

Olfactory perception in dreams: Analysis of a long dream series

Michael Schredl

Central Institute of Mental Health, Medical Faculty Mannheim/Heidelberg University, Germany

Summary. The present study analyzed the frequency of olfactory perceptions in a long dream series (N = 11,180 dreams) reported by a single participant. Overall, about 0.30% of the dreams included references to olfactory perceptions with unpleasant odors outweighing positive ones. Moreover, most of the olfactory perceptions are uncommon with regard to typical everyday life. To expand these findings, it would be very interesting to study larger samples using a diary paradigm including explicit questions about type, quality, and commonness of the dream odors.

Keywords: Dream series, olfactory perception, continuity hypothesis

1. Introduction

Studying the human olfactory system during sleep is a very interesting research topic for several reasons: First, odors presented during sleep can deepen sleep (Perl et al., 2016) – comparable to the positive effect of aromatherapy (odors presented prior to sleep onset) on sleep (Hwang & Shin, 2015). Second, olfactory stimuli without a trigeminal component, such as hydrogen sulfide, do not cause arousals even when presented in high concentrations during sleep (Stuck et al., 2007) because olfactory information processing largely bypasses the spinal cord, the brain stem, and the thalamus (Gottfried, 2006). This is used in targeted memory reactivation, i.e., a learning task is coupled with a specific odor in waking life and this odor is then presented during sleep in order to enhance the sleep-dependent memory consolidation (Rasch, Buchel, Gais, & Born, 2007; Shanahan, Gjorgieva, Paller, Kahnt, & Gottfried, 2018). Third, Arzi et al. (2012) found that the olfactory sniff response (larger in-breaths while presenting positive odors compared to the in-breaths while presenting negative odors) is preserved in sleep and was able to demonstrate that simple condition paradigms associating different tones with different odors are successful during sleep and that the effects carry over to waking life. In addition, olfactory aversive conditioning during sleep (e.g., coupling cigarette smoke with very unpleasant odors) has reduced smoking behavior during the day (Arzi et al., 2014).

Given the specific features of the olfactory system during sleep, the question is whether olfactory stimuli presented during sleep affect dream content like auditory or tactile stimuli (Schredl, 2018) sometimes do. The first systematic study (Trotter, Dallas, & Verdone, 1988) found that about 19% of the stimuli, e.g., lemon, coffee, dirty ashtray, dog

feces, and onion, were incorporated into the dreams. However, in a subsequent study (Schredl et al., 2009), purely olfactory stimuli, i.e., olfactory stimuli without a trigeminal component (e.g., H₂S and phenyl ethyl alcohol), did not affect dream content while a positive odor was associated with more positive dream emotions compared to an unpleasant odor – commensurate with the neuroanatomical close connection between the olfactory bulb and the limbic system. Rural pictures associated with a specific odor prior to sleep were more often found in dreams after stimulation with the same odor during REM sleep, supporting the idea of targeted memory reactivation during sleep (Schredl, Hoffmann, Sommer, & Stuck, 2014).

Despite this intriguing relationship between olfaction, sleep, and dreaming, systematic studies of olfactory dreaming, especially the features of these dreams, are quite rare. Depending on the sample about 20% to 40% of the participants reported having had at least one dream that included an explicit olfactory perception (Arshamian, 2007; Lovati et al., 2014; Stevenson & Case, 2004-05; Weitz, Croy, Seo, Negroias, & Hummel, 2010; Zadra, Nielsen, & Donderi, 1998). Analyzing diary dreams or dreams obtained in the sleep laboratory, yielded relative low figures of olfactory dreams ranging from 1% to 2% (Calkins, 1893; Snyder, 1970; Strauch & Meier, 2004; Zadra et al., 1998) compared to 50% to 100% of the dreams that included visual and auditory perceptions (Schredl, 2018). If participants were presented with categories of sensory perception categories (smell, odor, etc.) after they recorded their dreams (diary), the percentage of olfactory dreams went up to 8.1% (N = 397 dreams) (Carskadon, Wyatt, Etgen, & Rosekind, 1989). This difference suggests that not all olfactory perceptions within a dream might be reported spontaneously. According to the available data, the odors experienced in the dreams are often related to food, body odors, animals, smoke, perfume (Arshamian, 2007; Carskadon et al., 1989; Monroe, 1899; Stevenson & Case, 2004-05; Weitz et al., 2010). Systematic studies of the emotional valence of the olfactory perception were not yet carried out but examples cited in different publications suggest that unpleasant odors prevail, e.g., foul odor of rotten rat carcasses (Wayne & Clinco, 1959), a very disagreeable food odor (Weed & Hallam, 1896), disgusting smell in a house due to a pitbull (Zadra et al., 1998). Persons who report fre-

Corresponding address:

Michael Schredl, Sleep laboratory, Central Institute of Mental Health, PO Box 12 21 20, 68072 Mannheim, Germany.
Email: Michael.Schredl@zi-mannheim.de

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quent dreams including olfactory perceptions showed higher interest in odors in waking life, recalled smelling more odors the previous day, and are better in identifying odors (Arshamian, Willander, & Larsson, 2011; Stevenson & Case, 2004-05; Weitz et al., 2010). This fits very well with the continuity hypothesis of dreaming (Schredl, 2018), i.e., the more attention the persons directs towards odors the more often s/he dreams about them. Patients with migraine who are quite often hypersensitive to smells in waking also reported more olfactory dreams than controls or patients with tension headaches (Lovati et al., 2014). Similarly, blind persons reported more non-visual perceptions (including olfactory perceptions) than seeing persons (Hurovitz, Dunn, Domhoff, & Fiss, 1999). Although there were no gender differences in the prevalence of olfactory dreamers in retrospective studies (Stevenson & Case, 2004-05; Weitz et al., 2010), Zadra et al. (1998) found that more women reported at least one diary dream including an olfactory perception than men (20.9% vs. 2.0%, $d = 0.62$, $p < .01$); a finding that is also consistent with the continuity hypothesis as women show more interest in odors (Weitz et al., 2010) and are better in odor identification (Öberg, Larsson, & Bäckman, 2002). Despite the relationship between olfaction in waking and dreaming, it has not been studied whether the olfactory perceptions in dreams were common everyday life experiences (e.g., smelling coffee) or extraordinary (e.g., smell of rotten rat carcasses).

The present study analyzed a long dream series regarding the frequency of olfactory perceptions in dreams. In addition, it was determined whether the odor was pleasant or unpleasant and whether the olfactory experience in the dream was comparable to everyday life or extraordinary.

2. Method

2.1. Participant and dream diary

The male participant kept an unstructured dream diary from the age of 22, beginning in September, 1984 through July 2014. For the present analysis, all 11,180 dreams from that period were included. The mean dream length was 134.60 ± 85.46 words. The participant never had any sort of formal olfactory or taste training. The Vividness of Olfactory Imagery questionnaire score (Gilbert, Crouch, & Kemp, 1998) of the participant was 55, about 2.48 standard deviations above the mean of male non-experts (32.4 ± 9.1) and, thus, indicating very low vividness of olfactory imagery (high scores represent low vividness).

2.2. Procedure

The dream reports were typed and entered into a database, Alchera 3.72, created by Harry Bosma (www.mythwell.com). This database allows assigning key words to the dreams, a task carried out by the dreamer himself. Each dream was rated by the dreamer himself for the occurrence of olfactory perception. In a second step, all "olfactory" dreams were coded according to the topic of the olfactory perception (e.g., related to food, bathroom, or body odor), the ordinarieness of the situation in which the odor occurred (common in daily life, uncommon), and the subjective quality of the olfactory perception (pleasant, neutral, unpleasant).

The Alchera software also provides a word count for each dream report. The analysis unit was a single dream report. The data were exported into an Excel spreadsheet (Micro-

soft) and data analysis was carried out using the SAS 9.4 software package for Windows.

3. Results

Overall, 0.30% of the dreams included some reference to olfactory perception. The 33 dreams were classified into several groups (see Table 1). The most common olfactory perceptions were associated with bathroom/feces/vomit and Smoke/Cigarettes. Fragrances or body odors are quite rare. Most of the olfactory perceptions ($N = 24$) were negative (feces, body odors, cigarette smoke (dreamer is a non-smoker), etc. Only 4 perceptions were positive, e.g., nice-smelling ointment or tasty-smelling cake. For 5 olfactory perceptions, no emotional quality was mentioned, e.g., smell of wine or practicing a smelling game (see Table 1).

In a next step, the context of the olfactory perceptions was classified regarding their ordinarieness, i.e., are these incidences very likely to occur in the dreamer's daily life. For example, a flat that smells dusty or smelling a perfume is very common. Also, the smell of petroleum related to fire torches are for this dreamer a common experience as he juggled those as a leisure time activity. On the other hand, reentering a burnt house or playing smelling games are activities that never occurred in the dreamer's life. Even bizarre olfactory experiences occurred: a bottle of ketchup smelling of fish or not smelling anything while being in a bathroom where another person is defecating. Overall, eleven dreams were classified as commonplace whereas twenty-two dreams included olfactory experiences that were out of the ordinary.

4. Discussion

The present findings confirm previous results showing that spontaneously mentioned olfactory perceptions in dreams are rare since the frequency found in this male dreamer (0.30%) was close to the figure of 0.11% diary dreams reported by males that include references to olfactory perceptions (Zadra et al., 1998). However, one has to keep in mind that the dreamer was not aware of the study's rationale, i.e., analyzing olfactory perceptions, and, thus, the spontaneously reported olfactory perceptions might be an underestimation compared to a paradigm with explicit questions about sensory perceptions after recording the dreams (Carskadon et al., 1989).

From a methodological viewpoint it has to be considered that the codings were done by the dreamer himself alone; there was no second external judge so that interrater reliabilities could be ascertained. However, previous research indicated that for simple scales measuring the presence or absence of a specific topic have shown high interrater reliability (Schredl, Burchert, & Grabatin, 2004).

As reported in previous studies (Arshamian, 2007; Carskadon et al., 1989; Monroe, 1899; Stevenson & Case, 2004-05; Weitz et al., 2010) the olfactory perception included a large variety of topics. However, a closer look showed that only one third of the contexts in which olfactory perceptions in the dreams were experienced also occurred in the dreamer's everyday life, most of the olfactory perception contexts were unusual for the dreamer or even bizarre (ketchup with fish smell) – indicating the dreams are not simple replays of waking life experiences (Fosse, Fosse, Hobson, & Stickgold, 2003; Malinowski & Horton, 2014). This contributes to the discussion whether dream content is continuous and/

Table 1. Classification of olfactory dreams (N = 33)

Class	N	Examples
Bathroom, feces, vomit	9	<ul style="list-style-type: none"> “... The injured woman had vomited and everything stinks.” Several small elephants running with people demonstrating in a city produce very odorous feces.
Smoke, cigarettes	6	<ul style="list-style-type: none"> “I don't want to reenter a house that burned almost to the ground because of the very bad smell.” “I enter a large room and wonder why there is a smell of cigarette smoke, then I see two women smoking, and a man is smoking a cigar.
Food	4	<ul style="list-style-type: none"> The piece of poppy seed cake belonging to a woman nearby smells very tasty. A small bottle of ketchup smells strongly of fish.
Indoor	4	<ul style="list-style-type: none"> The interior of a historic building smells “earthy”, it is musty and damp. The bureau of the dreamer smells stale, like a bathroom.
Fragrances	3	<ul style="list-style-type: none"> Nice-smelling ointment “I smell a perfume that my partner also uses.”
Body odor	2	<ul style="list-style-type: none"> The feet of the dreamer stink. A man stinks from his mouth.
Game	2	<ul style="list-style-type: none"> “There are 20 tasks of olfactory identification. Groups of three have to solve the tasks as quickly as possible. We are practicing.”
Others	3	<ul style="list-style-type: none"> Juggling culls that smell of petroleum Old toy with bad-smelling liquid in it Brackish water (sea)

or discontinuous to waking life (Hobson & Schredl, 2011). In this context, it would be interesting to study odor experts (perfumers, chefs, oenologists etc.) who focus quite often on olfactory perceptions during the day.

Most of the spontaneously reported odors in this dream series were unpleasant. One might speculate that there might be a report bias similar to the underreporting of positive emotions compared to negative emotions (Röver & Schredl, 2017; Schredl & Doll, 1998; Sikka, Feilhauer, Valli, & Revonsuo, 2017). To test this hypothesis, it would be interesting to ask explicitly for olfactory perceptions in the dream and their emotional quality after the dream is recorded. Although the reported dream examples in the literature are mainly negative (Wayne & Clinco, 1959; Weed & Hallam, 1896; Zadra et al., 1998), the preponderance of negative odors in dreams might be characteristic for this special dreamer, i.e., larger samples are necessary to corroborate this finding. It would also be interesting to test pleasantness/unpleasantness in the context of other sensory modalities like visual or auditory experiences. As the olfactory system is closely linked to the limbic system (Gottfried, 2006), one would not expect a strong relationship between perception per se and emotions.

To summarize, the analysis of this dream series indicate that olfactory perceptions in dreams are quite rare, mainly unpleasant and uncommon regarding the context compared to everyday life. Due to the design (single case study), the findings raise a lot of questions as to what olfactory perceptions look like in larger dream samples and/or in other subjects, for example, in odor experts. It would be very interesting to carry out an experimental dream study using ambulatory assessment techniques with one group regularly reminded to focus on olfaction during the day and answering questions about type, pleasantness and commonness of the odor. According to the continuity hypothesis (Schredl, 2018), the percentage of olfactory dreams should increase and the pleasant/unpleasant ratio of waking olfactory perception should be reflected in the participants' dreams. These studies might help to elucidate the interesting relationship between olfaction, sleep, and dreams.

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References

- Arshamian, A. (2007). Olfactory dreams, olfactory interest, and imagery: Relationships to olfactory memory. Stockholm University, Faculty of Social Sciences, Department of Psychology: Bachelor Thesis.
- Arshamian, A., Willander, J., & Larsson, M. (2011). Olfactory awareness is positively associated to odour memory. *Journal of Cognitive Psychology*, 23(2), 220-226.
- Arzi, A., Holtzman, Y., Samnon, P., Eshel, N., Harel, E., & Sobel, N. (2014). Olfactory Aversive Conditioning during Sleep Reduces Cigarette-Smoking Behavior. *The Journal of Neuroscience*, 34(46), 15382.
- Calkins, M. W. (1893). Statistics of dream. *American Journal of Psychology*, 5, 311-343.
- Carskadon, M. A., Wyatt, J., Etgen, G., & Rosekind, M. R. (1989). Nonvisual sensory experiences in dreams of college students. *Sleep Research*, 18, 159.
- Fosse, M. J., Fosse, R., Hobson, J. A., & Stickgold, R. J. (2003). Dreaming and episodic memory: a functional dissociation? *Journal of Cognitive Neuroscience*, 15, 1-9.
- Gilbert, A. N., Crouch, M., & Kemp, S. E. (1998). Olfactory and visual mental imagery. *Journal of Mental Imagery*, 22(3-4), 137-146.
- Gottfried, J. A. (2006). Smell: central nervous processing. *Adv Otorhinolaryngol*, 63, 44-69.
- Hobson, J. A., & Schredl, M. (2011). The continuity and discontinuity between waking and dreaming: A Dialogue between Michael Schredl and Allan Hobson concerning the adequacy and completeness of these notions. *International Journal of Dream Research*, 4, 3-7.
- Hurovitz, C. S., Dunn, S., Domhoff, G. W., & Fiss, H. (1999). The dreams of blind men and women: a replication and extension of previous findings. *Dreaming*, 9, 183-193.
- Hwang, E., & Shin, S. (2015). The Effects of Aromatherapy on Sleep Improvement: A Systematic Literature Review and

- Meta-Analysis. *The Journal of Alternative and Complementary Medicine*, 21(2), 61-68.
- Lovati, C., DeAngeli, F., D'Amico, D., Giani, L., D'Alessandro, C. M., Zardoni, M., Scaglione, V., Castoldi, D., Capiluppi, E., Curone, M., Bussone, G., & Mariani, C. (2014). Is the brain of migraineurs "different" even in dreams? *Neurological Sciences*, 35(Suppl 1), S167-S169.
- Malinowski, J. E., & Horton, C. L. (2014). Memory sources of dreams: The incorporation of autobiographical rather than episodic experiences. *Journal of Sleep Research*, 23, 441-447.
- Monroe, W. S. (1899). A study of taste dreams. *American Journal of Psychology*, 10, 326-327.
- Öberg, C., Larsson, M., & Bäckman, L. (2002). Differential sex effects in olfactory functioning: The role of verbal processing. *Journal of the International Neuropsychological Society*, 8(5), 691-698.
- Perl, O., Arzi, A., Sela, L., Secundo, L., Holtzman, Y., Samnon, P., Oksenberg, A., Sobel, N., & Hairston, I. S. (2016). Odors enhance slow-wave activity in non-rapid eye movement sleep. *Journal of Neurophysiology*, 115(5), 2294-2302.
- Rasch, B., Buchel, C., Gais, S., & Born, J. (2007). Odor cues during slow-wave sleep prompt declarative memory consolidation. *Science*, 315(5817), 1426-1429.
- Röver, S. A., & Schredl, M. (2017). Measuring emotions in dreams: Effects of dream length and personality. *International Journal of Dream Research*, 10(1), 65-68.
- Schredl, M. (2018). *Researching Dreams: The Fundamentals*. Cham: Palgrave Macmillan.
- Schredl, M., Atanasova, D., Hörmann, K., Maurer, J. T., Hummel, T., & Stuck, B. A. (2009). Information processing during sleep: the effect of olfactory stimuli on dream content and dream emotions. *Journal of Sleep Research*, 18, 285-290.
- Schredl, M., Burchert, N., & Grabatin, Y. (2004). The effect of training on interrater reliability in dream content analysis. *Sleep and Hypnosis*, 6, 139-144.
- Schredl, M., & Doll, E. (1998). Emotions in diary dreams. *Consciousness and Cognition*, 7, 634-646.
- Schredl, M., Hoffmann, L., Sommer, J. U., & Stuck, B. A. (2014). Olfactory stimulation during sleep can reactivate odor-associated images. *Chemosensory Perception*, 7, 140-146.
- Shanahan, L. K., Gjorgieva, E., Paller, K. A., Kahnt, T., & Gottfried, J. A. (2018). Odor-evoked category reactivation in human ventromedial prefrontal cortex during sleep promotes memory consolidation. *eLife*, 7, e39681.
- Sikka, P., Feilhauer, D., Valli, K., & Revonsuo, A. (2017). How you measure is what you get: Differences in self- and external ratings of emotional experiences in home dreams. *American Journal of Psychology*, 130(3), 367-384.
- Snyder, F. (1970). The phenomenology of dreaming. In L. Madow & L. H. Snow (Eds.), *The psychodynamic implications of the physiological studies on dreams* (pp. 124-151). Springfield: Charles C. Thomas.
- Stevenson, R. J., & Case, T. I. (2004-05). Olfactory Dreams: Phenomenology, Relationship to Volitional Imagery and Odor Identification. *Imagination, Cognition and Personality*, 24(1), 69-90.
- Strauch, I., & Meier, B. (2004). *Dem Traum auf der Spur: Zugang zur modernen Traumforschung* (2. Auflage). Bern: Hans Huber.
- Stuck, B. A., Stieber, K., Frey, S., Freiburg, C., Hörmann, K., Maurer, J. T., & Hummel, T. (2007). Arousal responses to olfactory or trigeminal stimulation during sleep. *Sleep*, 30, 506-510.
- Trotter, K., Dallas, K., & Verdone, P. (1988). Olfactory stimuli and their effects on REM dreams. *Psychiatric Journal of the University of Ottawa*, 13, 94-96.
- Wayne, G. G., & Clinco, A. A. (1959). Psychoanalytic observations on olfaction: With special reference to olfactory dreams. *Psychoanalysis and Psychoanalytic Review*, 46, 63-74.
- Weed, S. C., & Hallam, F. M. (1896). A study of the dream consciousness. *American Journal of Psychology*, 7, 405-411.
- Weitz, H., Croy, I., Seo, H. S., Negoias, S., & Hummel, T. (2010). Studies on olfactory dreaming. *Chemosensory Perception*, 3(2), 129-134.
- Zadra, A. L., Nielsen, T. A., & Donderi, D. C. (1998). Prevalence of auditory, olfactory and gustatory experiences in home dreams. *Perceptual and Motor Skills*, 87, 819-826.