Sleep Medicine 47 (2018) 72–76

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Favorite odor induces negative dream emotion during rapid eye movement sleep

Satomi Okabe [a, b, *], Kazuhiko Fukuda [c], Hiroko Mochizuki-Kawai [d], Kazuo Yamada [e]

[a] Graduate School of Integrated Arts and Sciences, Hiroshima University, Higashi-Hiroshima, Japan
[b] College of Psychology, School of Human Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan
[c] College of Sociology, Edogawa University, Nagareyama, Chiba, Japan
[d] Institute of Vegetable and Floriculture Science, National Agriculture and Food Research Organization (NARO), Tsukuba, Ibaraki, Japan
[e] Faculty of Human Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan

ARTICLE INFO

Article history:
Received 30 October 2017
Received in revised form
8 January 2018
Accepted 14 March 2018
Available online 19 April 2018

Keywords:
Dreaming
Emotion
REM sleep
Olfactory stimulation
Phenyl ethyl alcohol
Odor perception

ABSTRACT

Objective: As connections between nightmares and various psychiatric disorders have been reported, the clinical significance of studying dream emotionality is now growing in importance. Because the olfactory bulb connects directly to the amygdala odor presentation may be a crucial tool to study dream emotions. Previous studies have demonstrated that presentation of positive/negative odors during rapid eye movement (REM) sleep affects various aspects of dreaming. Although olfactory perception can be influenced by personal experiences, the role of individual preferences in the effects of olfactory stimuli on dreaming has not yet been clarified. The purpose of the current study was to clarify the effects of odor on dreaming during REM sleep, taking individual preferences into account.

Methods: Phenyl ethyl alcohol (rose-like smell) airflow was presented as an experimental stimulus, and odorless airflow was presented as the control. Participants who like (n = 7) and dislike (n = 8) the odor of phenyl ethyl alcohol were presented air with and without the odor of phenyl ethyl alcohol, respectively, during REM sleep and then awakened to report and rate their dream contents. Thereafter, the transcribed dream reports were rated by independent raters.

Results and Conclusions: Participants who liked the odor of phenyl ethyl alcohol reported more emotionally negative dreams when they were presented with phenyl ethyl alcohol airflow than that with odorless airflow. In other words, the participant's favorite odor was associated with emotionally negative dreams. These findings could be attributed to the nature of odor perception and the characteristics of brain activities during REM sleep.

1. Introduction

Several studies have demonstrated that nightmares are related to suicide attempts, depression [1–4], and/or insomnia [4,5]. Therefore, the clinical significance of studying dreams is now growing in importance.

Smell differs from the other sensory modalities in that the olfactory bulb is directly connected to the amygdala and hippocampus, which process emotional memories. Dreams, which occur during rapid eye movement (REM) sleep, are thought to be created from randomly chosen memories [6] and have strong emotionality. Olfactory stimulation during REM sleep may be a crucial tool to study dream emotions.

One of the first studies on this topic was conducted using positive odors, such as cinnamon and lemon, and negative odors, such as onion and dirty ashtray [7]. The olfactory stimuli were incorporated into dream contents, such as sniffing a flower that smelled like lemons, but the stimuli had no hedonistic effect on dream emotion.

Schredl et al. [8] indicated that dream emotion changed according to the pleasantness of the olfactory stimuli that were applied during REM sleep. In comparison to dreams during the control condition without odor presentation, the use of phenyl ethyl alcohol (PEA; known for a rose-like smell) as a positive stimulus led to more positive dreams, whereas the use of hydrogen sulfide (known for a rotten-egg smell) as a negative stimulus led to more negative dreams. The odors, however, were not incorporated into the dreams. The authors attributed the discrepancy between

* Corresponding author. Graduate School of Integrated Arts and Sciences, Hiroshima University, 1-7-1 Kagamiyama, Higashi-Hiroshima 739-8521, Japan.
E-mail address: satomiokabe.sleep@gmail.com (S. Okabe).

https://doi.org/10.1016/j.sleep.2018.03.026
1389-9457/

their results and those of a previous study conducted by Trotter et al. [7] to some methodological issues in the latter study, such as the absence of a control condition and the method of stimuli presentation being unclear [8].

Schredl et al. [9] later conducted a study using the same stimuli (ie, PEA and hydrogen sulfide) [8]. Their study [9] examined whether participants who underwent a learning task in which pictures of scenes (eg, city and rural) that were associated with olfactory stimuli before the sleep experiment incorporated these scenes into their dreams if presented with the associated olfactory stimuli. The results demonstrated that the incorporation of dream scenes associated with odors partially occurred; however, the effects of odor on dream emotion were not confirmed and were contrary to the preceding findings [8].

So why did the results vary between these studies? The hedonic tone of the odor used may shed light on the arguments about this problem. Experiences influence olfactory perception [10] and play a critical role in odor preference. For instance, an odor that has been pair conditioned with a bitter taste can lead to a negative preference [11]. Furthermore, Pavlovian conditioning can also modify someone's odor preferences [12]. Thus, odor preferences can vastly differ from person to person [10]. In the above-mentioned studies [7–9], individual odor preferences were not considered, which could have led to discrepancies between their results.

Therefore, the purpose of the current study was to examine the effects of olfactory stimulation on dreams, in consideration of the degree of individual preference for the odor.

2. Methods

This study was conducted at the sleep laboratory of Edogawa University. The ethical review board of Edogawa University approved the current protocol, and written informed consent was obtained from all participants. Our methods were adopted from a previous study [8]. The purpose of the study and odor stimulation were undisclosed to participants until the end of the experiment to avoid subjective bias caused by the knowledge of odor presentation during sleep.

2.1. Participants

We recruited participants who either liked or disliked the PEA odor. A total of 168 undergraduate and graduate students (mean age 19.61 ± 1.43 years, range: 18–25 years, 77 men and 91 women) answered a questionnaire, which consisted of the following: their history of chemosensory and/or sleep disorders, the use of medicine known to affect chemosensory function, and their impression of the PEA odor (eg, preference [like or dislike], familiarity [familiar or unfamiliar], and eight other items) rated on a nine-point adjective scale after smelling the PEA odor sample. These simple methods were adopted to ensure sufficient data to determine the distribution of preferences for the odor. Moreover, if the same device that was used for the sleep experiments was used, the participants would know the true purpose of the sleep experiment, which could introduce subjective bias on their dream reports.

For the PEA preference item (1, 5, and 9, being dislike very much, neutral, and like very much, respectively), the mean score of the students' responses was 4.73 ± 1.88. The scores were normally distributed.

Respondents who rated their preference for PEA as 1–3 (ie, below the mean value) were assigned to the "dislike group," whereas those who rated their preference as 7–9 were assigned to the "like group." The exclusion criteria were as follows: a history of chemosensory or sleep disorders, the use of medicine known to affect chemosensory function, and no or scarce dream experiences.

In conclusion, a total of 18 participants who met the inclusion criteria and were not excluded participated in the sleep experiment. Analysis was not conducted on the data from three participants, as REM sleep ended before odor presentation for two participants, and no dream report was provided for one participant. Thus, in total, the data of 15 participants (mean age 19.87 ± 1.19 years, range: 18–22 years, dislike group: 2 men and 6 women, like group: 4 men and 4 women) were analyzed.

2.2. Sleep recordings

The participants were instructed to come to the sleep laboratory of Edogawa University. An overnight polysomnography was performed. Monitoring included four electroencephalographic recordings (C_3-A_1, C_4-A_2, O_1-A_1, and O_2-A_2), two electrooculograms (left, right), and one submental electromyogram (bipolar lead). Sleep stages were scored according to Rechtschaffen and Kales [13].

2.3. REM awakenings, self-reports, and self-ratings of dreams

Participants were awakened by the experimenter, who asked: "What was on your mind before I woke you up?" After pauses in reporting, the experimenter prompted up to three times: "Was there anything else?"

Subsequently, the participants were asked to estimate positive and negative dream emotions (0 = none, 1 = mild, 2 = moderate, and 3 = strong feelings). The negative score was subtracted from the positive score to determine the emotional tone. In addition to the methods of Schredl et al. [8], we used the Dream Property Scale [14,15], which was designed to estimate the four factors of dream properties, namely, emotionality, rationality, activity, and impression, on 15 seven-point scale items to determine precise dream characteristics. The score of each factor was calculated by summing the scores of the items within each factor.

2.4. Dream content analysis by independent raters

The two independent raters were unaware of the olfactory stimulus that had been applied and whose dream report they were rating. Therefore, they were blinded to the condition and were not involved in the collection of the dream reports.

The raters were asked to estimate the dreams using the following scales: realism/bizarreness (1 = realistic, 2 = realistic but extraordinary, 3 = one or two bizarre elements, 4 = several bizarre elements), positive and negative dream emotions (0 = none, 1 = mild, 2 = moderate, 3 = strong feelings), and the Dream Property Scale [14,15].

The degree to which the olfactory stimuli were incorporated into dreams was estimated according to the following criteria: whether there was explicit mention of the perception of smell; whether dream elements normally associated with a strong odor were present; and whether the raters could correctly guess the olfactory stimulus (ie, favorite, nonfavorite, or none) that was applied.

2.5. Olfactory stimulation

The olfactory stimulation device that was constructed for this study is shown in Fig. 1. This allowed the presentation of evaporated PEA and distilled water (DW) in a continuous airstream, each flowing at 4 L/min. Thus, the mixture ratio of the stimulus (8 L/min), containing PEA and DW, was 50% by volume. The airstream was generated using an air pump (HIBLOW CD-8S; TECHNO TAKATSUKI) and regulated using a flowmeter with a precision needle valve (model 1250 series; KOFLOC). The stimuli were