# CreaSenses: Fostering Creativity Through Olfactory Cues

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## ABSTRACT

Smell is a strong trigger of memories and creativity. Different smells can create sensitive environments that can foster creative tasks. In this paper, we present CreaSenses, a study that includes olfactory cues, representing different types of sensitive environments such as "food" and "ambience" in a within-subject design. Our aim was to obtain a deeper understanding of which smell cues promote higher levels of creativity during the process of creative writing. We discuss the results in the light of creative senses and potential implications for the design of creativity support tools. In addition, our study was evaluated trough the Creativity Support Index.

## CCS CONCEPTS

**• Human-centered computing - User centered design**

## KEYWORDS

Creativity Support Tools; Creativity; Olfaction; Odor; User studies;

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## 1 INTRODUCTION

Creativity can be fostered by our senses [1], and surroundings' [2]. Sound and visual cues have been used as stimuli for inspiration, e.g., listening music while writing or looking at images while drawing. Although olfactory cues can be strong triggers of memories, emotions [3] and, therefore, of creativity, they remain poorly assessed in the studied [4]. The rise of digital computing accelerated writing in all its forms, and people in today's society have even easier access to reading and writing. Creative writing is a field that will continue to develop because it is not only related to human creativity and to the significance of words as tools of human communications. Keeping in mind that one goal of digital tools for creative writing is to help users produce greater quantities of writing, some researchers note that the productivity expectations placed on writers are, at present, higher than ever before [9]. Therefore, there is a need for tool support that can promote not only writers' creativity but also their productivity levels. Some researchers provided results from the first empirical demonstration that olfactory stimulation can facilitate tactile performance, and also highlight the potential modulatory role of task-difficulty in odor-induced task performance facilitation [5]. Others [6], presented a prototype system – Olfaction - that emits odor emoticons and it was applied in two contexts: online text chatting and voicemail receiving. Their results suggested that odor emoticons induced more chatting, and were easy to use, and also helped participants to better perceive and convey emotions. Studies have been conducted with auditory cues in different areas such as consumer behaviors [7] and consumers' perception of food texture and quality [8]. Others provide useful insights suggesting that olfactory cues have an important role in the creative process of users and even when this type of cues are combined with auditory cues [9]. Demattè et al. [10], investigate the effect of visual cues on olfactory perception in humans. In these experiments it was possible to demonstrate that auditory frequency manipulations can have on the perceived tactile roughness and moistness of surfaces.

In this paper, we aim to study how different odors can influence a creative writing task, considering that writing is one of the main artistic expressions of humans [11]. We have selected olfactory cues that most people are used in their daily life during a creative writing task. Therefore, we have decided to focus on two main groups of odors, "food" and "ambience", and selected two odors per group, "coffee"/"orange" for "food", and "perfume"/"laurel" for "ambience". We contribute with a within-subject study with 7 participants for writing a slogan using a text processor and smelling the different odors. Our approach that addresses a sensitive modality such as olfactory cues it was measured using Creativity Support Index (CSI) [12], self-assessments, Flow Theory [13], and Creative



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Behavior Inventory (CBI) [14]. We triangulate this data to assess the creativity and mental well-being of participants while writing.

## 2 USER STUDY - CREASENSES

We conducted a within-subject experiment to investigate whether smell cues affect people's creativity and mental well-being during a creative process. The experiment was conducted for one week. As a prerequisite, the participants had to have prior writing skills and a basic amount or computer and Internet experience, since our questionnaires are all online.

### 2.1. Conditions

The creative activity in this experiment included writing a Slogan in a text processor, in different conditions: *No Odor*; and Odor as *Food* and Odor as *Ambience*. We choose Microsoft Word because the participants were more familiar with.

**No Odor.** Our baseline. A word processor without any explicit smell in the control room.

**Food.** In this condition we used two types of olfactory cues: coffee and orange.

**Ambience.** We used the fragrance of perfume (fragrance fruity fresh, including mint, lavender, citronella and limonene) and laurel (with a touch of floral fragrance and dew).

Before starting the experiment, it was conducted a multiple study with two participants to identify potential bias. The scope of the study and the session rules was explained to participants before starting each session.

### 2.2 Participants

The participants had a mean of ages of 31.3 (*SD*= 8.6). The percentage of female was 85.7% (6 female, 1 male). All reported having a normal or corrected visual acuity and sensitivity to odors. The total time per participant including instructions, experiment, breaks and debriefing took over forty minutes. Participants were allowed to take breaks (five minutes) between each environment conditions. All participants were naïve to the experimental conditions.

### 2.3. Procedure

The study consisted in collecting demographic data (gender, age, profession, how often they write), self-assessments about their creativity [15] in a ten-point values Likert scale survey, and self-rated their past creative behavior and activities filling the CBI. The procedure of this study was based on writing a specific challenge – Slogan - in each condition. The participant used one portable computer with screen size 13.3', display resolution 1920 x 1080 pixels.

To initiate their writing challenge, we have to define five different objects of a similar degree of complexity that they were equally familiar with. Participants were presented with one of five objects they often use in their daily routine – a ballpoint pen, a mobile phone, a post-it, a pen drive and a power back. The participants were asked to write a different slogan under each one of the conditions. We used a fan to prevent the smell was kept in the room, since odors are connected with memory. We used hermetic bags that were only open in the desired condition, to spread olfactory cues around the room (Fig. 1). Participants had a maximum of five minutes to finish the writing challenge but they were free to finish it sooner. At the end of each condition, participants were asked to fill out the first part of the Creativity Support Index and a Likert scale (ten-point) survey about their perception of how the all experience made them feel based on Flow Theory and also rating their creativity in each condition after writing. Finally, after finishing all conditions they fill out the paired-comparison part of Creativity Support Index and they were interviewed. We collected qualitative data with a semi-structured interview with questions such as: *"Did you enjoyed to write in this condition and why?"; "In this condition did you felt more creative and why?"*, in order to know the participant opinion about the whole experience.

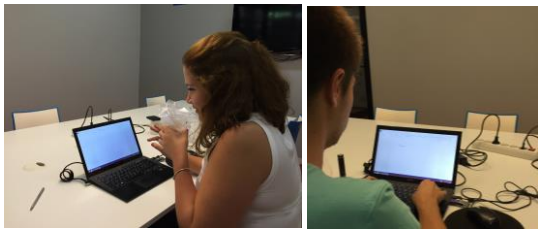

**Figure 1 – Participants performing the study in laboratory.**

## 3 STUDY FINDINGS

In order to analyze the results, we crossed the data from the different sources: the survey, self-assessments of creativity, interviews and the slogan's themselves. We also discuss the particularities of each participant smell in order to elucidate the potential design qualities of singles smells. 14.3% of participants assumed that they write three hours per day. 42.9% of participants write at least one hour per day and 42.9% have assumed that they write at least two per day. Also participants considered themselves creative persons (*Mdn*= 7; *M*= 7.29; *SD*=0.95). The CBI in a 77-item inventory for assessing creative accomplishments and activities in past behaviors [14]. We classified participants that had less than 30 points on the CBI as being *less creative*, and participants that had more than 30 points on the CBI as *highly creative* [16]. Considering the self-report scale in the 30-item CBI that could capture a creative accomplishments and activities in past behaviors, our results suggest that our sample was likely compose by creative persons in terms of past creative actions. *Six* out to seven participants had more than 30 points on the CBI and only *one* participant had less than 30 points on the CBI. We used repeated measures such us Friedman's ANOVA approach to test different between each conditions from the answers in the survey based on the dimensions of Flow Theory [13] (i) intense and focused concentration on the present moment, (ii) sense of personal control or agency over the situation or activity, (iii) loss of reflective self-consciousness, and (iv) distortion of temporal experience; and ranked by participants in a ten-point Likert scale. Trough Cronbach's alpha, the survey based in the Flow Theory [13] dimensions was found to be reliable (α= .77). In Orange condition participants exhibited a higher level of Flow values

(*Mdn* = 7.75, *M*=6.86, *SD*=2.02) while in No Odor condition they exhibited lower levels (*Mdn*=6.0, *M*=5.79, *SD*=0.93) and in Perfume condition (*Mdn*=5.0, *M*=5.82, *SD*=1.30). In Coffee condition participants exhibited similar level of Flow values (*Mdn*=6.75, *M*=6.29, *SD*=1.50) as in the Fragrance condition (*Mdn*=5.0, *M*=6.21, *SD*=1.75). However, Friedman's ANOVA the participants' mental well-being – their "flow", was not statistically significant ($F$ (4) =3.42, $p$>.05). We asked them also to select up to three adjectives from the following list: Surprised, Delighted, Laid back, Depressed, Pacific, Happy, Tired, Bored, Sad, Satisfied, Frustrated, Angry, Serious, Animated, Distressed, Creative and Frightened. Table 1 displays the percentages for each adjective, as selected by the participants on each environment. We can see that 85.7% of participants felt more creative in the Orange Condition while only 14.3% felt creative in the No Odor Condition. In Coffee condition participants felt more relaxed (57.1%) and in Perfume and Fragrance conditions they felt more creative (57.1% in both). In No Odor condition participants felt more pacific (71.4%). Also, from observation in Table 1 we can see that the most adjectives in Food (Coffee and Orange) and Ambience (Perfume and Fragrance) Conditions indicates a positive mental well-being, while in No Odor condition we can see that adjectives as serious and bored were chosen expressively. During the experience, we observed that the participants stopped to think and to smell the environment in the room before they start the writing challenge. They were curious to know what they were supposed to do and what smell came next. It was clear that all participants felt somewhat creative during the experiment. Triangulating the results with semi-structured interviews allowed us to support some of these results and observations. In the semi-structured interview, all participants considered that they did feel more creative in Orange condition expressing e.g. *"it was a natural odor" (P4, P7, food), "because make me feel happy" (P6, food).* Others considered that Coffee odor is a smell of "day-to-day", is more familiar and is connected to work activity, *"The smell of a coffee is linked to my day routine of work"*(P4, food) ; *"the coffee did not make any difference to my creativity to write, because is a familiar smell to me"*(P6, food); *The coffee smell was a neutral smell from me, because I get used to my day at work"*(P7,food); 71.4% of participants considered that olfactory cues in the Perfume and laurel Fragrance conditions give them a "writer's block" or it was more difficult to find ideas for their writing, *"It was a less natural smell, the perfume and fragrance (…) more industrialized, and gave me blocks to write."*(P2, ambience); *"I was out of ideas in both conditions"*(P4, ambience); *"I did not felt immersive in the activity with the smell of perfume"* (P6, ambience); *"the laurel fragrance and perfume, are relaxing but in a long term I did not like it"*(P7, ambience).

After the experiment, participants self-rated their creativity in each condition. In Coffee (*Mdn* = 7.0, *M*=6.71, *SD*=1.70) and Orange (*Mdn* = 8.0, *M*=6.57, *SD*=2.44) conditions participants self-rated their creativity higher than No Odor (*Mdn* =5.0, *M*=5.43, *SD*=2.13) , Perfume (*Mdn* = 7.0, *M*=6.23, *SD*=2.21) and Fragrance (*Mdn* = 6.0, *M*=6.0, *SD*=2.65) Conditions. However, using Friedman's ANOVA, this difference was not found to be statistically significant (*Fr* (4) =1.42, $p$>.05). The analysis of the Creativity Support Index (CSI) scores through repeated measures ANOVA (normality checked with Shapiro-Wilk test) did not show significance difference, $F$(1.57, 9.42) =1.42, $p$>.05, among the five conditions but all fragrances present higher values when compared with the baseline (*M*= 55,76, *SD*= 21.14), particularly the ones related with "Food"(Coffee *M*=67.76, *SD*=13.33; Orange *M*=66.19, *SD*=14.52), than "Ambience" (Perfume *M*=61.81, *SD*=12.39; Laurel *M*=59.57, *SD*=16.68).

**Table 1 - Adjective selection on each environment (%).**

| Adjectives | No Odor | Coffee | Orange | Perfume | Fragrance |
|---|---|---|---|---|---|
| **Distressed** | ----- | ----- | ----- | 14,3 | 14,3 |
| **Animated** | ----- | 28,6 | 42,9 | 42,9 | 42,9 |
| **Satisfied** | 14,3 | 42,9 | 42,9 | 42,9 | 42,9 |
| **Bored** | 28,6 | ----- | ----- | ----- | ----- |
| **Pacific** | **71,4** | 42,9 | 14,3 | 14,3 | 14,3 |
| **Relaxed** | 57,1 | **57,1** | 42,9 | 28,6 | 14,3 |
| **Creative** | 14,3 | 42,9 | **85,7** | **57,1** | **57,1** |
| **Astonished** | ----- | ----- | ----- | ----- | ----- |
| **Serious** | **42,9** | 14,3 | ----- | ----- | 28,6 |
| **Fear** | ----- | ----- | ----- | ----- | ----- |
| **Frustrated** | ----- | ----- | 14,3 | 14,3 | 14,3 |
| **Happy** | ----- | 14,3 | ----- | 14,3 | 14,3 |
| **Delighted** | ----- | 14,3 | 28,6 | 14,3 | 14,3 |
| **Tired** | ----- | ----- | ----- | ----- | ----- |
| **Angry** | ----- | ----- | ----- | ----- | ----- |
| **Sad** | ----- | ----- | ----- | ----- | ----- |
| **Depressed** | ----- | ----- | ----- | ----- | ----- |

Despite the experimenter have said that would not be necessary to connect the smell in the displayed object to the writing challenge – Slogan, participants in the Coffee condition for instance, they (two out to seven participants) wrote, *"Your pen is constantly fails and smear it all documents? We have the solution for you: the Caféneta - for consistent writing and even flavored coffee! Try it!"* (P1, food); *"If you're down on productivity, wake up! Get energized with the pen."* (P3, food). While, in Orange condition they (four out to seven participants) expressed genuine connections to this type of smell, e.g., *"(…) We have the solution: A mobile battery, lightweight compact and available in several colors. And the funny thing is that each color is associated with a fruit! Try it…. your purse is always fragrant ... and your mobile phone always with battery!"* (P1, food); *"Recharge your batteries with vitamin!"*(P2, food); *"Fill your life with the exotic power of our products, fill your life with Power Bank."*(P6, food); *"Do you consider vitamin C to be a fundamental ingredient in your day to day life? Well if not you should. Have you wondered your electronics could use the same type of vitamin? Would you carry it in your pocket? Of course not, you haven't had that chance, well now you do! ChargeMe is available in our stores across the city. Lightweight, compact, and easy to handle, buy your ChargeMe right away, and feed your electronics!"* (P7, food). Participants, also they (four out to seven participants) identified the sense of Perfume Condition in their writing, e.g., *"(…) Try our post-its! They are customizable, from color to shape, without forgetting that you can give your favorite scent!"*

(P1, ambience); *"(…) Find your inspiration in the smells of nature."* (P2, ambience); *"When you can't cover up the scent of your responsibilities, freshen up with Post-it notes."* (P3, ambience); *"Make your life a sense that you will never forget and use our notepad."* (P6, ambience). Finally, in Fragrance Condition participants (four out to seven) wrote, *"Connect with the environment."* (P2, ambience); *If you need to clear up your troubles, freshen your day with the iPhone.* (P3, ambience); *"Clean your life and your thoughts use smartphones to give your brain liberty for the pleasures of life"* (P6, ambience); *"Looking for the latest tool to help you document your memories? Try the new phone X. It´s breezy, light and convenient to carry with you. It stores your images, and perfect to use as your personal camera. Plus you can talk to people who are not there with you, with its special 4g connection. Trust me this phone should be yours! Bring back the nature with X as your company!"(*P7, ambience). In semi-structured interviews we asked participants to categorize the olfactory cues into two categories: alert and relaxed [17], as shown in Table 2.

**Table 2 – Self-categorization of each odor (%)**

| | Coffee | Orange | Perfume | Fragrance |
|---|---|---|---|---|
| **Relaxed** | 42.9 | **85.7** | 14.3 | 42.9 |
| **Alert** | 57.1 | 14.3 | **85.7** | 57.1 |

While olfactory cues such as Orange and Perfume are evident to participants in each categories they belong, whereby 85.7% of participants considered the Orange cue can give them a relaxed sense, and 85.7% of participants considered the Perfume can give them an alert sense, in the other two olfactory cues – Coffee and Fragrance – they consider almost as equivalent. One participant commented that the smells also may be distractors *"I believe that the smells are distracting. They can be used for* inspiration *to arise naturally and not purposely."* (P5) and other participant considered that olfactory cues can be messy, *"The smell can become confusing because use many memories and it would take to write a lot about you. The smell can disturb." (*P7).

## 4 DISCUSSION AND CONCLUSION

The high percentage of participants that have chosen the "Creative" adjective combine with the high CSI overall scores with fragrance conditions and Slogan content analysis, show that olfactory cues can influence creativity. In addition, we observe that "food" fragrances present higher values when compared "ambience" fragrances. However, we did not find particular influence if we classify the fragrances as Relax or Alert. The Orange condition was the olfactory cue that users raised their creativity. Also, triangulating data from their mental well-being – their flow state – and interviews results shows that the Orange condition was the one that users felt that fostered more their creativity. To improve and foster creative tasks, our study suggests that olfactory cues should increase research on the development of creativity support tools and environments. In this paper, we compared four different olfactory cues (Food – Coffee/Orange; Ambience – Perfume/Fragrance) using MS Word as a word processor. From a creative perspective, and triangulating qualitative and the statistical results, it is suggested that users considered to felt more creative during the writing task. A significant problem faced by interaction designers that are involved in multisensory interaction is when to apply the multisensory stimulus. Writing prompts are sometimes used to stimulate the creative process, when writing. In this research, we highlight the value of olfactory interaction as a powerful mean to encourage that same process.

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