Olfaction Sensitivity in Sleep: The Effects of Fragrances on the Quality of Sleep

A Summary of Research Conducted for the Fragrance Research Fund

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We know that when auditory (sounds), visual (light) or tactual (touch) stimuli are presented to sleeping individuals they awaken to them. Scientists have provided information on the latter topic for many years, and it is well established that people, to a degree, are responsive to these types of stimuli while sleeping. In contrast, we know much less concerning the sense of smell in sleep. Until the series of studies (described below) were conducted only anecdotal accounts but not scientific reports were available concerning olfaction in sleep. We proposed that knowing more about the sense of smell in sleep may be beneficial in terms of safety and in terms of health.

Since there were no data available regarding whether the sense of smell was responsive in sleep, the first series of studies that were proposed focused on this topic. We asked a simple question, "Can individuals sense (detect) odors or fragrances that are presented to them in sleep?" Given that the answer is "yes," thus indicating that the sense of smell functions in sleep, we also proposed a second series of studies, contingent on the outcome of the first series, assessing the effects that different fragrances might have on the quality of sleep. The question here was whether fragrances judged to be alerting in the waking state and then presented while sleeping would disrupt sleep. And, whether fragrances judged to be relaxing in the waking state and then presented while sleeping would enhance sleep.

The Fragrance Research Fund

This article is an informal description of one of the research projects supported by The Fragrance Research Fund. This fund has as its main objective the financing of research related to the impact of fragrances in humans.

It studies the sense of smell and human reaction to olfactory stimulation. The research is of an interdisciplinary nature, including anatomatical and ultrastructural observations, physicological and biochemical studies, as well as psychological and behavorial reactions to fragrance.

This research is expected to clarify how fragrances operate and how they impact, via the central nervous system and hormonal mediators, on moods, mental attitudes and general physical health.

The President of The Fragrance Research Fund is Dr. Jack Mausner, Senior Vice President Research and Development, Chanel, Inc. For further information on the research and educational activities of The Fragrance Research Fund and of The Fragrance Foundation contact: Annette Green, The Fragrance Foundation, 142 East 30th Street, New York, NY 10016, USA.

Background Knowledge on Subject

As noted, little research on the sense of smell during sleep has been done but a large body of research exists examining the sense of smell in waking. The literature suggests that in the waking state odors have both subjective effects (alerting/relaxing, pleasant/unpleasant, etc.) and physiological effects (changes in brain waves, heart rate, skin conductance level, etc.). Interestingly, there is also

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evidence that odors can affect physiological measures (e.g., brain waves) in waking even when the odor is not detected by the subject, i.e., it is presented below their detection threshold. Such findings indicate that the person does not have to be aware of an odor for it to produce behavioral and physiological changes[1,2]

A search of the literature concerning the sense of smell in sleep revealed one study that tested the ability to smell in newborn infants. Unfortunately objective, polygraphic recordings of sleep were not made. However, our recent work, which we describe below, reveals that the sense of smell functions in sleep and that individuals are responsive to fragrances when they are presented in sleep. We describe these findings below.

Methodology

Our sleep laboratory assesses the quality of sleep using objective polygraphic recordings, behavioral measures, and subjective reports. Objective recordings place emphasis on psychophysiological measures, such as electroencephalogram (EEG or brain waves), electromyogram (muscle activity), electrooculogram (eye movements), respiration, heart rate, and arousal level. These recordings are used to calculate the duration and quality of sleep (sleep architecture). From these measures we can determine how quickly a person falls asleep, how long they sleep, the number of arousals and the number of awakening that they experience, the time that they spend in the different sleep stages 1,2,3,4, and REM (rapid eye movement), the number of times that they shift stages, their sleep efficiency, the number of movements made, and movement duration.

We also have the participants in our research complete a questionnaire that deals with the subjective aspects of sleep, e.g., "How well did you sleep?" "Was your sleep restful?" etc. To record the above physiological measures requires expensive polygraphic equipment and a highly skilled technician to attach sensors to the scalp, legs and chest, to the area around the eyes, and to the mastoid regions. These electrodes are then attached to high quality amplifiers that greatly amplify the physiological signals so that they can be seen on a computer screen and on pen write outs. This system of measurement is referred to as polysomnographic recording.

Our Findings

Our first study investigated whether the sense of smell functioned in sleep by testing college students overnight and across days.[3] The initial interest was simply in determining whether they could detect odors that were presented to them while sleeping. Either peppermint (an alerting odor) or room air was randomly presented to the participants every four minutes for a period of three minutes throughout the night while they were sleeping.

Participants were instructed to try to awaken if they detected an odor. They also wore a soft glove with their thumb inserted over a microswitch and were instructed to press the switch if they detected an odor. In addition to measuring the number of times that they were able to awaken to the odor and to press the microswitch, physiological measures were recorded (EEG, heart rate, respiration, muscle tension, arousal level).

Analyses of all measures (behavioral and physiological) revealed clearly that the sleeping research participants reacted more strongly when an odor was presented than when room air was presented. Thus, our first study clearly established that the sense of smell functioned in sleep. However, we should note that the responsiveness to odors in sleep was greatly diminished compared to responsiveness to odors in the waking state.

A subsequent study by our laboratory examined the effects of continuous, all-night odor presentation of either peppermint, jasmin, or room air. It was hypothesized that jasmin, reported as relaxing in waking, would enhance sleep while peppermint, reported as alerting in waking, would disrupt sleep. The results revealed that the odors did affect sleep quality but, contrary to our expectations, both odors, when compared to room air, had a disrupting effect on sleep.

A follow-up series of studies was then initiated comparing again the odors of peppermint and jasmin, with room air.[4] In addition, we added two odors judged to be relaxing, coumarin and heliotropin. We used short (30 minutes) daytime naps initially and each odor was compared to room air in terms of the effects on sleep quality. Again, our findings revealed that jasmin and peppermint tended to be disruptive to sleep. Coumarin also tended to be disruptive. However, heliotropin tended to enhance sleep (latency to sleep was shorter and sleep efficiency was higher) although the effect was not statistically significant. The latter findings must be interpreted cautiously since the results were not statistically significant and additional research on all-night sleep (as opposed to naps) is needed. However, this is the only odor that we have investigated to date that has not disrupted sleep. While our current research is now focused on replicating the heliotropin findings using all-night sleep and longer daytime naps, we are also assessing the effects on sleep of several other odors.

To date it can be safely concluded that the sense of smell is responsive in sleep and that odors can affect the quality of sleep. The current evidence is strong that odors can disrupt sleep and very weak concerning whether they can enhance sleep.

References

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