

## THE EMOTIONAL POWER OF ODORS: IDENTIFYING THE DIMENSIONS REFERRING TO FEELINGS PRODUCED BY ODORS

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### Abstract

There is broad literature on the emotional effect of odors but, so far, little concern with the precise mechanism underlying the elicitation of emotions via olfactory stimuli. One reason for this neglect might be the lack of answers to a major question that underlie any research on odors and emotions: What exactly are the emotions associated to odors and how are they organised? The major issue addressed in the present paper concerns the nature of the verbal labels that refer to the specific states produced by odors. We conducted a series of studies in order to examine which terms are best suited to describe the feelings associated to odors and autobiographical memories. In Study 1, the relevance of a broad list of candidate affect terms to describe odor-related feelings was examined by two groups of participants with different level of knowledge about odors. In study 2, the most relevant terms retained from study 1 were evaluated with actual odorant samples and the data were submitted to a series of exploratory factor analyses to reduce the set of variables to a smaller set of summary-scales and to get a preliminary sense of the differentiation of affects elicited by odors. The Study 3 replicated Study 2 with a larger and more representative sample of odorant samples and participants. Overall, the findings point to a structure of affective responses to odors that differs from the more traditional taxonomies of emotion such as posited by discrete emotion or dimensional theories and suggest that affective states elicited by odors are structured around few dimensions that clearly reflect the role of olfaction in social interactions, danger prevention and arousal/relaxation sensations.

**Keywords:** *emotion, odors, feelings, affective response, consumer*

### INTRODUCTION

Identifying the determinants of food choice and preference has been the focus of interest of many disciplines such as anthropology, biology, history or psychology over the last decades. Consequently, this issue has been addressed using different types of approaches. Quite recently, sensory evaluation has become very influential in this area of research and has extended the focus to other products such as cosmetics. The tradition in sensory evaluation is to link sensory properties of diverse products, measured by instrumental or descriptive approaches, to preferences, measured by consumer subjective tests. Thus, this approach put the emphasis on the properties of the product as the main determinant of preference but does not take into account more complex aspects such as emotional aspects. However, we know that emotions play a crucial role in consumer behavior (Loken, 2006).

In fact, this may be particularly relevant when considering food or cosmetics since it has been well established that odor, important component in the perception of these kind of products, is a powerful elicitor of emotional reactions (see e.g. review by Ehrlichman & Bastone, 1992). For example, odors have been used in laboratory to induce mood changes which subsequently can influence cognition and behavior such as reaction time in a simple task (Millot et al., 2002), resolution of logical or reasoning tasks (Degel and Köster, 1999; Herz et al., 2004), memory performance (Ludvigson and Rottman, 1989), alertness (Ilmberger et al., 2001), and motivation (Epple and Herz, 1999). Moreover, several authors showed that odors are impressively powerful to evoke autobiographical memories that are particularly emotional (Rubin et al., 1984; Chu & Downes, 2002; Herz, 2004).

Curiously, most research carried out in sensory evaluation has not yet directly addressed the emotional modulation of food or cosmetic preference via olfactory factors. We suggest that a paradigm change, integrating the measurement of emotional reaction to olfactory compounds, would enable researchers to study more systematically the determinants driving consumer choice and preference for food or cosmetic products. The remaining question is now: How to measure emotional reaction to odors?

While emotional reactions can be recorded by asking participants to describe in their own words their emotional experience, more often, for the purpose of highly-controlled paradigm, a forced-choice self-report questionnaire is preferred. This forced-choice measurement derives from two kinds of approaches: the discrete emotion approach, postulating the existence of a small number of so-called basic emotions (Ekman, 1984) or the dimensional approach that reduces the emotions to positions in a bi-dimensional valence by arousal space (Russell, Weiss, & Mendelsohn, 1989). These theoretical models that often serve as a framework for any empirical studies on emotional feelings may not be ideally suited to study the specific reaction to odors. Because odor stimuli produce a rich set of highly differentiated responses and feeling states, in many cases these do not match basic emotions such as anger, fear, sadness or joy. And while they can be projected onto a bi-dimensional grid of valence and arousal, such a characterization loses important qualitative differences between the affective effects of different types of fragrances.

For these reasons, we suggest that, instead of relying on well-established emotion models that have been elaborated to describe emotions occurring in broad contexts, more attention should be given to the nature and the organization of descriptors that refer to specific affective states elicited by odors. This was the main purpose of the present paper.

To do so, we carried out a series of interrelated studies in order to investigate which labels, in every day life, people find most appropriate to describe emotional effects of odors. We adopted an approach similar to the one used recently by Zentner, Scherer, & Grandjean (2005) for studying emotions elicited by music. This approach, relying on strictly empirical criteria and not on traditional emotion models as described above, consisted in two steps. The first step aimed at selecting the terms rated as the most appropriate to describe music-elicited feelings from a large list of candidate affect terms. In the second step, psychometric analyses were performed on several sets of emotion ratings made while

people were listening to widely different types of music. Using a similar approach, we conducted a series of three studies on odors and emotions. Study 1 was conducted to compile a list of odor-relevant affect terms. The aim of Study 2 was to examine emotion ratings that were provided when participants were exposed to actual odors and to get a preliminary model of the structure of affects elicited by odors based on Exploratory Factor analytic procedures. The Study 3 was a replication of Study 2 with a larger and more representative sample of odorant samples and participants in order to validate the preliminary model obtained in Study 2 by using Confirmatory Factor Analytic procedures.

## **STUDY 1**

### **Material and Method**

**Participants.** 96 undergraduate students (83 females) from the Faculty of psychology in Geneva and 121 Employees from Firmenich (71 females) took part in this study.

**Material.** A list of 480 candidate terms was established on the basis of several sources. Among the 480 terms, 147 came from the music studies because they were rated as relevant terms to describe affective feelings in broad contexts (Zentner et al, 2005). Three hundred and three terms were added to this preliminary list, some coming from empirical data on odors and some from literature related to odor expert classification, descriptions and emotion.

**Procedure.** The experimental task consisted in a questionnaire in which participants rated the relevance of candidate terms by answering this question “According to you, how relevant is this term to describe an emotional feeling induced by odors?” Participants had to report the degree of relevance of each term on a continuous scale ranging from “*not relevant at all*” to “*extremely relevant*”.

### **Results and discussion**

The main goal of Study 1 was to select the most relevant terms to describe affective feelings related to odors. We decided of a selection criterion in sort that a substantial majority had to agree on the relevance of the term for it to be retained. Thus, only terms that were considered relevant (*i.e.* score over the middle of the relevance rating scale) by at least two-thirds of the participants (66%) were retained. Thus, we obtained a reduced list of 124 terms. Interestingly, were absent from this reduced list many affect terms used to refer to commonly experienced emotions such as guilt, shame, anger, sadness. Moreover, we found that the relevant emotions elicited by odors were mostly positive affects with the exception of some negative affects related mostly to disgust and displeasure.

## **STUDY 2**

### **Material and Method**

**Participants.** 38 undergraduate students (24 females) from the Faculty of Psychology in Geneva took part in this study.

**Material.** The inspection of the 124 relevant terms resulting from Study 1 indicated that some terms clearly reflected the intrinsic quality of the odors rather than the affective sensation they may elicit (e.g. sweet, feminine, spring-like) but some could also be evaluated as both affective or qualitative (e.g., fresh, clean, strange). Thus, based on judgments of ten experts on emotion, we split the initial list of 124 terms into a primary list of 73 affective terms and a secondary list of 60 qualitative terms with nine terms overlapping between the two lists.

24 odorants corresponding to everyday odors were selected in order to cover a large range of odor types. The odorants, provided by Firmenich SA, were diluted in odorless Di-propylène glycol (DIPG) in order to obtain an average intensity roughly similar for all odorants. The diluted solutions were presented in a pen-like odor dispensing device.

**Procedure.** Participants rated the odorants twice in two sessions separated by at least one day. One of the two sessions consisted in emotion ratings, where participants were asked to rate the intensity of their subjective emotional experience elicited by each odorant sample with the means of the 73 affect terms. The other session consisted in an odor quality rating, where participants rated the intensity of the descriptive quality of the odors using the 60 qualitative terms. In both sessions, answers were given on continuous scales ranging from 'not intense at all' to 'extremely intense.'

### **Results and discussion**

The individual data for the emotion ratings and the odor quality ratings were submitted to separate PCA Exploratory Factor Analyses, followed by VARIMAX rotation. The factor analysis on the emotion ratings yielded five main factors which were respectively interpreted as happiness-well being, awe-sensuality, disgust-irritation, soothing-peacefulness, energizing-refreshing. The factor analysis on the odor quality ratings yielded four main factors, which were respectively associated to the delicateness, heaviness, sweetness and healthiness feature of the odors.

In order to evaluate to what extent odor quality may predict the emotional response elicited, we performed a series of multiple regression analyses using the odor loadings on the odor quality factors as the predictors of the odor loadings on the affect factors. The results of these regressions suggested that some qualitative features of the odors can predict specific affective states. Thus, odors, described as sweet, elicited happiness and well being, heavy odors provoked disgust and irritation, delicate odors were associated to awe and sensuality as well as soothing and peacefulness feelings and healthy odors induced energizing and cooling sensations.

In sum, the findings point to a preliminary structure that clearly reflects the important role of olfaction in social interactions, danger prevention, well-being and relaxation/arousal sensations. Moreover, the results suggest that there is a close relationship between the affective states produced by odors and the intrinsic chemosensory quality of the odorant substances.

### STUDY 3

Because one of the main limitations of Study 2 was the representativeness of both the odorant samples and the population sample, we replicated Study 2 in two distinct experiments conducted in important public fairs, namely *La nuit de la Science* (NDLS) and *La cité des métiers* (CDM).

#### Material and Method

**Participants.** 282 participants in the NDLS and 245 in the CDM took part in this study.

**Material.** A list of 36 terms was derived from Study 2 on the basis of internal reliability, loadings on the PCA factors and homogeneity among the different PCA factors.

56 odorants were selected to cover a large range of everyday odors for the NDLS. 24 commercial perfumes were selected to cover a large range of perfume classes for the CDM.

**Procedure.** Participants were recruited during their visit in the two public fairs. In both experiments, the instructions and rating procedure were similar to Study 2. Participants were asked to rate their emotional feelings elicited by the odors with the help of the 36 affect terms selected from Study 2.

#### Results and discussion

The main goal of Study 3 was to extend findings from Study 2 by examining the differentiation of odor affect ratings based on Confirmatory Factor Analytic procedures. This procedure provides a stronger test of the model's validity because, unlike Exploratory Factor Analysis, the model is specified prior to data analysis.<sup>2</sup>

We first tested the preliminary model obtained in Study 2 that consisted of five factors. Then we tested this original model against alternatives models. For both stimuli conditions, we found that the model in five factors fit reasonably well with the set of new judgments made on everyday odorants and commercial perfumes (SRMR = 0.047, RMSEA = 0,048, CFI= 0,914 for the everyday odorants and SRMR = 0.058, RMSEA = 0.053, CFI= 0,878 for the perfumes). However, we found that the fit was improved by creating a 6th variable referring to sensory pleasure (SRMR = 0.047, RMSEA = 0,048, CFI= 0,914 for the everyday odorants; SRMR = 0.056, RMSEA = 0.052, CFI= 0,892 for the perfumes; significant Chi-Square Difference test for both everyday odorants and perfumes).

We tested alternative models with fewer latent factors (*e.g.* positive affects *vs* negative affects) but they gave rise to an inferior fit compared to the six factorial model (SRMR = 0.111, RMSEA = 0,068, CFI= 0,829 for the everyday odorants and SRMR = 0.062, RMSEA = 0.062, CFI= 0,845 for the perfumes).

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<sup>2</sup> For this analysis, three fit indexes were considered: the standardized root mean square residual (SRMR), the root-mean-square error of approximation (RMSEA) and the comparative fit index (CFI). A combination of an SRMR < 0.8 with RMSEA < 0.6 correspond to a good fit. Similarly, CFI values of .90 or greater indicate an acceptable fit.

Finally, below are the 6 dimensions emerging from the various psychometric analyses as the underlying structure to differentiate odor-elicited feelings:

- a dimension of pleasant feelings including well-being, happiness,
- a dimension of sensuality including desire and romanticism,
- a dimension of unpleasant feelings including disgust and irritation,
- a dimension of relaxation including soothing and peacefulness,
- a dimension of refreshment including invigorating and clean feelings,
- a dimension of sensory pleasure including the feeling of nostalgia, amusement and salivating sensation.

## **CONCLUSION**

We conducted a series of three studies to select the verbal labels to be used in empirical research, by examining the knowledge showed by the general public about which terms are best suited to describe the feelings associated to odors and autobiographical memories.

These studies, conducted with various types of odorant stimuli and populations, suggest that six dimensions enable to represent the psychological structure of the fundamental dimensions required to describe olfactory-elicited feelings. These dimensions clearly reflect the important role of olfaction in bringing old autobiographical memories back to awareness, social interactions, danger prevention, well-being and relaxation/arousal sensations. In order to validate this empirical approach, the question is now to know whether this set of new scales is more appropriate to describe odor-elicited feelings than traditional models such as discrete emotion models or dimensional models.

To test this hypothesis, an ongoing study aims at comparing the olfactory-specific model emerging from the reported studies to the two well-known emotions models. From these new data, we will compare the reliability and the discriminability of the three models. We expect these two latter indicators to be higher for the olfactory-specific model compared to the two traditional models. If so, this new set of scales, based strictly on empirical data, will provide promising leads to study in a more applied fashion the emotional effects of food or cosmetic products.

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