Mood Benefits of Fragrance

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IFF developed an interest in aromatherapy in the early 1980s as a potential means for imparting a stress-reducing benefit to fragrance. Aromatherapy is an age-old practice of applying the healing benefits of certain aromatic essential oils. In the tradition of aromatherapy, specific essential oils are stress reducing, whereas others are energizing, and still others can have either effect, depending on the user's state of mind/body interaction. We reasoned that the best way to study the stress-reducing properties of fragrance would be to investigate their physiological effects. In 1983 IFF initiated a joint program with Dr. Gary E. Schwartz, a psychophysiologist and stress researcher at Yale University. The original focus of this program was on the well-known stress response in humans, which can be measured using the galvanic skin response, skin temperature, muscle tension, heart rate, respiration, and especially blood pressure. Although physiological measurement can be used to index the stress response, these measures do not provide direct information about how fragrance affects a person's moods or feelings. Psychological self-report measures are needed to do this. In 1985 IFF instituted an in-house Aroma Science program, whose focus was on the effects of fragrance and fragrance ingredients on subjective moods.

Today, nine years of experience with physiological measures and seven years with the psychological measurement of mood have led to the following observations:

1. Fragrance-evoked mood changes are small, but beneficial to our well-being.
2. Fragrance can be used to reduce the stress response in humans, but its physiological effects on a non-stressed subject are minimal and difficult to measure.
3. Measurement of fragrance-evoked mood change by psychological methods is feasible, and yields intriguing results.

This paper will now examine these three observations in some detail.

Heightened Well-Being

Why aren't odor-evoked mood changes more potent? Why are humans the only mammals who exhibit sexual and social behavior that is not under olfactory control? In his book, *The Scented Ape*, Dr. Michael Stoddard argues that the loss of olfactory-controlled sexual and social behavior was necessary for the development of the human race. Stoddard contends that:

> "...during the Miocene epoch, man's pre-hominid ancestors started to band together in order to hunt the large ungulates, which evolved in association with the grassy plains, and that this gregarious habit posed a threat to the integrity of the pair-bonds which existed between males and females by allowing the oestrus-advertising odor signals of the females to be perceived by all of the males in the band. To retain the sociobiological advantages which the pair-bonds affords the young, it was necessary for the information present in the signal to be scrambled by the brain until it was meaningless."[1]

Stoddard goes on to say that he does not know how the ability to perceive estrus odors (i.e., odors associated with ovulation) was lost, but it is logical to assume that it occurred when the cerebral cortex was gaining in ascendancy over the ancient brain.

Humans do not depend upon odors as a valuable source of information about their environment, as do other animals. In infra-human mammals, sexual and emotional behaviors are governed largely by the limbic system, a primitive series of interconnected structures deep beneath the cerebral cortex. In contrast, the olfactory system in humans is dominated by the cerebral cortex. Odors no longer control our sexual and social behavior. Rather, as we will see below, they create small changes in feeling states. Although the olfactory system is under the command of the cerebral cortex, neural signals generated by odors travel first to the limbic area of the brain, and then to the cerebral cortex where they give rise to conscious perceptions.

If odors do not cause overt changes in our sexual and emotional behaviors, what do they do? Ehrlichman and Bastone propose that odors can influence a variety of cognitions and behaviors in ways similar to mood states. The authors state that "in contrast to strong emotions, these feeling [mood] states do not interrupt our thoughts, but subtly color and redirect them often without our notice."[2] The authors' research suggests that odors are more likely to influence some types of cognitive processes than others. In particular, they speculate that cognitive processes that were automatic may be more sensitive to odor effects than are cognitive processes that are controlled. Cognitive processes that are influenced by odors include such tasks as creative performance, evaluations of people or words, and personal memories triggered by neutral words. Compared to unpleasant odors, pleasant odors tended to: a) enhance creative performance, b) generate more positive evaluations of words and pictures of people, and c) elicit more happy memories. Each of these three tasks has been shown to be influenced by moods in past research. However, odors did not affect other behaviors that are also known to be affected by moods, such as propensity to help other people, and judgments about the likelihood of risks. The authors proposed that such behaviors are influenced by thoughts that accompany moods, but not by the mood states themselves.

Baron[3] (1990) found that subjects working in the presence of a pleasant ambient odor set higher goals, and were more likely to employ an efficient strategy, than subjects working in an unscented room. In a negotiation task with a same-sex confederate, subjects exposed to the pleasant fragrance set higher monetary goals, were more likely to make concessions, and were less likely to state a preference for confrontational approaches to future negotiations than were subjects in the unscented room. Baron attributed these effects on work performance to mood changes brought about by the odor's pleasantness.

The results of Baron, Ehrlichman and Bastone suggest that pleasant odors stimulate, or prime, both pleasant thoughts and positive mood states, whereas unpleasant odors prime unpleasant thoughts and mood states. Furthermore, odors are less dependent on higher cognitive processes to produce these effects than are auditory or visual stimuli.

Reduced Stress

IFF's initial direction in the area of aroma science arose from psychological research on stress management. In collaboration with Yale University, we examined whether odors could have an ameliorating effect on stress. Under stress a person often shows what is called "the fight or flight response." We wanted to start with a wide variety of psychophysiological measures and determine which ones were the most valuable for our objective of quantifying the effects of odor on stress.

Psychophysiology is concerned with the measurement of physiological responses in the study of psychology, meaning behavior, emotion and cognition, or thinking. The nervous system is divided into two domains, the central nervous system (brain, brainstem and spinal cord) and the peripheral nervous system (all other nerve fibers). The peripheral nervous system can be further subdivided into the somatic nervous system and the autonomic nervous system. The somatic nervous system consists of the nerves to and from sensory and motor organs (voluntary muscles) whereas the autonomic nervous system innervates the internal organs and involuntary muscles. The autonomic nervous system can be separated further into the sympathetic nervous system and the parasympathetic nervous system. The basic function of the sympathetic nervous system is the mobilization of the body for action, especially in an emergency (fight or flight response). The action of the sympathetic nervous system tends to be diffuse, affecting all organs at the same time. The parasympathetic nervous system is concerned with restoration and conservation of the body resources. Its responses are localized, and its components operate somewhat independently.

Blood pressure: For our first series of studies, blood pressure was chosen as a measure of level of stress. Blood pressure is controlled primarily by the sympathetic nervous system. We investigated nutmeg oil due to its rich anecdotal history of use as an aromatherapy essential oil for reducing the effects of stress. We used traditional psychophysiological stressors such as mental arithmetic, and a phrase completion task that involved mildly provocative phrases, such as "my most secret desire is..." We found that when nutmeg was added to a fragrance, our subjects displayed a reduced blood pressure response to stress, compared to the same fragrance without nutmeg. We obtained a U.S. Patent for this stress-reducing use of nutmeg in a fragrance (#4,671,959). We also found that a nutmeg-based fragrance did not have any relaxing or stress-reducing properties when the typical subject was sitting quietly at rest, that is, in a non-stressed state.

Peripheral nervous system: Further research indicated, however, that other fragrances exert minimal effects on a variety of peripheral autonomic nervous system measures when non-stressed, resting subjects were tested. In a study of 28 college students, we examined physiological changes in facial muscle tension, galvanic skin responses, heart rate, and skin temperature as subjects smelled spiced apple, neroli or galbanum, as well as a non-odor control.[4] The three odorants were chosen to generate a range of hedonic preference. Apple spice was evaluated as pleasant, galbanum as unpleasant, and neroli gave a mixed response with half of the subjects saying it was pleasant, and the other half saying it was unpleasant. The three odor conditions could not be distinguished on the basis of their physiological patterns. Interestingly, subjects who liked neroli were distinguishable from those who disliked it: the former group showed physiological patterns indicative of interest and attention relative to the latter group. The lack of differentiation among widely different odorants led us to conclude that peripheral physiological measures probably are not sensitive enough to discriminate the effects of odors that are of commercial interest. The effects of all but the most unpleasant odors are probably too subtle to register appreciable consequences in the peripheral nervous system.

Central nervous system: IFF has also become involved in several studies of the central nervous system, and in particular, "brainwaves." The technical name for brainwave measurement is electroencephalography, or EEG. This term refers to tiny voltage changes that are measured from the scalp by surface electrodes. Spontaneous EEG refers to the ongoing brainwave measured over a period of several seconds to minutes or hours. When EEG is recorded in response to a stimulus such as a visual image or sound, or odor, the resulting brainwave is called an event-related potential, or ERP. This research is still in a very early stage, and its results have so far proved to be difficult to interpret. In IFF's most recent study, directed by Dr. William Klemm at Texas A & M University,[5] spontaneous EEG was recorded in response to seven odors varying widely in character, hedonics, and perceived intensity. Although odor-related EEG findings were obtained, they were not interpretable in terms of these three major characteristics of odor. Indeed, individual differences in subjects' EEG responses to the odors were remarkably large.

Another area of brainwave research at IFF is the ERP called contingent negative variation, or CNV. IFF's work developed from a study conducted by Professor Torii and colleagues at Toho University in Japan.[6] The experiment recorded the CNV of perfumers as they smelled jasmine, lavender, or nothing at all (control condition). The results showed that lavender reduced CNV and jasmine increased it. Torii et al. interpreted their findings to indicate that jasmine is stimulating and lavender is relaxing. However, these investigators did not record any of the perfumers' evaluations of the odors. It is also not clear whether these results will apply to the general public.

Dr. Tyler Lorig of Washington & Lee University expanded on Torii's work in a collaborative project with IFF.[7] In the first part of this experiment, Lorig et al. replicated the Japanese study methods, but also obtained the subject's evaluations of the odors. In the second part, Lorig et al. added a condition in which the subjects were deceived to expect two separate administrations—one of lower-strength jasmine and one of lower-strength lavender. Instead, the subjects actually received only one administration—a mixture of lavender and jasmine, both at lower strength.

In the first part of the study, CNV findings of Lorig et al. replicated those of Torii et al. in terms of the administration of full-strength jasmine and lavender presented separately. Once again, jasmine increased the CNV and lavender decreased CNV, as compared to the no-odor control condition. However, a revised explanation of lavender's effect was required. Although our subjects evaluated jasmine as moderately pleasant and moderately strong, they rated lavender as very unpleasant and very strong—too strong and unpleasant to be relaxing. Lavender's ability to decrease CNV was probably due, therefore, to its distracting effect, rather than its relaxing effect. It is well known that CNV can be reduced by such distracting conditions as fatigue or stress, as well as by relaxation.

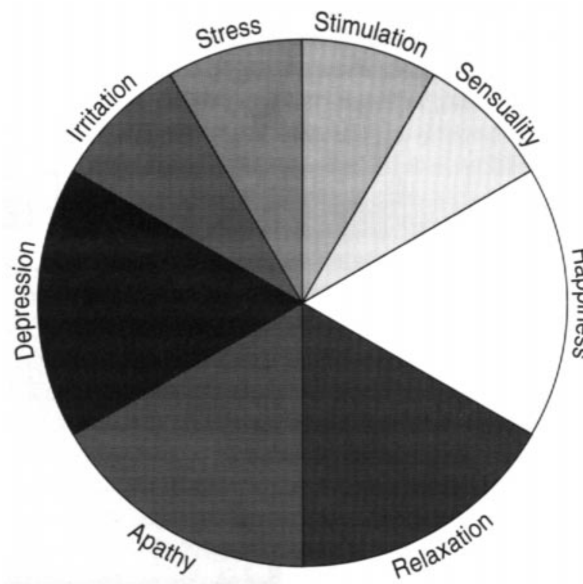

Figure 1. Mood categories.

The second part of the Lorig study was equally revealing. Post experimental debriefing confirmed that subjects were indeed deceived. When subjects expected to be smelling jasmine at lower concentration, their CNV looked just like the response to full strength jasmine. Similarly, when subjects expected to be smelling lavender at lower concentration, their CNV looked just like the response to full strength lavender. In other words, brainwave patterns can be affected by subjects' beliefs and thoughts about the stimulus.

Summary: The results of our psychophysiology studies suggest that a nutmeg-based fragrance reduces the blood pressure response to stress, but that its physiological effects are not readily detectable in a non-stress state. When a normal subject is at rest, the effects of odors on the peripheral nervous system appear to be minimal and difficult to measure. It may be that further research may uncover such effects, however. In the central nervous system, fragrances do have effects, but the interpretation of these effects has proved to be difficult. Physiological measures, particularly those of brain events, can be influenced by a person's thoughts and beliefs about a stimulus, rather than always being true measures of a person's real response. In conclusion, we feel that the use of physiological measurement with fragrances is still in an early exploratory stage. The discovery of how the brain processes information about odors and

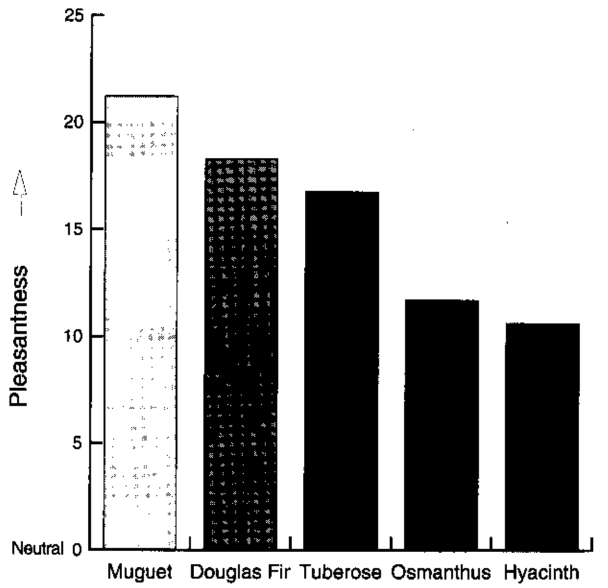

Figure 2. Pleasantness ratings of five living flower fragrances

fragrances remains a promising goal for future research.

Mood Changes

The realization that measurement of fragrance-evoked mood changes requires psychological assessment techniques led us to the development of a mood profiling procedure. Mood profiling is a self-administered, quantitative method that measures subjective mood changes evoked by fragrance. The test was modeled after similar tests (such as those of Nowlis[8] or McNair et al.[9]) used to measure emotion disorders. Three years of research were required to adapt the methods reported in the literature into a test that measured mood change instead of mood state, and was sensitive to the particular mood changes evoked by fragrance. Our research led to the definition of eight dimensions, or factors, of mood that are affected by fragrance: four positive and four negative. Four positive mood factors are happiness, sensuality, relaxation and stimulation. Four negative mood factors are irritation, stress, depression and apathy. These eight mood categories can be visualized in a circular arrangement, or wheel, as shown in Figure 1.

The mood wheel shows the positive moods on the right side and the negative moods on the left. Moods involving more physiological arousal are shown at the top of the wheel, and low arousal moods are at the bottom. This general arrangement is usually found in mood research studies carried out in a variety of settings by researchers all over the world.[10]

As an example of its application, the mood profiling technique will be shown as applied to five "living flower" fragrances. These fragrance creations are based upon the chemical analysis of living flowers. The analysis has been expanded to include fruits, herbs, spices and trees. The

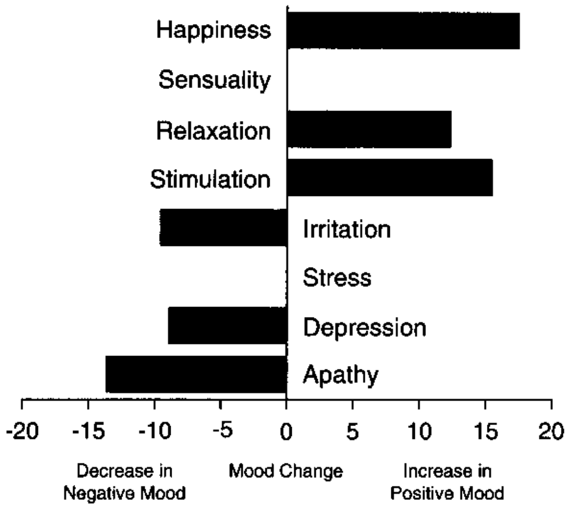

Figure 3. Muguet. ***Note:*** **For figures 3-7 only changes exceeding p<0.05 are shown.**

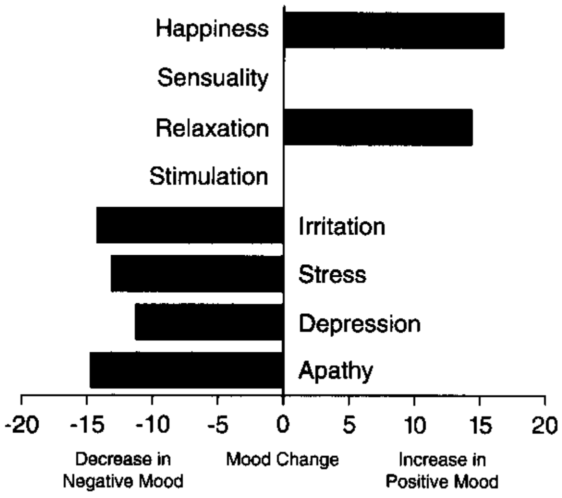

Figure 4. Douglas fir

odor given off by a living plant changes within five hours after it is picked. The odor of the living plant tends to be more vibrant and fresh relative to the essential oil extracted from the plant. IFF's Natural Product Chemistry Group, under the leadership of Dr. Braja Mookherjee, has analyzed and recreated the aroma of many flowers, fruits, spices, herbs and trees. All the notes were very delightful to smell and quite true to the actual living version. The pleasantness ratings (Figure 2) were all significantly different from neutral.

Mood profiles depicting changes in the eight mood factors are shown (Figures 3-7) for each of the five living flower scents. These profiles were selected from different panels of 35 to 50 women. Panelists indicate how a fragrance makes them feel by marking on a line how much each of the eight mood categories has changed. Our scale allowed a 50-point range of change in one direction for any one mood, but none of the mood changes reported by the panelists exceeded 20 points. Only changes that exceeded 0.05 probability level are shown. A desirable response to a fragrance is exhibited when there is an increase in one or more of the positive moods, and a decrease in one or more of the negative moods. For instance, if a fragrance evokes an increase in happiness and a decrease in apathy, this is a more desirable response than an increase in happiness alone.

As expected for the most pleasant-smelling fragrance of the set, muguet (Figure 3) makes people happy. Unlike most fragrances, however, muguet increases both relaxation and stimulation. In the past we have found that when a fragrance evokes increases in both stimulation and relaxation, a number of panelists tell us (in post-panel interviews) that they experience both a heightened sense of calm and at the same time an increase in awareness and energy. We call this state calm vitality. Researchers have known for years that stimulation and relaxation are not mutually exclusive mood states. Rather, they bear no constraining relationship with respect to each other. Aromatherapists say that fragrance materials with this type of mood effects are "balancing," for the restorative effects they have on distressed moods of anxiety and related states, or depression and lethargy.[1] Consistent with this increase in calm vitality, muguet also lowers depression and apathy, as well as irritation.

Douglas fir (Figure 4) living flower fragrance has a very soft and pleasant scent that is very different from the usual, coarse pine note. Douglas fir profiles as distinctly relaxing, a feeling that might be qualitatively similar to that obtained by meditating or taking a warm bath. In Japan there is an entire therapy built around taking a "forest shower," by walking into an evergreen forest and becoming "at one with nature." Douglas fir also appears to be effective in lowering the negative moods. It is well suited for the personal care, cosmetic and bath arena, where it may inspire a return to the soothing bath that reduces stress and nurtures inner peace.

Tuberose (Figure 5) presents a relaxing and sensuous profile. Clearly, the added dimension of sensuality takes tuberose out of the strictly relaxing, stress-reducing category of the Douglas fir fragrance. A classically sensuous fragrance in popular literature, tuberose represents a languorous and seductive entry for the fine fragrance market. Reinforcing its prominent positive mood of happiness is a pronounced decrease in the opposite mood, depression (see Mood Wheel in Figure 1).

Osmanthus (Figure 6) is a flower that originated in China and is highly coveted in both China and Japan. It has a floral and fruity quality somewhat like apricot. The mood profile for osmanthus is quite different from the preceding ones in that it highlights stimulating properties. Its stimulating and

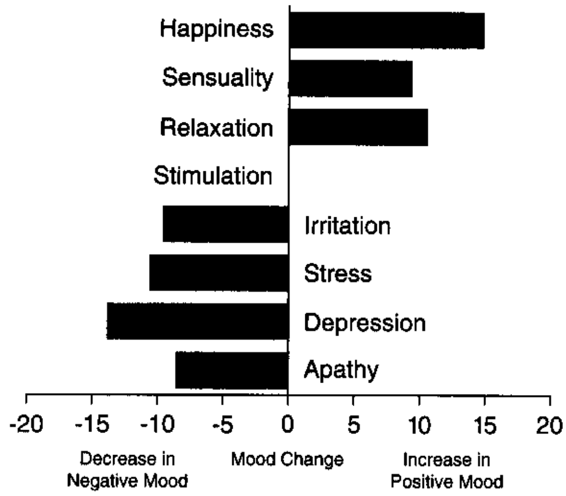

Figure 5. Tuberose

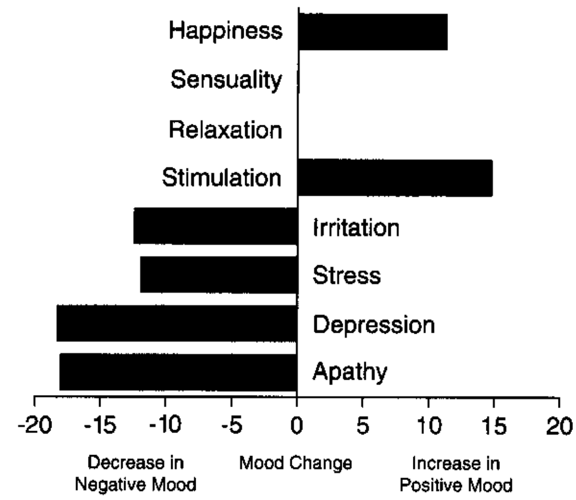

Figure 6. Osmanthus

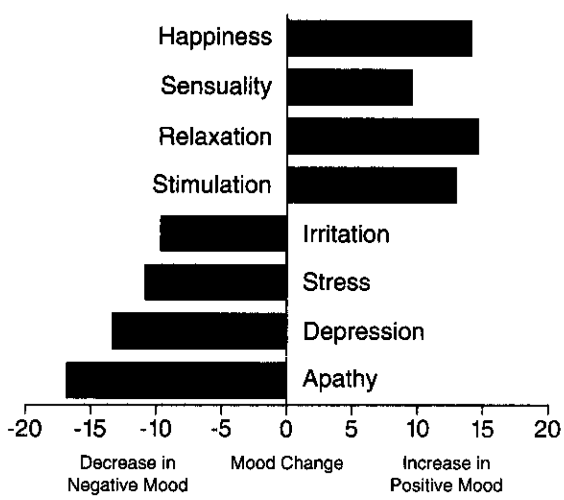

Figure 7. Hyacinth

happy qualities are further supported by prominent reductions in the negative moods of apathy and depression.

Hyacinth (Figure 7) presents a surprisingly rich mood profile, and one that would not be expected based on its pleasantness rating alone. It appears to be a very complex fragrance, with a broad selection of mood effects. It evoked increases in happiness, sensuality, relaxation and stimulation (calm vitality), while decreasing all the negative moods.

Conclusions

The issues discussed in this article concerning the mood benefits of fragrance will need to be studied further. In the meantime, these basic mood profiles of the five living flower fragrances certainly provide "food for thought" on the emotional perception of fragrance. The profiles presented here illustrate that fragrances can have measurable and distinctive effects on our mood in ways that could prove beneficial for the user. We believe that further improvements in our measurement techniques, and a better understanding of the mood changes evoked by specific perfumery ingredients will allow for the development of more impactful mood-altering fragrances.

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