabilities, such as problem solving, planning, cooperation and respect for ownership (Wrangham & Carmody, 2010). (Wrangham & Carmody, 2010)

The social impact the night campfire has had on hunter-gatherer societies is complex. It has represented the place where the group meets at the end of the working day. Fire light has elongated the day with light, which has been too dim for productive labor and thus fire might have been the basis for the evolution of culture (Wiessner, 2014). In her study of !Kung hunter-gatherers Wiessner found that topics of communication shifted from mainly labor organization and gossip at daytime towards spiritual rituals and creative acts with teaching character, such as storytelling at night (Wiessner, 2014).

However, fire also represents a direct life threat and a potential hazard due to toxic chemical compounds in fire smoke, especially carbon monoxide, which might be inhaled. Given the crucial role fire has played in our evolution, its perception should trigger strong emotional response.

There have been exhaustive debates about the definition of emotion. Dimensional concepts of emotion exist, saying that emotions can be classified into dimensions of valence, intensity and in some cases time (Wundt, 1913). Other concepts categorize emotions into distinct phenomena, as the approach that complex emotions are composed of basic or primary emotions, which are cross-cultural (Schmidt-Atzert, 1996). Ekman's basic emotions, joy / happiness, sadness, fear, anger, disgust, and surprise are preferably used in behavioral and psychological studies (Ekman, 1992). Kleinginna and Kleinginna reviewed about 100 definitions to create a working definition of emotions (Kleinginna & Kleinginna, 1981):

“Emotion is a complex set of interactions among subjective and objective factors, mediated by neural-hormonal systems, which can (a) give rise to affective experiences such as feelings of arousal, pleasure/displeasure; (b) generate cognitive processes such as emotionally relevant perceptual effects, appraisals, labeling processes; (c) activate widespread physiological adjustments to the arousing conditions; and (d) lead to behavior that is often, but not always, expressive, goal-directed, and adaptive.” (p. 355)

Neurobiological findings indicate that emotional stimuli trigger modulations of neural systems in the Amygdala, which initiate cognitive and social responses subsequently (Anderson & Phelps, 2000; Phelps, 2006; Whalen et al., 1998). The resulting physiological reactions should prepare the organism to responsive behavior, which is often adaptive and may be lifesaving (Brandstätter, Schöler, Puca, & Lozo, 2013). The Amygdala is allocated to the limbic system and is implicated to play a role in an array of emotional processes, such as aversive conditioning, reward learning and motivation as well as emotional states associated with aggressive, maternal, sexual and ingestive behaviors (Phelps & LeDoux, 2005).

Disrupted functions of the Amygdala have been associated with changes in fear conditioning in animals and humans (LeDoux, 2012) and with various psychiatric disorders (e.g. Herpertz et al., 2001; Rauch et al., 2000). The human Amygdala is shown to respond to the perception of emotional faces (e.g. Morris et al., 1996; Whalen et al., 1998) and of odorants by various functional magnetic resonance imaging (fMRI) studies (e.g. Anderson et al., 2003; Koch et al., 2007).

In addition to the crucial function in processing emotions, the Amygdala has the function of processing olfactory stimuli (Schablitzky & Pause, 2014; Soudry, Lemogne, Malinvaud, Consoli, & Bonfils, 2011). Subsequent to the sensory perception of an odorant, the chemical gets translated into a nerve signal in the olfactory neuroepithelium, is then sent to the olfactory bulb, which signals the cues to secondary olfactory structures, such as the piriform cortex (Soudry et al., 2011). Olfactory information is processed in tertiary olfactory structures, of which the Amygdala, the Hippocampus, the orbitofrontal cortex, the insula and the anterior cingulate cortex represent some of the structures, which are involved in processing emotions as well (Soudry et al., 2011).

Due to the structural overlap of olfactory and emotional processing in the limbic system, smell-induced affect became an attractive new research field (Soudry et al., 2011). Odors potentially evoke emotions that trigger mechanisms to adapt humans to the environment (Ferdenzi et al., 2013). Thus, the olfactory-emotional system presumably represents a key function shaping human evolution.

Various studies have shown that odor stimuli can alter humans' emotional state (Knasko, 1992, 1995; Schiffman, Sattely-Miller, Suggs, & Graham, 1995). Orange and lavender aromas, for instance, were shown to have relaxing effects in a dental office (Lehrner,

Marwinski, Lehr, Jöhren, & Deecke, 2005). The effect of odors on shopping behavior is of huge interest (e.g. Chebat & Michon, 2003; Morrin & Ratneshwar, 2000) and more recent findings indicate an association of aberrant olfactory perception with psychiatric disorders (e.g. Lombion-Pouthier, Vandel, Nezelof, Haffen, & Millot, 2006; Schablitzy & Pause, 2014).

There is no consensus among researchers about an appropriate way to investigate the affective impact of odors on humans hitherto. The debate emphasizes the complexity of human feelings, of which the description depends on the sense of interest and on the context, e.g. body odors or food aroma. Most psychological emotional studies use the dimensions intensity, valence, and sometimes familiarity (e.g. Delplanque et al., 2008; Winston, Gottfried, Kilner, & Dolan, 2005), Russel's circumplex model of affect, including pleasure, arousal and dominance (Russell, 1980), or basic emotions theories (e.g. Ekman, 1992). However, most of them deal with visual stimuli. Particularly regarding olfaction many approaches are not suitable. The concept dealing with the dimensions intensity, valence (and familiarity) seems superficial, because it sums up diverse positive and negative feelings in one bipolar scale of the dimension valence. Russel's dimension of dominance (Russell, 1980) seems of minor relevance to supply participants with terms to express their conscious subjective feelings in response to food aroma. In response to odors basic emotions like joy / happiness and disgust are used frequently, whereas fear and sadness are expressed rarely, in contrast to the feedback to visual cues (Alaoui-Ismaïli, Robin, Rada, Dittmar, & Vernet-Maury, 1997; Bensafi et al., 2002).

Recently, Ferdenzi and colleagues (Ferdenzi et al., 2013) have established a standardized method "Emotion and Odor Scale" (EOS) for examining the affective responses

to odors in higher depth and for diverse odor categories. The authors attempted to attend the concept of affection comprehensively and regarded feelings, attitudes, personality traits and moods (Ferdenzi et al., 2013). To take cultural and language differences into account, diverse EOS catalogues have been established dedicated to various countries and verified there, and a universal consensus catalogue (uniGEOS) in English has been generated for use in other countries (Ferdenzi et al., 2013).

Olfactory function had the reputation of being regressed during human evolution and thus having low significance, hence human sense of smell has been largely underestimated in the past (Kohl, Atzmueller, Fink, & Grammer, 2001). However, behavioral studies suggest that nasal, retronasal and olfactory brain structures as well as language compensate successfully for the lack of functional olfactory receptor genes and that humans are very good smellers, or “macrosmats” (Laska, Seibt, & Weber, 2000; Shepherd, 2004).

Age and gender related differences in olfactory performance are in focus of many studies (Brand & Millot, 2001; Doty & Kamath, 2014). Human olfactory function starts to decrease significantly at about 60 to 65 years of age (Doty, Shaman, Applebaum, et al., 1984; Doty & Kamath, 2014). The effect of gender is complex; however if differences are found women usually outperform men (Brand & Millot, 2001). This applies to general olfactory abilities (e.g. Hummel, Kobal, Gudziol, & Mackay-Sim, 2007; Kobal et al., 1996, 2000; Thuerauf et al., 2009 but Larsson et al., 2000; Venstrom & Amoore, 1968) as well as single odorants of interest (e.g. Doty & Cameron, 2009). Moreover, there is some evidence that smoking habits and medication could impact olfactory performance (Doty & Kamath, 2014; Katotomichelakis et al., 2007; Lötsch, Geisslinger, & Hummel, 2012; Ship & Weiffenbach, 1993; but Venstrom & Amoore, 1968).

A handful of well-established and practical methods to measure olfactory performance exist (Hummel, Sekinger, Wolf, Pauli, & Kobal, 1997). To name the most popular, the University of Pennsylvania Smell Identification Test (UPSIT) is a “scratch and sniff” test to measure odor identification abilities (Doty, Shaman, Kimmelman, & Dann, 1984). With the Connecticut Chemosensory Clinical Research Center (CCCRC) test odor threshold and identification performance are determined via squeeze-bottles (Cain, Goodspeed, Gent, & Leonard, 1988). The “Sniffin’ Sticks” test considers olfactory threshold (T), odor discrimination (D) and identification (I) abilities, which are combined to the “TDI score” (Hummel et al., 1997; Kobal et al., 1996). Sniffin’ Sticks are quick and easy to handle “pen-like odor dispensing devices” (Kobal et al., 1996). The tool is widely used in the clinical (e.g. Hüttenbrink, 1997) as well as in the psychological context (e.g. Papo et al., 2006; Stevenson, Prescott, & Boakes, 1999) in order to evaluate an individual’s olfactory function comprehensively.

We used Sniffin Sticks to observe human affective feelings evoked by the chemosensory perception of cooking fire smoke odors. This study is the first one dedicated to this topic and we approached it descriptively. In addition we expected women to feel more repelled by fire smoke odors, since women usually avoid potential hazards more carefully than men in order to protect herself and her offspring, considering the theory of parental investment (Kaplan & Lancaster, 2003).

Method

Participants

A total of 105 subjects (54 women and 51 men) participated in the study after exclusion of individuals with metabolic disorders (e.g. phenylketonuria) as well as individuals with decreased olfactory abilities (TDI score of less than 31 in the Sniffin' Sticks test). Criteria for choosing the participants were health condition, age, language, and familiarization to similar food. Subjects were healthy and did not suffer from acute allergies, which could impair olfactory abilities. The age of the participants ranged from 18 to 39 years, because in that life span olfactory performance reaches a peak (Doty & Kamath, 2014). In order to prevent language-related misunderstandings we included German-speaking individuals only and used German terms describing emotions. Participants were Caucasian and spent at least two years in Austria to ensure that they are used to similar food tastes.

Materials

Stimuli. Samples of five different cooking fire smoke flavors provided by Red Arrow Handels-GmbH (Bremen, Germany) were chosen randomly: "CharDex H", "Natural Mesquite Smoked Maltodextrin", "Natural Hardwood Smoked Maltodextrin", "SmokeZ C-10", and "SmokeZ Oil H SF". Since the flavors are designed for taste and smell, appropriate concentrations for smell-exclusive use were tested. About ten individuals volunteered to describe the intensities of Sniffin' Sticks filled with different concentrations of the flavor samples. The resulting final concentrations and properties of the flavor samples are given in Table 1. "SmokeZ Oil H SF" was dissolved in common household clarified sunflower oil and the remaining samples were dissolved in ultrapure water. Lipid and water solutions were

preserved using α -Tocopherol (about 10% final concentration) and sodium benzoate (0.06% final concentration), respectively. 5mL of the solutions were transferred into fresh Sniffin' Sticks and stored upside down at 4° C for a minimum of 24 hours before first use. We used five standard Sniffin' Sticks (Burghart, Germany), lemon, pear, ginger, garlic, and mushrooms as controls by introducing variation and to camouflage the substance of the experiment. Additionally, five meat flavors were used for the associated study (Rennisch et al.). Throughout the study all Sniffin' Sticks in use were kept upside down, stored at 4° C and warmed to room temperature at least 30 minutes before use.

Affective ratings. We used the “Emotion and Odor Scale” (EOS) (Ferdenzi et al., 2013) to assess the participants' affective response to the odor stimuli. The 25 affective terms of the universal EOS scale (uniGEOS) (Ferdenzi et al., 2013) were translated into German language using the online dictionaries dict.cc GmbH (www.dict.cc) and LEO GmbH (www.leo.org). For each affective term, one of the first few terms listed in the dictionaries, which was considered a common Austrian expression, was chosen and loanwords were avoided (find the selected terms in Table 2). In addition to that back-translation was checked. By the use of the computer-rating system “Emotional Systems” (Grammer, Abend, Welke, & Holzleitner, 2013), subjects evaluated the 25 affective terms of the uniGEOS scheme for each odor stimulus. The experimental setup was a desk with a computer screen and a tray with numbered odor samples in the form of Sniffin' Sticks (Figure 1). The rating system was constructed of an instruction page and one individual page per odor sample presenting the 25 affective terms. To rate subjective intensities alongside each affective term we arranged a scale growing in size from the left side to the right side indicating the intensity poles “not at all” (value 0) on the left side and “extremely intense” (value 200) on the right. At the onset all

cursors were placed at the left side (value 0). The affective terms as well as the odor sample numbers appeared in random orders on the screen.

Olfactory function. In order to consider normosmic subjects exclusively, their olfactory function was assessed. Via the Sniffin' Sticks test we measured olfactory threshold, odor discrimination and odor identification abilities (Hummel et al., 1997; Kobal et al., 1996). The test was performed following the manufacturer's protocol of testing both nostrils concurrently. Odor threshold was evaluated using *n*-butanol.

Questionnaire. In a questionnaire descriptive data were ascertained including sex, age, nationality, country of birth, hormonal contraception (women), intake of medication, smoking habits, food allergies and intolerances of the participants. Subsequently, we asked questions about their behavior in the presence of potential cooking fire, for instance campfire and barbecue grills (Table 3 and find the original German text in Table 4).

Experimental environment. The experiments were performed in two cities of Austria, Vienna and Eisenstadt. We attempted to keep away smell by using an air cleaner (Comedes LR 200; Comedes GmbH, Landau a.d. Isar, Germany), which was turned on 30 minutes before each experimental session and kept active meanwhile. Participants were requested not to smoke, eat and drink (except for water) 15 minutes before the tests, as recommended by the manufacturer of the Sniffin' Sticks (Burghart, Wedel, Germany), and not to use perfume. Experimenters as well obeyed the instructions and additionally spared fragrant cosmetics. Participants as well as experimenters wore fresh and closed lab coats and tied long hair.

Procedure

The empirical data collection was composed of three parts. First, we tested the participants' olfactory function, second, their affective response to cooking fire smoke odors, and third, we collected relevant data via a questionnaire. Tasks were performed in random order, except that the affective ratings were performed before the questionnaire task in every case, in order to avoid a bias due to knowledge of the topic.

Olfactory function was evaluated using the extended version of the Sniffin' Sticks test following the manufacturer's protocol for testing both nostrils concurrently (Hummel et al., 1997).

The evaluation of the subjects' affective response to cooking smoke flavors was performed using a computer-rating system. Subjects sat in front of a desk with a computer screen and a tray with numbered odor samples in the form of Sniffin' Sticks (see the experimental setup in Figure 1). They were requested to describe their feelings evoked by each odor sample using 25 given terms (Table 2), successively. For that, the screen would give them the number of the respective Sniffin' Stick. They should open up the corresponding stick and smell it for about three seconds, keeping a distance of 2 to 3 centimeters to the nostrils, then close the stick and put it back into the tray upside down. Subjects were free to repeat the smelling procedure if necessary. Subsequently, they should move the cursor of each affective term to the appropriate subjective intensity on scales ranging from "not at all" on the left side to "extremely intense" on the right side. When they were finished, they should click the "next" button and apply the same procedure for the following samples, respectively.

We provided drinking water for odor neutralization during the whole experiment.

Results

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 22 (IBM Corp., Armonk, New York, USA) for Macintosh. The alpha level was set at .05. All given significance levels of interference statistics are two-sided.

Sample description. Data of 105 normosmic subjects, 54 women and 51 men, were statistically analyzed. Women, including 17 smokers, had a mean age of 26.48 years ($SD = 0.527$) and a mean TDI score of 36.45 ($SD = 0.38$), ranging from 31 to 41. Men, including 21 smokers, had a mean age of 27.69 years ($SD = 0.702$) and a mean TDI score of 35.31 ($SD = 0.42$), ranging from 31.5 to 43.5. Note that participants with a TDI score of less than 31 had been excluded from analyses. Find the single test scores of women and men in Figure 2.

Smoke odors evoked more Disgust and Well-being in women. Ferdenzi and colleagues (Ferdenzi et al., 2013) originally categorized the affective terms into nine factors (“affective categories”), whereas in this study factor analysis of EOS ratings resulted in five factors (Table 2). Terms of the category Well-being were clearly used most abundantly, yielding a factor load of 32.141 compared to factor loads of 12.049 for Energy/Interest, 6.191 for Disgust, 5.548 for Nostalgia/Spirituality, and 4.388 for Appetite. We analyzed gender effects of the affective impact of the cooking fire smoke odor stimuli. At the perception of two of the five smoke flavors (“SmokEz Oil H SF“ and “CharDex H”) women rated their feelings significantly more intense in the affective category Disgust than men (Mann-Whitney tests, $U = -2.007, p = .045$ and $U = -1.972, p = .017$, respectively). At the same time, the charcoal smoke odor „CharDex H” elicited higher levels of the category Well-being in

women than in men (Mann-Whitney U-test $U = -2.388$, $p = .049$). Boxplots depicting the gender effects are given in Figure 3.

Potential cooking fire attracted men stronger than women. Relevant questions of the questionnaire are given in Table 3 and are referred to in the following text. At the thought of (controlled) fire (question 1) men clearly described their feelings more positive than women (Fisher's exact test (FET) = 11.091, $p = .026$) (Figure 4) on a scale ranging from 1 (very bad) to 7 (very good). Men and women reported similar affective impact when residing near fire (FET = 3.59, $p < .681$) (question 2) as well as sensing fire visually (FET = 5.69, $p < .121$) (question 3), olfactorily (FET = 6.32, $p < .275$) (question 4) and auditorily (FET = 3.87, $p < .434$) (question 5). Whereby reported affective feelings about the smell of fire (question 4) were favorable, with the smallest ratings being 5.02 for women and 5.41 for men on a scale ranging from 1 (very unpleasant) to 7 (very pleasant). (Figure 4)

Mann-Whitney U-tests of the participants' questionnaire reports resulted in significant gender differences. Men rating higher pleasure at barbecue grilling events ($U = -2.238$, $p = .025$) (question 6), to prepare grilled food ($U = -6.141$, $p < .001$) (question 7), and higher frequency of doing so ($U = -6.351$, $p < .001$) (question 8). Men and women reported to like grilled food ($U = -0.955$, $p = .341$) (question 9), the smell of grilled food ($U = -0.180$, $p = .857$) (question 10) as well as the smell of the smoke, which rises at the barbecue ($U = -0.784$, $p = .436$) (question 11) with similar intensities. Furthermore, we found no significant difference in the reported affective state of women and men when residing close to a barbecue grill ($U = -1.592$, $p = .112$) (question 12).

Women reported to be more sensitive concerning the smell, flavor and/or texture of food (Mann-Whitney U-test; $U = -2.266$, $p = .023$) (question 13). Participants reported to

observe men (90%) to prepare the grilled food, rather than women (1%) or both with equal frequencies (8%) (question 14). Men reported to prepare the grilled food and to light the barbecue grill at family barbecues significantly more often than women ($\chi^2 (1, N = 105) = 16.13, p < .001$ and $\chi^2 (1, N = 105) = 29.383, p < .001$, respectively) (questions 15 and 16). The majority of the participants stated to prefer fireplaces with visible fire in the living area (84%) compared to other heating systems (11% favor fireplaces with nonvisible fire, 1% gas heating and 4% electric heating) (question 17).

Women outperformed men in their olfactory ability and hormonal contraception enhanced their odor sensitivity. Women showed significantly higher combined TDI scores (student's t-test; $t (103) = 2.062, p = .042$) and odor discrimination performance (student's t-test; $t (103) = 2.335, p = .022$) as well as a trend towards better identification abilities (Mann-Whitney U-test; $U = -1.839, p = .066$) (Figure 2). Concerning odor threshold no significant gender difference was measured (student's t-test; $t (103) = -0.48, p = .962$). However, women taking hormonal contraception clearly showed higher sensitivity than other women (Mann-Whitney U-test; $U = -2.050, p = .040$). They did not show higher combined TDI scores, odor discrimination or identification abilities than women who do not take hormonal contraception (Mann-Whitney U-tests; $U = -1.168, p = .247$; $U = -0.027, p = .982$; and $U = -0.640, p = .531$, respectively).

Smoking habits had no effect on olfactory test performances. Student's t-tests resulted in $t (103) = -0.994, p = .322$ for the TDI score, $t (103) = -1.399, p = .165$ for odor threshold, and $t (103) = 0.202, p = .841$ for discriminative abilities, and a Mann-Whitney U-test yielded $U = -0.181$ and $p = .859$ comparing the identification proficiencies of smokers versus non-smokers.

Discussion

Cooking fire is perceived favorably and women harbor ambivalent feelings towards fire

The controversial affective responses to the perceived fire odors show concordance with the diverse effect of fire on humans, being essential on the one hand and representing a serious threat on the other. The EOS ratings as well as the questionnaire resulted in high attraction of the participants towards cooking fire. However, our findings suggest that women are more ambivalent in their affective response to the proximity of fire, as they showed significantly less attraction and more aversive feelings.

Smoke odors evoked more Disgust and Well-being in women. In the EOS ratings the most frequently used affective category associated with the cooking fire smoke odor cues was Well-being, shown by the highest factor load. Women responded to one of the smoke odors with significantly increased levels of Well-being. Interestingly, two specific smoke flavor stimuli evoked stronger feelings of Disgust in women than in men (Figure 3).

Regarding the three major functions of olfaction, namely ingestion, avoidance of environmental hazards and social communication (R. J. Stevenson, 2010), the first two functions presumably play a role in human fire perception. Open fire represented the basis for cooking over the majority of our evolutionary time, maybe since about 1.8 mya and at least since the middle Pleistocene (Dunsworth, 2010; James et al., 1989; Wrangham & Carmody, 2010). Thus, cooked food has contained aroma and flavor of fire smoke and wood at least until the invention of the closed hearth in the 18th century and still does in case of cooking strategies involving open fire, such as campfires and barbecue grills. The positive feelings associated with fire odor might reflect the olfactory function of ingestion. Additionally, women rated stronger feelings of Disgust at the perception of two smoke odors. Disgust is an

emotional feeling, which is typically associated with danger avoidance (R. J. Stevenson, 2010). The gender effect might be explained by Kaplan and Lancaster's theory of unequal parental investment and women's pronounced cautious behavior (Kaplan & Lancaster, 2003).

To our knowledge no study has focused on human affective response to fire smoke odors hitherto. Few studies have used a single smoke odor and smoked meat odors among many other stimuli (e.g. Delplanque et al., 2008; Ferdenzi et al., 2013). Delplanque and colleagues (Delplanque et al., 2008) classified agarwood smoke odor as pleasant in their study about emotional processing of odors. In contrast, Ferdenzi and colleagues (Ferdenzi et al., 2013) found a significant gender by odor interaction at the category Disgust and the effect depended on the odor source, as smoky, sulfuric, human and animal odors evoked higher disgust in women. The authors further showed that feelings of disgust decreased with identification of fire smoke (Ferdenzi et al., 2013). A correlation of stronger positive impact with higher identification rate has been recognized in other studies for some, but not all odorants (e.g. Moustafa Bensafi, Rinck, Schaal, & Rouby, 2007; Distel et al., 1999; Herz, 2003). At the same time, an innate hedonic polarity towards evolutionary relevant odors in concordance with their biological role is evident (Khan et al., 2007). Herz found that potentially threatening odor cues are quickly recognized and alerting, however, do not get cognitively processed as diligently as positive stimuli (Herz, 2003). Thus, concerning aversive odors, protection from the odorous source seems to dominate over the motivation of identifying it.

Cooking fire attracts men more than women. Both genders reported pleasure when sensing potential cooking fire visually, olfactorily and auditorily (Figure 4). In addition, men reported significantly higher attraction towards fire than women, for instance, they stated to

feel more comfortable at the thought of controlled fire (Figure 4). Men also indicated higher pleasure of grilling and preparing grilled food and do so more often than women. Ninety per cent of the subjects stated that men typically prepare the grilled food. The observation that fire making is a task mainly accomplished by men in traditionally living societies while cooking is assigned to women almost exclusively has been reported in a study of sexual division of labor (White, Burton, & Brudner 1977).

Women reported to enjoy eating grilled food just as men did. These similar reported taste preferences indicate that the gender effect depends on another component, such as the open fire.

Women outperform men in their olfactory proficiencies and hormonal contraception enhances their odor sensitivity

In accordance with many studies, the results of the Sniffin' Sticks test emphasize female olfactory superiority, shown by the significantly higher cumulative TDI score (e.g. Katotomichelakis et al., 2007; Thuerlauf et al., 2009). Specifically, women showed better abilities to discriminate odors and a trend towards higher odor identification skills than men, whereas no difference in sensitivity was measured (Figure 2). Interestingly, women using hormonal contraception exhibited significantly lower odor threshold than other women.

In the literature, women's superiority in odor identification seems more evident than in odor discrimination (e.g. Katotomichelakis et al., 2007; Thuerlauf et al., 2009) and have been shown by the use of different approaches (e.g. Richard L. Doty, Applebaum, Zusho, & Settle, 1985; Larsson et al., 2003; Wysocki & Gilbert, 1989). Larsson and colleagues (Larsson et al., 2003,) concluded that women's identification proficiency is a consequence of

better verbal and semantic skills. This might represent a powerful argument for methods, which include odor terms to be guessed without hints. However, in the commonly used Sniffin' Sticks test and the University of Pennsylvania Smell Identification Test (UPSIT) (Doty, Shaman, Kimmelman, et al., 1984) participants have to choose one out of four given odor identities.

Higher olfactory sensitivity in women are detected in several studies (e.g. Wysocki & Gilbert, 1989), including studies using identical methods to this study (*n*-butanol) (e.g. Katotomichelakis et al., 2007; Kobal et al., 2000; Thuerauf et al., 2009). However, as in this study, others do not find these gender differences (e.g. Brand & Millot, 2001; Larsson, Lövdén, & Nilsson, 2003).

Hormonal additives have rarely been taken into account. Aside from methodological factors, hormonal factors could be responsible for the discrepancy between the genders (Doty & Cameron, 2009). Results of studies about olfactory function across the human lifespan might suggest hormonal influences, since they found sex differences in the reproductive ages and these differences to vanish in younger and / or older age groups (Hummel et al., 2007; Larsson, Nilsson, Olofsson, & Nordin, 2004). We found women using hormonal contraception to show higher odor sensitivity than other women, strengthening the theory of endocrine impacts on olfaction. Since the hormonal supply simulates an early pregnancy state, this side effect might reflect the protective importance of hypersensitive olfactory abilities for pregnant women. Experimental replications with higher sample sizes are clearly needed. An enormous sample size is necessary to investigate olfaction in high resolution and take hormonal additives and women's menstrual status into account. Taking this study as a model, about half of the adult women in a reproductive age do not take hormonal contraception, and

about 25% of those women are in their potentially fertile phases (Wilcox, Weinberg, & Baird, 1995). Concluding, 400 female subjects in similar and reproductive ages must be involved in the study to yield about 50 potentially conceptive women.

Hitherto, the role of the female hormonal status in association with olfaction remains largely in the dark (Doty & Cameron, 2009). Our knowledge could be augmented if future olfaction studies take hormonal additives and women's menstrual phases into account.

Most of the studies referred to in this section show gender differences in some of the olfactory tests, but not in all, and others fail to show any differences (e.g. Larsson et al., 2000). To sum up, if sex differences in human olfactory proficiency are found, they almost exclusively favor women, however, reasons are far from being clarified (Brand & Millot, 2001). The choice of the odorants to test could represent a largely neglected criterion. The odorants' biological significance is critical (Bensafi et al., 2002) and may harbor sex differences. Moreover, the tight link to cognition might explain the discordance, since the participants' cognitive profile has been shown to shape odor discrimination and identification performances (Hedner, Larsson, Arnold, Zucco, & Hummel, 2010; Larsson et al., 2004). This leads to the assumption that the olfactory test result is influenced by the subjects' ability to focus, thus daytime of testing should be regarded and personal factors such as their state of mind. Other influences might represent different methodological approaches, smoking habits (e.g. Doty & Kamath, 2014), medication (e.g. Lötsch et al., 2012), and differences in motivation of the subjects due to the sex of the experimenter (H. W. Stevenson & Allen, 1964). In this study both experimenters were female and no influence was detected (data not shown), minimizing the chance of bias to an inter-subject gender bias. We found no clear differences in olfactory proficiencies between smokers and non-smokers. The reason for that

might be the young age of the participants, at that a consequential damage of their sense of smell due to smoking might have not been established yet.

The evolutionary significance of women's precaution towards fire. Taken together, the findings of this study suggest that fire is perceived largely favorable by both genders. Just as men women responded to the smoke odor cues with high levels of Well-being and showed increased levels at the perception of one specific stimulus. However, the ubiquitous idea that the male species dominates the barbecue grill is not made up out of thin air. The vast majority (90%) of the participants reported to observe men to prepare the grilled food, and only 1% found women to be the masters of the grill. In addition, women expressed more feelings of Disgust at the perception of two of the five fire smoke odor stimuli in the EOS ratings, and less attraction towards fire in the questionnaire. The theory of unequal parental investment might explain the discordance between the sexes. It predicts that women should protect themselves and their offspring from potential hazards more carefully than men (Kaplan & Lancaster, 2003). Hence, women should have adapted functions to avoid the proximity of dangerous situations, such as open fire. Our study indicates that women have developed chemosensory adaptations to avoid the threat via the emotional system: olfactory perception of fire smoke might trigger aversive feelings and thus prevent women from getting too close to open fire. This notion is also supported by the finding that women rated the EOS scale with higher emotional content than men. The phenomenon has been observed in many emotional studies (Brody & Hall, 2008), including studies dedicated to emotion and olfaction (e.g. Olofsson & Nordin, 2004). From that point of view the ambivalent findings about sex differences in human olfaction and the predominant role of smell-induced emotions in women taken together, might suggest an exclusively emotional adaptation. As opposed to this study

(data not shown), Wysocki and Gilbert (Wysocki & Gilbert, 1989) found that women compared to men have a higher opinion of their sense of smell. Stronger emotional attachments towards odors could give the odorous individual or item's character a higher weight, which could engender the impression of higher sensory proficiency.

Nevertheless, men reported stronger affective attraction towards potential cooking fire than women in the questionnaire.

Female olfactory and emotional adaptations. Regarding the division of labor by sex in traditionally living societies, some of the typical female tasks are to gather (vegetal) food and to prepare the food for the family or group (White, Burton, & Brudner 1977). Hence, in our evolutionary past as well, women have been responsible for the welfare of other group members and the women's ability to discriminate between non-toxic and toxic items or spoiled food in the complex natural odor world could have been crucial for the whole group. The attachment of intense emotions towards odorants could result in quicker responses to threats like fire or toxic plants. This might have led to the beneficial adaptation of distinct chemosensory sensitivity in women. The notion is also supported by the finding that women stated higher sensitivity towards the smell, taste, and / or texture of food (Table 3, question 13). Moreover, better female olfactory proficiencies and particularly their superiority to discriminate between different odorants are in line with this evolutionary interpretation.

Emotions have communicative function (Brandstätter et al., 2013). Recognizable emotions evoked by hazards, such as fire or spoiled food can be life-saving for people around the perceptive person as well. For instance less experienced young or individuals with impaired olfactory function, e.g. due to age. In hunter-gatherer societies women have taken over the responsibility of (inexperienced) children during the day, when food items were

gathered and eaten. Hence, strong emotional communication by the mother probably also has teaching character and could have been a critical social adaptation.

Complex social context. The complexity of a social event involving a campfire or a barbecue grill probably discloses less obvious exciting behavioral aspects. The potentially dangerous situation of open fire could trigger the behavior of showing off in men (Hawkes, 1991). The show-off hypothesis proposes the reproductive advantage of successful game hunters at that the advantage is attributed to the good hunters as good neighbors, from which the whole group profits, since the prey is shared among the group, in contrast to a direct nutritional advantage of the core family (Hawkes, 1991). The observation that men favor the proximity of cooking fire might be explained by an opportunity to demonstrate hunted prey and display generosity. Additional prowess and status might be evoked by the potentially dangerous situation involving open fire as well.

Study limitations

This master's thesis is the first study with the aim of illuminating the affective responses towards the smell of cooking fire smoke. Due to the small number of participants, the conclusions of the results should be regarded as ideas and future replicate studies are clearly needed. In order to reveal universal patterns, studies should include participants from other countries and cultures.

We randomly picked five different smoke flavor samples that's complex compositions are unknown. Natural odorants consist of dozens of volatile molecules (e.g. many floral scents) up to hundreds (e.g. coffee aroma). On the one hand, more complex aromas could trigger more relevant responses than single chemicals in emotional studies (Distel et al.,

1999). On the other hand, specificity would decrease and the clarification of effects of single molecules would be neglected. The goal of this study was to gain information about the affective response to cooking fire. As a first step, we used complex flavors out of natural sources, which are evaluated as resembling the smoke odor characteristic. Though, we cannot assume that the randomly chosen fire smoke flavors are composed of the same volatile molecules as natural wood fire. The molecular compositions of the flavor samples in use are unknown to us. Future research could involve investigation of the compounds of rated odorants and focus on single molecules to enlighten the neurological effect and the evolutionary relevance of specific chemicals.

Methodological limitations must be kept in mind. The translation from the English uniGEOS to German language could be problematic, due to subtle differences in the meaning of emotional feeling terms. Importantly, the EOS scale for measuring affective responses of odors only considers the conscious subjective feeling component of emotions and does not allow conclusions about emotions in their whole spectrum. This first attempt should be regarded as a hint for emotions associated with cooking fire and should be comprehensively challenged in future studies by elucidating additional behavioral, physiological and cognitive levels of emotions.

Furthermore, this study represents the first step towards illuminating human's complex emotional relationship to cooking fire in that we focused on the olfactory perception. Illuminating fire perception regarding the other senses would be a highly interesting and novel field of study.

Conclusion

The way an organism perceives odorants indicates the biological significance of the source of the smell (Bensafi et al., 2002). Our findings point to a crucial and favorable relationship of humans to fire.

Women perceive fire smoke odors with ambivalent feelings, which can be explained by the various impact of fire in human evolutionary history. Fire might imply greater threat to women than to men, since their own health and the health of the children has most probably been their direct responsibility for the majority of our evolutionary time.

Taken together the findings, the notion that women's superior olfactory proficiencies have been of major relevance in human evolution is supported. The essence of fire use in human evolution seems to have led to an adaptation of the olfactory-emotional system and the adaptation might not be reduced to the sense of smell.

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Tables

Table 1

Properties of the cooking fire flavor samples

Sample name	Wood origin	Substance condition	Recommended concentration (mg / ml)	Used concentration (mg / ml)
CharDex H	hickory	powder	0,1 - 0,3	1,8
Natural Mesquite Smoked Maltodextrin	mesquite	powder	0,1 - 0,4	2,4
Natural Hardwood Smoked Maltodextrin	hardwoods	powder	0,1 - 0,4	2,4
SmokeZ C-10	hardwoods	aqueous solution	0,2 - 0,6	2,4
SmokeZ Oil H SF	hickory	lipid solution	0,25 - 0,5	3

Note: Five different cooking fire smoke flavors, provided by Red Arrow Handels-GmbH (Bremen, Germany), were randomly chosen. Due to the olfactory use of samples fabricated for olfaction and taste purposes, we used higher concentrations of the flavor samples than recommended.

Table 2

Affective terms and categories of the uniGEOS scheme and resulting from this study

English terms	German terms	Original affective categories (uniGEOS)	New affective categories (this study)
relaxed	entspannt	Soothing/Peacefulness	Well-being
soothed	beruhigt	Soothing/Peacefulness	Well-being
well-being	Wohlbefinden	Happiness/Delight	Well-being
happy	glücklich	Happiness/Delight	Well-being
comforted	getröstet	Soothing/Peacefulness	Well-being
romantic	romantisch	Sensuality/Desire	Well-being
pleasantly surprised	angenehm überrascht	Happiness/Delight	Well-being
amusement	Vergnügen	Interest	Well-being
sensual	sinnlich	Sensuality/Desire	Well-being
impressed	beeindruckt	Interest	Energy/Interest
revitalized	erquickt	Energy	Energy/Interest
energetic	energiegeladen	Energy	Energy/Interest
refreshed	wiederbelebt	Energy	Energy/Interest
interesting	interessant	Interest	Energy/Interest
disgusted	angeekelt	Unpleasant feelings	Disgust
unpleasantly surprised	unangenehm überrascht	Unpleasant feelings	Disgust
irritated	gereizt	Unpleasant feelings	Disgust
melancholic	trübsinnig	Nostalgia	Nostalgia/Spirituality
nostalgic	wehmütig	Nostalgia	Nostalgia/Spirituality
sad	traurig	Nostalgia	Nostalgia/Spirituality
spiritual feeling	spirituelle Gefühle	Spirituality	Nostalgia/Spirituality
famished	ausgehungert	Hunger/Thirst	Appetite
mouth-watering	köstlich	Hunger/Thirst	Appetite
desire	Verlangen	Sensuality/Desire	Appetite
thirsty	durstig	Hunger/Thirst	Appetite

Note: Original affective terms in English and corresponding categories (Ferdenzi et al., 2013) as well as German translations of the terms and corresponding “new categories” resulting from factor analysis of this study are listed.

Table 3

Questionnaire for assessing the participants' appeal towards controlled fire

Question	Answer
<i>Answer style: scale 1 - 7</i>	
1) How do you feel at the thought of (controlled) fire?	very bad - very good
2) Do you like to reside near (controlled) fire?	I dislike - I like very much
3) How do you find the view of (controlled) fire?	very unpleasant - very pleasant
4) How do you find the smell of (controlled) fire?	very unpleasant - very pleasant
5) How do you find the sound of (controlled) fire?	very unpleasant - very pleasant
6) Do you like to barbecue grill?	I dislike - I like very much
7) Do you like to prepare the grilled food at the barbecue grill?	I dislike - I like very much
8) How often do you prepare the grilled food?	never - every time
9) Do you like grilled food?	I dislike - I like very much
10) How do you find the smell of grilled food?	very bad - very good
11) How do you find the smell of the smoke, which rises at the barbecue?	very bad - very good
12) How do you feel when you are near the barbecue grill?	very bad - very good
13) I dislike groceries, which are usual in middle Europe, because of their taste, smell and/or texture?	does not apply at all - absolutely applies
<i>Answer style: multiple choice (mc) / single choice (sc)</i>	
14) Who do you observe preparing the grilled food usually?	women, men, both with equal frequencies; (sc)
15) Which family member usually prepares the grilled food at family barbecues?	myself, wife/girlfriend, husband/boyfriend, mother, father, grandmother, grandfather, sister, brother, other; (mc)
16) Which family member usually lights the grill at family barbecues?	myself, wife/girlfriend, husband/boyfriend, mother, father, grandmother, grandfather, sister, brother, other; (mc)
17) To your mind, which one of the usual heating methods creates the most pleasant atmosphere?	fireplace with visible fire in the living area, fireplace without visible fire in the living area, oil heating, gas heating, electric heating, other; (sc)

Note: Questions and answers are translated from original German language (Table 4) into English. Two types of answers were chosen: 1) bipolar scales including 7 steps and 2) multiple (mc) or single (sc) choice. Pole captions and answers are given in the table.

Table 4

Questionnaire for assessing the participants' appeal towards controlled fire in original

German language

English question	English answer	Original German question	German answer
<i>Answer style: scale 1 - 7</i>			
1) How do you feel at the thought of (controlled) fire?	very bad - very good	Wie fühlen Sie sich beim Gedanken an (kontrolliertes) Feuer?	sehr schlecht - sehr gut
2) Do you like to reside near (controlled) fire (e.g. campfire, fire place)?	I dislike - I like very much	Halten Sie sich gerne in der Nähe von kontrolliertem Feuer auf (z.B. Lagerfeuer, Kamin)?	sehr ungern - sehr gerne
3) How do you find the view of (controlled) fire?	very unpleasant - very pleasant	Wie empfinden Sie den Anblick von (kontrolliertem) Feuer?	sehr unangenehm - sehr angenehm
4) How do you find the smell of (controlled) fire?	very unpleasant - very pleasant	Wie empfinden Sie den Geruch von (kontrolliertem) Feuer?	sehr unangenehm - sehr angenehm
5) How do you find the sound of (controlled) fire?	very unpleasant - very pleasant	Wie empfinden Sie das Geräusch des Feuerprasselns?	sehr unangenehm - sehr angenehm
6) Do you like to barbecue grill?	I dislike - I like very much	Grillen Sie gerne?	sehr ungern - sehr gerne
7) Do you like to prepare the grilled food at the barbecue grill?	I dislike - I like very much	Stehen Sie gerne selbst am Grill?	sehr ungern - sehr gerne
8) How often do you prepare the grilled food?	never - every time	Wie oft stehen Sie selbst am Grill?	nie - immer
9) Do you like grilled food?	I dislike - I like very much	Essen Sie gerne Gegrilltes?	sehr ungern - sehr gerne
10) How do you find the smell of grilled food?	very bad - very good	Wie empfinden Sie den Geruch von Gegrilltem?	sehr schlecht - sehr gut
11) How do you find the smell of the smoke, which rises at the barbecue?	very bad - very good	Wie empfinden Sie den Rauchgeruch, der beim Grillen entsteht?	sehr schlecht - sehr gut
12) How do you feel when you are near the barbecue grill?	very bad - very good	Wie fühlen Sie sich, wenn Sie sich in der Nähe des Grills aufhalten?	sehr schlecht - sehr gut
13) I dislike groceries, which are usual for middle Europe because of their taste, smell and/or texture.	does not apply at all - absolutely applies	Einige in Mitteleuropa übliche Lebensmittel sagen Ihnen aufgrund des Geschmacks, Geruchs bzw. der Konsistenz nicht zu	trifft gar nicht zu - trifft völlig zu

Table 4 (Continued.)

English question	English answer	Original German question	German answer
<i>Answer style: multiple choice (mc) / single choice (sc)</i>			
14) Who do you observe preparing the grilled food usually?	women, men, both with equal frequencies; (sc)	Wenn gegrillt wird, wer steht Ihrer Beobachtung nach meistens am Grill?	Frauen, Männer, beide etwa gleich oft; (sc)
15) Which family member usually prepares the grilled food at family barbecues?	myself, wife/girlfriend, husband/boyfriend, mother, father, grandmother, grandfather, sister, brother, other; (mc)	Welches Familienmitglied bereitet beim Grillen Ihrer Beobachtung nach meistens das Grillgut zu?	ich selbst, Ehefrau/Partnerin, Ehemann/Partner, Mutter, Vater, Großmutter, Großvater, Schwester, Bruder, anderer; (mc)
16) Which family member usually lights the grill at family barbecues?	myself, wife/girlfriend, husband/boyfriend, mother, father, grandmother, grandfather, sister, brother, other; (mc)	Welches Familienmitglied zündet den Grill meistens an?	ich selbst, Ehefrau/Partnerin, Ehemann/Partner, Mutter, Vater, Großmutter, Großvater, Schwester, Bruder, anderer; (mc)
17) To your mind which one of the usual heating methods creates the most pleasant atmosphere?	fireplace with visible fire in the living area, fireplace without visible fire in the living area, oil heating, gas heating, electric heating, other; (sc)	Welche der üblichen Heizungsmethoden bietet Ihnen die angenehmste Atmosphäre?	Kamine/Öfen mit sichtbarem Feuer im Wohnraum, Kamine/Öfen ohne sichtbares Feuer im Wohnraum, Ölheizung, Gasheizung, Elektroheizung, anderes; (sc)

Note: Questions and answers are translated from original German language into English. Two types of answers were chosen: 1) bipolar scales with 7 steps and 2) multiple (mc) or single (sc) choice (pole captions and answers are given in the table).

Figures

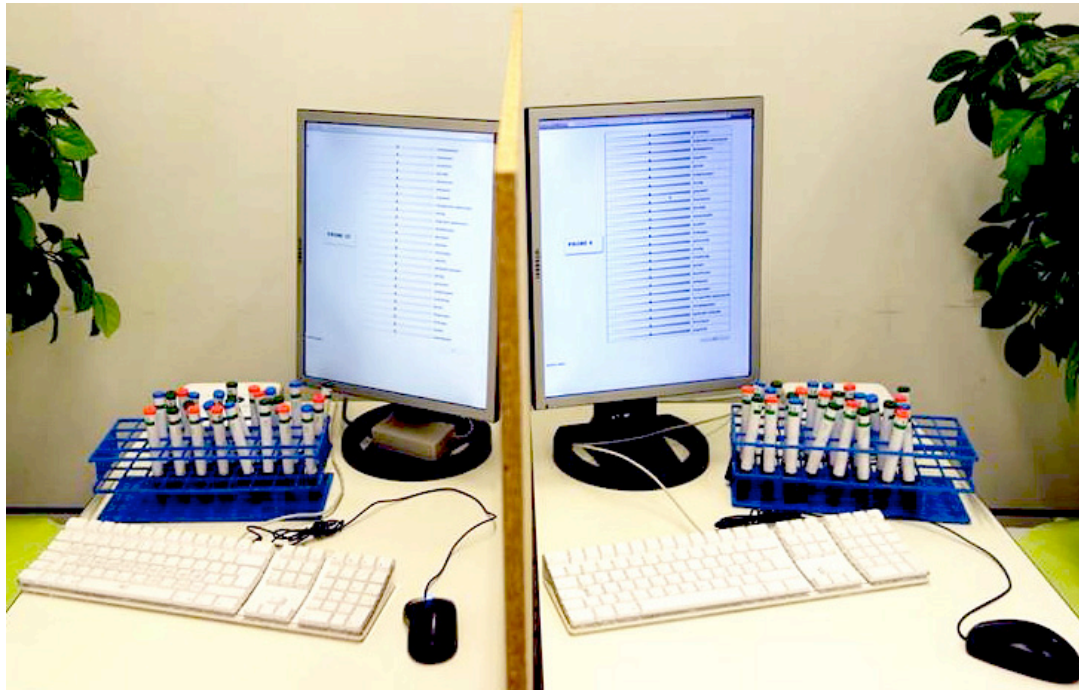


Figure 1. Experimental setup of the affective ratings. Participants smelled Sniffin' Sticks containing five different cooking fire smoke odors and described their evoked feelings using given affective terms via a computer rating system.

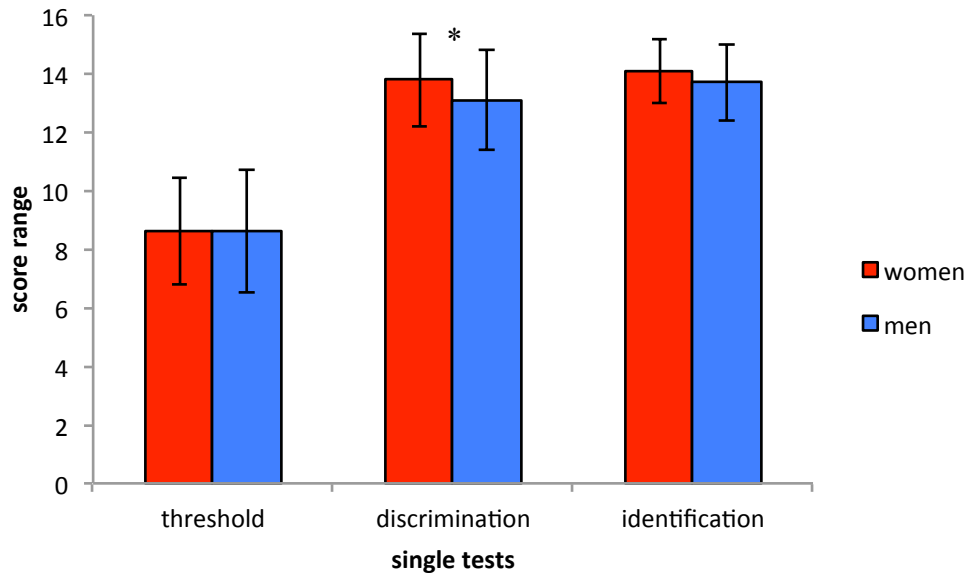


Figure 2. Single test scores of the commercial Sniffin' Sticks test. The higher the score, the better the result (maximum score: 16). * Women yielded a significantly higher score than men at the odor discrimination test (student's t-test; $t(103) = 2.335$, $p = .022$).

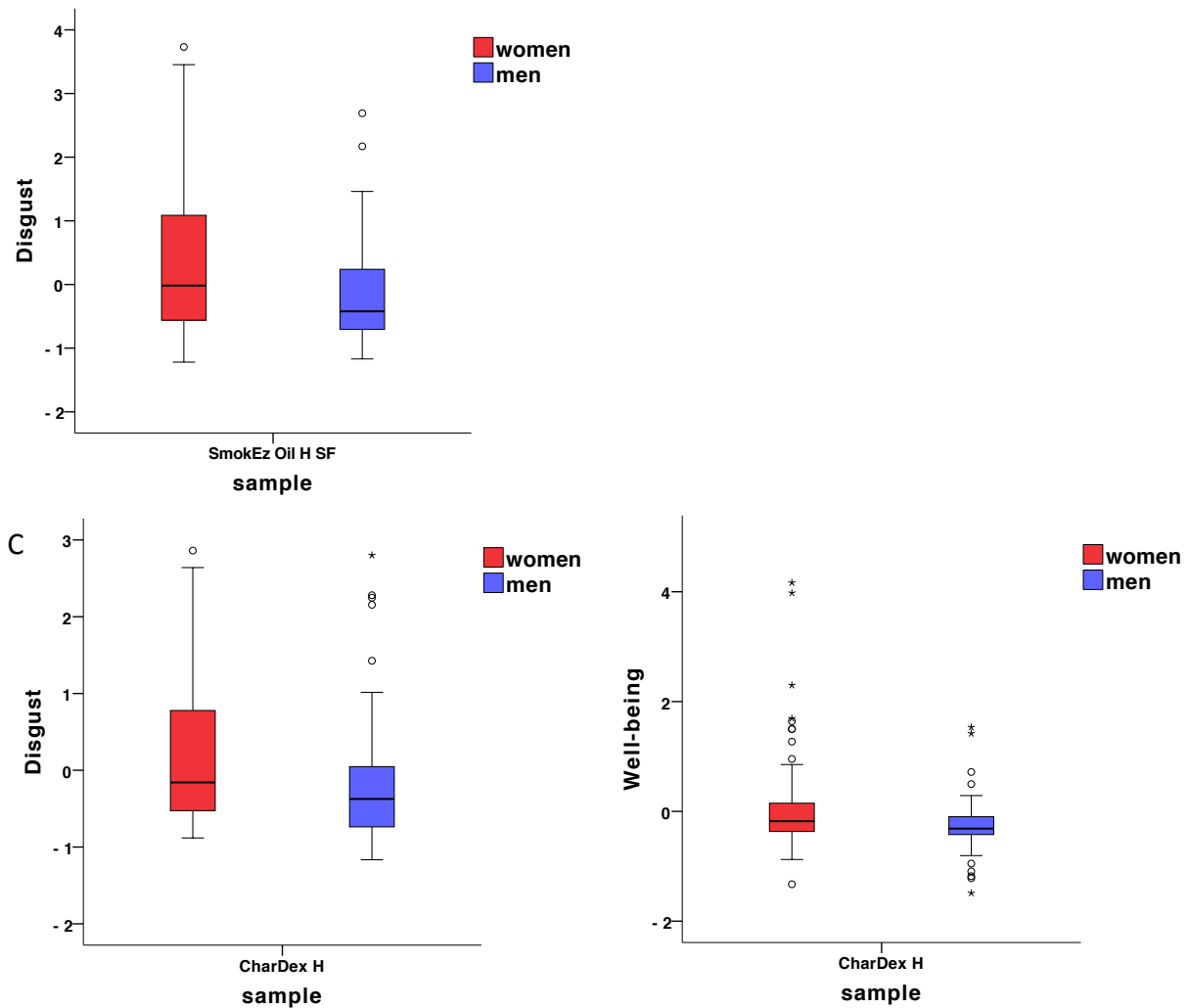


Figure 3. Boxplots depicting the significant gender differences in affective ratings per odor stimulus. Women rated stronger feelings of Disgust than men at the perception of the odors “SmokEz Oil H SF” (A) and “CharDex H” (B) (Mann-Whitney tests, $U = -2.007$, $p = .045$ and $U = -1.972$, $p = .017$, respectively) and „CharDex H” (C) additionally elicited stronger feelings of Well-being in women than in men (Mann-Whitney U-test $U = -2.388$, $p = .049$).

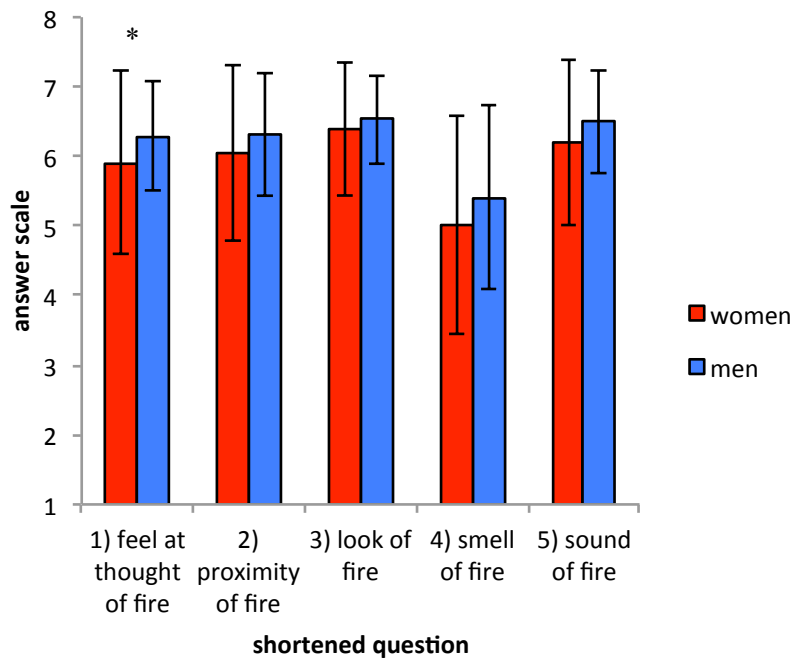


Figure 4. Representation of the reported appeal of women and men towards controlled fire (questionnaire). The numbers of the x-axis are referring to the complete questions given in Table 3. The 7-point answer scales (y-axis) ranged from negative (1) to positive affect (7) - find the specific pole captions in Table 3. * Men rated their affective state when thinking about controlled fire (question 1) as significantly more positive than women (Fisher's exact test (FET) = 11.091, $p = .026$).

Zusammenfassung

Die attraktive Wirkung des Grillens auf Männer scheint transkulturell bekannt zu sein, bisher wurde diese Beobachtung jedoch nicht wissenschaftlich untersucht. Der Grill könnte als urbane Art eines Lagerfeuers betrachtet werden. Die Kontrolle über das Feuer hat die Evolution des Menschen maßgeblich geprägt; sie brachte wesentlichen Nutzen, wie Wärme, Licht, Schutz gegen Raubtiere und das Kochen. Neben der direkten Gefahr stellt Feuer auch aufgrund der toxischen Bestandteile des Rauchs eine Bedrohung dar. Diese ist die erste Studie, die sich mit der emotionalen Reaktion auf Kochfeuer-Gerüche beschäftigt und hat zum Ziel diese zu beschreiben. Zusätzlich stellten wir unter Betracht der Theorie des ungleichen parental Investments, nach der Frauen die potentielle Gefahr Feuer eher meiden sollten als Männer, folgende Hypothese auf: Im Vergleich zu Männern werden Frauen auf Feuergeruch mit abstoßenden Gefühlen höherer Intensität reagieren. Unter Einsatz der Methode "Emotion and Odor Scale" beschrieben 105 junge Erwachsene ihre durch Gerüche hervorgerufenen Gefühle. Fünf verschiedene Geruchsstimuli von Feuerrauch wurden in Form von „Sniffin‘ Sticks“ eingesetzt. Die Probanden zeigten positive Reaktionen darauf und Frauen berichteten stärkere Gefühle des Wohlbefindens bei der Wahrnehmung eines bestimmten Raucharomas. Frauen reagierten jedoch ambivalent und empfanden durch zwei der Aromen mehr Ekel als Männer. Der Fragebogen ergab eine stärkere Anziehung von Feuer auf Männer. Die Ergebnisse unterstützen die Theorie, dass Frauen olfaktorische Anpassungen entwickelt haben, die zu sensibleren Reaktionen auf Feuergerüche führen. Im Einklang mit der kritischen Rolle des Feuers in unserer Evolution unterstreicht die Studie die Komplexität der emotionalen Reaktion auf Feuer.

Stichwörter: Feuer, Geruch, Affekt, Geschlecht, Emotion and Odor Scale, Sniffin‘ Sticks