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Ambient odors of orange and lavender reduce anxiety and improve mood in a dental office

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Abstract

The goal of this study was to investigate the impact of the essential oils of orange and lavender on anxiety, mood, alertness and calmness in dental patients. Two hundred patients between the ages of 18 and 77 years (half women, half men) were assigned to one of four independent groups. While waiting for dental procedures patients were either stimulated with ambient odor of orange or ambient odor of lavender. These conditions were compared to a music condition and a control condition (no odor, no music). Anxiety, mood, alertness and calmness were assessed while patients waited for dental treatment. Statistical analyses revealed that compared to control condition both ambient odors of orange and lavender reduced anxiety and improved mood in patients waiting for dental treatment. These findings support the previous opinion that odors are capable of altering emotional states and may indicate that the use of odors is helpful in reducing anxiety in dental patients.

Keywords: Essential oil of orange; Essential oil of lavender; Anxiety; Mood; Aromatherapy

1. Introduction

Odors have long been known to be capable of altering the emotional state of humans. Physiological and psychological effects of essential oils have been acknowledged in folk medicine and aromatherapy for a long time [1]. Citrus and lavender fragrances have been particularly attributed with mood enhancing properties by aromatherapists [2].

In a previous ambient odor study using orange odor in a waiting room of a dentist's office, we found reduced anxiety and improved mood in female but not in male patients waiting for dental treatment [3]. Early studies demonstrated the sedative nature of lavender [4,5] and in two recent studies [6,7] lavender was shown to improve mood in young subjects; however, no data for the clinical setting in a dental office is available for lavender.

Given the potential of essential oils of altering psychological states, the goals of the present study were to tackle the important question whether the effect of reducing anxiety and improving mood in a dental office is specific to orange oil or if it can be extended to lavender odor. A second goal was to investigate whether stimuli from other modalities, music for example, have the same effect. For this purpose we set up an experimental trial taking place in the waiting room of a dental office. The setting of a dentist's waiting room was chosen because previous evidence suggested dental experience to be associated with fear and anxiety [8].

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2. Materials and methods

2.1. Subjects, experimental design and statistical analyses

We included 200 patients between the ages of 18 and 77 years in our study. All subjects gave informed consent for a protocol according to the Helsinki Declaration. Patients were told the purpose of the study was to determine the association between pain and mood. After the experiment, each patient was debriefed about the true nature of the study by the dentist and subsequently provided informed consent. The participants were assigned either to a control group with no odor and no music, or to a music group, or to an orange odor group, or to a lavender odor group, respectively. Patients were selected consecutively in order to control different dental procedures (regular check-up, dental hygiene, dental drilling, tooth pulling, pain). First we tested the no odor study group, followed by the music group, then the orange odor study group, and finally the lavender odor study group. Testing started November 2003 and ended in January 2004. As patients were assigned sequentially to the experimental conditions, we assumed that age, pain, nasal disease status, etc. were comparable across conditions. However, due to the season of the year, it was likely that the patient sample contained patients with nasal disease. In order to control for nasal disease status, we screened the patient sample by means of self report for allergies and common cold. The four study groups did not differ regarding frequency of self reported allergies (χ^2 test, $p>0.05$) and self reported common cold (χ^2 test, $p>0.05$), respectively. See Table 1 for details.

Upon arriving, patients were registered and then were handed the questionnaires to be filled-in while waiting for treatment. Importantly, answering the questionnaires was entirely self-paced and dependent only on the speed of patients. We did not measure fill-in time but in no case was it longer than 20 minutes. First, they completed a questionnaire asking for demographic data. The mean age of patients was comparable between the four groups as indicated by analysis of variance ($F(3,194)=1.27$, $p=0.293$). See Table 1.

Next they were asked about their current pain using an 11-point Likert scale ranging from 0 (no pain at all) to 10 (unbearable pain). Analysis of variance, for degree of toothache, detected no statistical difference between groups ($F(3,184)=0.74$, $p=0.534$) indicating that all four groups were comparable in terms of pain rating. See Table 1.

Patients were next given a German version of the State-Trait Anxiety Inventory (STAI) [9] a self report measure with demonstrated reliability and validity for assessing trait and state anxiety. High scores indicate high self-perceived anxiety.

Subsequently, they were given the Mehrdimensionale Befindlichkeitsfragebogen (MDBF) [10] for assessment of current mood, alertness and calmness. Patients had to answer questions on 5-point Likert scales regarding mood, alertness and calmness. Scale reliability (Cronbach's α) is above 0.9 for all three scales. Higher scores indicate more positive mood, high level of alertness and high level of calmness.

Ambient odors of orange and lavender were diffused separately in the waiting room through an electrical dispenser in both odor groups whereas in the control group and the music group no odor was in the air. The dispenser was hidden from the patients view and the system of Voitino Air100 (Krailling, Germany) with constant intermediate concentration was used. The odors were set free from 7:30 a.m. to 6:30 p.m. The waiting room was 16 m^2 large. After the change from orange to lavender the odor delivery system was thoroughly cleaned according to standard procedures of the odor delivering system.

The natural essential oils of citrus sinensis and lavender supplied by Primavera (Sulzberg, Germany) were used. The main components of the essential oil of orange was determined by gas chromatography to be limonene 95.3% and myrcene 1.88%, all other components were below 1%. The main components of the essential oil of lavender was determined by gas chromatography to be linalylacetate 34.8%, linaloole 30.6%, occimene-*cis* 5.9%, occimene-*trans* 3.5%, terpinene-4ol 5.4, lavandulylacetate 3.4%, caryophyllen 4.8%, all other components were below 1%. The gas chromatography data were provided by the delivery company.

For the music condition, the compact disk of "Café del Mar—Music from Ibiza" was used throughout the study. This particular music is considered up lifting and cheerful, reminding people of vacations and good times. The music was played through the speakers of the dental office in the waiting room situated on the ceiling of the room. The loudness of the music remained constant throughout the study.

In order to compare the variable state anxiety between the four "groups" an analysis of covariance with the fixed

Table 1
Mean, standard deviation, range of scores and frequency for each variable over experimental groups

Variables	Control ($N=51$)	Music ($N=49$)	Lavender odor ($N=48$)	Orange odor ($N=50$)
Age[a]	40.4±13.3	41.0±13.7	41.9±14.7	40.2±12.4
	19–77	23–74	23–74	21–70
Pain[a]	6.3±3.1	6.4±3.2	6.8±3.2	6.6±3.5
	0–10	0–10	0–10	0–10
Gender (female/male)	26/25	25/24	23/25	24/26
Allergy[b] (not present/present)	34/13	38/6	38/6	42/5
Common cold[c] (not present/present)	36/10	30/14	33/13	37/8

[a] Group effect $p>0.05$.
[b] χ^2 test, $p>0.05$.
[c] χ^2 test, $p>0.05$.

factors "group" (4 levels: control/music/orange odor/lavender odor), "gender" and the covariates age and trait anxiety was performed. The interaction between "gender" and "group" was also included in the model in order to test whether differences between the groups depend on gender because a gender effect for orange odor was found in our previous study. Post hoc comparisons between group means were performed by the method of Tukey–Kramer. A p-value<0.05 was considered to indicate statistical significance. A similar analysis was carried out for the variables mood, alertness and calmness, except that trait anxiety was not included as covariate. Calculations were performed using the SAS software system V8.2 (SAS Institute Inc., 2002, Cary, NC).

3. Results

Table 2 gives the means, standard deviations and range of scores of the raw data for each variable over experimental groups.

The analysis of covariance for the dependent variable of state anxiety detected a statistical group effect ($F(3,163)=3.1$, $p=0.028$); however, no significant interaction between group and gender ($p=0.740$) was observed. Post hoc analysis using Tukey–Kramer multiple comparisons revealed a statistical group difference between the control group and the orange group ($p=0.049$) and between the control group and the lavender group ($p=0.039$). No statistical significant group difference was found between control group and music group ($p=0.371$), and furthermore, no other group differences were significant.

The dependent variables of mood, alertness and calmness were analyzed in subsequent analyses of covariance with the fixed factors "group" (4 levels: control/music/orange odor/lavender odor), gender and the covariate age. For the measure of mood there was a significant effect of group ($F(3,165)=3.1$, $p=0.030$) and no significant group by gender interaction ($p=0.103$). Post hoc analysis using Tukey–Kramer multiple comparisons revealed a significant group difference between the control group and the orange group ($p=0.046$) and between the control group and the lavender group ($p=0.046$). No statistical significant group difference was found between control group and music group ($p=0.339$), and furthermore, no other group differences were significant. Statistical analysis of the dependent measure alertness showed no statistically significant main effect of group ($F(3,165)=2.2$, $p=0.097$) nor significant group by gender interaction ($p=0.166$). For the measure of calmness there was a significant group effect ($F(3,165)=4.5$, $p=0.004$), however, no significant group x gender interaction ($p=0.332$) was obtained. Post hoc analysis using Tukey–Kramer multiple comparisons revealed a borderline significant group difference between the control group and the orange group ($p=0.061$) and a significant group difference between the control group and the lavender group ($p=0.016$). No statistical significant group difference was found between control group and music group ($p=0.355$), and furthermore, no other group differences were significant.

Table 2
Mean, standard deviation and range of scores for each variable over experimental groups

Variables	Control ($N=51$)	Music ($N=49$)	Orange odor ($N=50$)	Lavender odor ($N=48$)
State anxiety[a,b]	43.3±13.4	38.1±10.8	35.7±10.1	38.1±11.3
	24–79	23–68	20–69	20–65
Mood[a,b]	27.9±7.4	31.2±4.9	31.7±6.1	30.5±7.6
	9–40	20–40	13–40	8–47
Alertness[c]	25.6±6.3	28.2±7.0	28.5±5.8	27.1±7.2
	14–37	14–40	18–40	8–38
Calmness[a,b]	25.1±8.0	28.2±6.4	30.1±6.5	28.7±7.9
	8–40	17–40	10–40	9–40

[a] Group effect $p<0.05$.
[b] Interaction of sex × group $p>0.05$.
[c] Group effect $p>0.05$ and sex × group interaction $p>0.05$.

4. Discussion

It is widely believed that odors have the power to influence emotional states in humans. We tested this hypothesis in a controlled experimental study taking advantage of the highly emotional situation in a dentist's waiting room. While waiting for their dental procedures patients were stimulated either with ambient odor of orange or ambient odor of lavender. These conditions were compared to a music condition and a control condition (no odor, no music). We found that patients who were exposed to orange odor or lavender odor had a lower level of state anxiety, a more positive mood, and a higher level of calmness compared to the patients in the control condition.

The results of this study confirmed the previous notion of sedative properties of the natural essential oil of orange in a clinical setting and extended it to the essential oil of lavender. We further found that exposure to music in a dentist's waiting room has an intermediate effect. This finding is consistent with a growing body of evidence showing that odors are capable of changing emotional states in humans. Several prior studies reported that ambient odors of orange [3] and lavender [4–7] can influence anxiety and mood in humans. Our study extended this evidence to the clinical setting in a dental office.

The mode of action of ambient odors in inducing emotional changes is currently unknown. Recent work suggests that some essential oils possess pharmacological properties that may be responsible for the emotional effects reported in this study. For instance, lavender has been demonstrated to act postsynaptically, and it is suggested that it modulates the activity of cyclic adenosine monophosphate (cAMP). A reduction in cAMP activity is associated with sedation, a causal relationship that has been established for

the effects of cannabis [11]. Transdermal administration of (−)-linalool, one of the main constituents of essential lavender oil, lowered physiological arousal level by means of autonomic deactivation [12] without affecting mood ratings. After experimentally reducing olfactory function in rats, inhalation of cedrol, a major component of cedarwood oil, still had marked sedative effects suggesting that the mechanism of action is via a pathway other than the olfactory system [13]. On the other hand it is well known that olfactory processing is directly linked to the limbic system including the amygdala and that emotional changes are induced by means of olfactory stimulation as evidenced by neuroimaging studies [14]. Further research is needed to resolve this question.

In conclusion, our study supports the traditional use of essential oils in altering emotional states. It also demonstrated that essential oils, used as ambient odors, might be helpful to reduce anxiety and improve mood in dental offices. Future studies should also take up suggestions [15] to investigate effects of odorant mixtures, as well as those of single odor molecules and effects of natural odor mixtures compared to synthetic products.

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