Dream emotions: a comparison of home dream reports with laboratory early and late REM dream reports

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SUMMARY
The aim of this study was to compare the emotional content of dream reports collected at home upon morning awakenings with those collected in the laboratory upon early and late rapid eye movement (REM) sleep awakenings. Eighteen adults (11 women, seven men; mean age = 25.89 ± 4.85) wrote down their home dreams every morning immediately upon awakening during a 7-day period. Participants also spent two non-consecutive nights in the sleep laboratory where they were awoken 5 min into each continuous REM sleep stage, upon which they gave a verbal dream report. The content of a total of 151 home and 120 laboratory dream reports was analysed by two blind judges using the modified Differential Emotions Scale. It was found that: (1) home dream reports were more emotional than laboratory early REM dream reports, but not more emotional than laboratory late REM dream reports; (2) home dream reports contained a higher density of emotions than laboratory (early or late REM) dream reports; and (3) home dream reports were more negative than laboratory dream reports, but differences between home and early REM reports were larger than those between home and late REM reports. The results suggest that differences between home and laboratory dream reports in overall emotionality may be due to the time of night effect. Whether differences in the density of emotions and negative emotionality are due to sleep environment or due to different reporting procedures and time spent in a sleep stage, respectively, remains to be determined in future studies.

INTRODUCTION
A dream refers to subjective conscious experiences occurring during sleep. Emotions are an important aspect of dreams (Hobson et al., 2000; Nir and Tononi, 2010). Studying the emotional content of dreams is not only theoretically relevant but also of clinical importance, due to the relationship between dream emotions and various sleep and psychiatric disorders (Levin and Nielsen, 2007; Nielsen and Levin, 2007; Schredl, 2011). However, research findings regarding the emotional content of dreams are inconsistent and often contradictory due, arguably, to unresolved methodological issues (Domhoff, 2005; Schredl, 2008).

One methodological discrepancy between studies lies in the experimental setting of the study; specifically, whether dream reports are collected at home or in the sleep laboratory. It has been debated whether and to what extent the (emotional) content of dream reports collected in the two settings is comparable (Domhoff, 2005; Schredl, 2008; Waterman et al., 1993). However, only a few studies have compared the emotional content of dream reports obtained from the same individuals in the two settings (see Table 1 for a summary of the key characteristics and findings).

As evidenced in Table 1, when dream reports are obtained using constant sampling (morning awakenings in both settings) and reporting (either written or oral in both settings) conditions, no differences between laboratory and home dream reports are found, at least when rated by external judges (Foulkes, 1979, study 3; Weisz and Foulkes, 2018).
METHODS

Participants and procedure

Data were collected as part of a larger study. A detailed description of the participant selection criteria and procedure can be found in Sikka et al. (2014). Briefly, of the 159 volunteers, 53 fulfilled participation criteria (healthy, righthanded, native Finnish speakers, good sleep quality) and were asked to keep a home dream diary. Of the 22 participants who filled in the diary, 21 were invited and 19 agreed to sleep in the sleep laboratory. However, the home dream diary of one participant was filled in inadequately. Hence, 18 participants (11 women, seven men) with an average age of 25.89 years [standard deviation (SD) = 4.85; range = 19–39] provided adequate home and laboratory dream reports. Participants gave written informed consent and received a compensation of 100 euros upon completing the study. The study received approval from the Ethical Board of the University of Turku, Finland.

Home dream report collection

Participants were instructed to keep a home dream diary during a 7-day period (based on instructions from earlier studies, e.g. Revonsuo and Salmivalli, 1995). They were asked to write down their dreams systematically every morning immediately upon awakening, and to report them accurately, truthfully and in as much detail as possible, without adding things they did not remember, or that would make the dream report sound more logical. Instructions did not specifically emphasize reporting emotions. Participants were instructed to fill in the dream diary even if they did not remember dreams on awakening, or felt they had had a dream but could not recall any content. Sleep stages were not monitored at home, thus the proportion of dream reports originating from REM or NREM sleep is unknown.

Laboratory dream report collection

Participants spent two non-consecutive nights in the sleep laboratory. To avoid REM sleep deprivation, there was approximately a week between the two nights. Sleep was monitored using polysomnography (PSG), including electroencephalography (EEG; 24 electrodes Fp1/2, AF3/4, AF7/8, F7/8, F3/4, Fz, T7/8, C3/4, Cz, P7/8, P3/4, Pz, O1/2, Oz positioned according to the standard 10/10 system), vertical and horizontal electro-oculography (EOG; four electrodes) and electromyography (EMG; two chin electrodes). All electrodes (except bipolar EOG and EMG electrodes) were referenced to the right mastoid. The EEG signal was amplified (SynAmps Model 5083) and recorded using NeuroScan equipment and software. Sleep stages were scored manually (Iber et al., 2007).

Participants were awoken using a signal tone after the REM sleep stage had lasted continuously for 5 min, and was in a phasic phase. Upon awakening they reported their dream to a microphone embedded in the room: starting with the last image they remembered, and then the whole dream as much detail as possible. After this, participants filled in two self-rating scales, one measuring emotions [Finnish version of the modified Differential Emotions Scale (fmDES); Fredrickson, 2013] and the other measuring presence (Lempiäinen, 2012, unpublished Master’s thesis). Participants were also asked to report if they recalled no dreams or felt as if they had had a dream but could not recall the content. Additionally, in the evening (before falling asleep) and in the morning (after having reported and rated the last dream), 8 min of waking state resting EEG was recorded, and participants rated their current waking state emotions using the fmDES. Data regarding waking state EEG and its relationship to self-rated emotions as well as dream presence will be reported elsewhere.

Early and late REM was specified as in Casagrande et al. (1996) and Sikka et al. (2014): the first two REM periods were defined as early REM and from the third period onwards as late REM.

Content analysis of dream reports

Home and laboratory dream reports were combined, randomized and anonymized. They were analysed following the
criteria, procedure, and measures described in detail elsewhere (Sikka et al., 2014). Briefly, two blind judges worked independently and first identified all emotions that the dream self either expressed explicitly or that could be inferred unambiguously from the behaviour of the dream self. Then, the judges classified these emotions using the fmDES. This scale consists of 20 emotion categories or items (with three words describing each category): 10 for positive emotions (PE) and 10 for negative emotions (NE). An additional ‘Other’ category was used for emotions which were difficult to classify into any of the existing 20 categories. Altogether, 38 occurrences of emotion were classified to belong into this category: 34 items with ambiguous valence (i.e. surprised: 12 occurrences; confused: 22 occurrences), one item referring to sexual pleasure, one item to irony and two items that the judges found difficult to label. The judges rated only the occurrence and not the intensity of emotions.

Subsequent analyses were based on both expressed and inferred emotions because (1) inter-rater reliability for the classification of both types of emotions was strong ($\kappa = 0.78–0.95$) and did not differ significantly (see Supporting information, Appendix S1 for detailed description and analysis); (2) preliminary analyses indicated that the pattern of results reported below was basically the same when including only expressed or only inferred emotions or both. In the analyses, each emotion category was counted only once per dream

| Study | Sample | Sampling procedure | Reporting procedure |
|-------|--------|--------------------|---------------------|
| Weisz and Foulkes (1970) | 12 young males (19–28 years) | Morning awakenings (2 non-consecutive nights) | Verbal |
| Okuma et al. (1975) | Five male psychiatrists (25–47 years) | 1. Morning awakenings (2 weeks; during 1967–1968) 2. REM awakenings using the ‘Dream Detector’ (during 1972–1973) | 1. Written 2. Verbal |
| Foulkes, (1979, study 3) | 14 children (8 girls, 6 boys; 10–11 years) | Morning awakenings (3 consecutive nights) | Written |
| Foulkes (1979, study 4) | 18 children (7 girls, 11 boys; 12–13 years) | Morning awakenings (six consecutive mornings) | Written 1. Verbal |
| St-Onge et al. (2005) | 28 younger (20–33 years) versus 30 older (60–77 years) women | Morning awakenings (seven consecutive days) | Written 2. Written (morning reports of recalled dreams) Verbal |

*Includes also other variables not measuring emotions. NS: no significant differences; REM: rapid eye movement.
report, so that the same emotion category referring to the same event would not be counted several times.

**Length of dream reports**

The length or word count of a dream report was a total count of all dream-related words, excluding repetitions, fillers, corrections, and waking commentary (Antrobus, 1983).

**Statistical analyses**

Statistical analyses were conducted using IBM SPSS Statistics (version 20). The Shapiro–Wilk test was used to test the normality distribution of the variables. For the comparisons of non-normally distributed variables, Wilcoxon’s signed-rank test (Z-value), and for normally distributed variables, paired-samples t-test were used. All statistical tests were two-tailed and for non-parametric tests exact tests were conducted. Effect sizes were calculated using Pearson’s correlation (r) and Cohen’s d, respectively. Spearman’s rank correlation coefficient ($r_s$) was used for correlation analyses.

**RESULTS**

For all subsequent analyses, aggregate scores of every variable across all dream reports were calculated for each
Table 2 Percentage of non-emotional and emotional dream reports, number of emotions per dream report and length of dream reports in the home and laboratory setting

|                      | Home All | Median (SD) | Laboratory All | Median (SD) | Early REM | Median (SD) | Late REM | Median (SD) |
|----------------------|----------|-------------|----------------|-------------|-----------|-------------|----------|-------------|
| Non-Emotional dreams % | 54.58    | 57.19 (31.56) | 70.69 | 76.36 (28.46) | 82.22 | 100.00 (21.10) | 62.20 | 62.50 (36.97) |
| Emotional dreams %    | 45.42    | 42.81 (31.56) | 29.31 | 23.63 (28.46) | 17.78 | 0.00 (21.10) | 37.80 | 37.50 (36.97) |
| Positive dreams %     | 2.59     | 0.00 (5.32)  | 8.40 | 4.55 (10.52)  | 4.44 | 0.00 (11.73)  | 9.50 | 0.00 (14.16)  |
| Negative dreams %     | 36.66    | 40.00 (26.73) | 12.64 | 4.17 (18.23)  | 8.33 | 0.00 (18.09)  | 18.48 | 0.00 (29.44)  |
| Balanced dreams %     | 3.10     | 0.00 (9.58)  | 3.21 | 0.00 (6.49)   | 1.67 | 0.00 (6.45)   | 3.29 | 0.00 (7.80)   |
| Undetermined dreams % | 3.07     | 0.00 (6.02)  | 5.06 | 0.00 (7.97)   | 3.33 | 0.00 (12.91)  | 6.53 | 0.00 (9.83)   |
| Positive emotions     | 0.77     | 0.69 (0.71)  | 0.47 | 0.24 (0.52)   | 0.31 | 0.00 (0.45)   | 0.53 | 0.38 (0.57)   |
| Negative emotions     | 0.11     | 0.00 (0.18)  | 0.16 | 0.11 (0.18)   | 0.09 | 0.00 (0.17)   | 0.15 | 0.00 (0.23)   |
| Emotions/100 words    | 0.80     | 0.79 (0.65)  | 0.24 | 0.25 (0.24)   | 0.20 | 0.00 (0.28)   | 0.29 | 0.25 (0.30)   |

Word count: 99.63 82.33 (103.61) 128.86 102.19 (81.58) 91.41 80.00 (69.46) 142.91 114.00 (96.51)

*Dream reports containing emotions classified into the “Other” category (e.g., surprised, confused).
†Includes also emotions belonging to the “Other” category. SD: standard deviation.

Number of dream reports

A total of 151 (mean = 8.39; SD = 4.39; range = 3–17) home dream reports were collected during the 7-day period. In the laboratory, a total of 133 awakenings (mean = 7.39; SD = 3.29) were conducted and 122 dream reports (mean = 6.78; SD = 3.26; range = 2–12) collected (see Supporting information, Appendix S2). The two laboratory nights did not differ in any of the dependent variables (see Supporting information, Appendix S2). Therefore, data from the two nights were pooled in subsequent analyses. Due to technical problems with recordings, two laboratory dream reports could not be included in the analyses. Thus, the following analyses were based on 120 laboratory dream reports (mean = 6.67; SD = 3.16). From these, 38 (mean = 2.11; SD = 1.28) were early REM and 82 (mean = 4.56; SD = 2.45) late REM dream reports (t(17) = −4.50, P < 0.001, d = −1.17). Three participants did not report any early REM dreams. Although the mean number of home and laboratory dream reports did not differ significantly (t(17) = 1.41, P = 0.178, d = 0.34), there were significantly more home dream reports compared to laboratory early REM (t(17) = 5.84, P < 0.001, d = 1.58) and late REM dream reports (t(17) = 3.38, P = 0.004, d = 0.83).

Percentage of emotional dream reports

A dream report was considered emotional if at least one of the 21 emotion categories was detected at least once in the report. To account for the different number of home and laboratory early and late REM dream reports, the analyses were based on the mean (or median) percentage of emotional dream reports of all reports per participant.

On average, a significantly larger percentage of home dream reports (45.42%), compared to laboratory dream reports (29.31%), was rated as emotional (t(17) = 2.43, P = 0.026, d = 0.58) (see Table 2). However, only the difference between the percentage of emotional home and emotional early REM dream reports was significant (n = 15, Z = −3.06, P < 0.001, r = −0.56), whereas the difference between the percentage of emotional home and emotional late REM dream reports was not significant (n = 18, Z = −1.08, P = 0.296, r = −0.18) (see Fig. 1). The percentage of emotional late REM dream reports was significantly larger than the percentage of emotional early REM dream reports (n = 15, Z = −2.55, P = 0.008, r = −0.47).

Percentage of emotionally valenced dream reports

A dream report was considered (a) positive, when the number of PE exceeded that of NE; (b) negative, when the number of NE exceeded that of PE; (c) to have a balanced emotional tone, when the number of PE and NE was equal; and (d) to have undetermined valence, when a report contained only those emotions for which the emotional valence could not be determined (‘Other’ category). All analyses were based on the mean (or median) percentage of emotionally valenced dream reports.

There was a significantly larger percentage of negatively valenced dream reports at home compared to the laboratory (n = 18, Z = −3.11, P < 0.001, r = −0.52) (see Table 2 and Fig. 1). Interestingly, the percentage of negatively valenced home dream reports was significantly larger than that of...
negatively valenced laboratory early ($n = 15$, $Z = -3.06$, $P < 0.001$, $r = -0.56$) and late ($n = 18$, $Z = -2.32$, $P = 0.017$, $r = -0.39$) REM dream reports. The two settings did not differ in the percentage of dream reports with positive, balanced or undetermined valence ($Ps > 0.05$). Similarly, laboratory early and late REM dream reports did not differ with respect to emotional valence ($Ps > 0.05$).

When looking at the settings separately, at home the percentage of dream reports with negative valence was significantly larger than that with positive valence ($n = 18$, $Z = -3.18$, $P < 0.001$, $r = -0.53$). In contrast, in the laboratory the difference between the percentage of dream reports with negative and positive valence was not significant ($n = 18$, $Z = -0.83$, $P = 0.445$, $r = -0.14$).

**Number of emotions per dream report**

The overall number of emotions per dream report was calculated by summing up the occurrence of the 10 PE and 10 NE categories as well as those classified as belonging to the ‘Other’ category. Thus, the maximum number of both PE and NE was 10 and of all different emotion categories per dream was 21.

Regarding the number of all the different emotions per dream report, there were no significant differences between home and laboratory dream reports ($n = 18$, $Z = -1.76$, $P = 0.083$, $r = -0.29$), home and laboratory late REM dream reports ($n = 18$, $Z = -1.17$, $P = 0.258$, $r = -0.19$) or laboratory early and late REM dream reports ($n = 15$, $Z = -1.48$, $P = 0.152$, $r = -0.27$). However, home dream reports were rated to contain a significantly greater number of emotions than laboratory early REM dream reports ($n = 15$, $Z = -3.06$, $P < 0.001$, $r = -0.56$) (see Table 2 and Fig. 2). The length of dream reports could not explain this difference, because the length of home and early REM reports did not differ significantly (see Table 2) ($n = 15$, $Z = -0.17$, $P = 0.890$, $r = -0.03$) (see Supporting information, Appendix S3 for detailed results).

![Figure 1](image1.png)

*Figure 1. Mean percentage of emotional and emotionally valenced dream reports in the home and laboratory sleep environment. **$P < 0.01$; *$P < 0.05$.\n
![Figure 2](image2.png)

*Figure 2. Mean number of (positive and negative) emotions per dream report in the home and laboratory sleep environment. **$P < 0.01$; *$P < 0.05$.\n
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However, when analysing the density of emotions in a dream report—that is, the number of emotions per 100 words (by dividing the total number of emotions by the number of words in that dream report multiplied by 100)—a different pattern of results occurred. There were significantly more emotions per 100 words in home dream reports compared to laboratory dream reports overall \((n = 18, Z = -3.01, P = 0.001, r = -0.50)\), early REM \((n = 15, Z = -2.90, P = 0.001, r = -0.53)\) and late REM \((n = 18, Z = -3.07, P = 0.001, r = -0.51)\) dream reports (see Fig. 2). The difference between early REM and late REM dream reports was not significant \((n = 15, Z = -1.78, P = 0.084, r = -0.33)\).

### Number of positive and negative emotions per dream report

Home dream reports contained a significantly greater number of NE compared to laboratory dream reports in general \((n = 18, Z = -3.11, P = 0.001, r = -0.52)\) and compared to both early REM \((n = 15, Z = -3.06, P < 0.001, r = -0.56)\) and late REM \((n = 18, Z = -2.54, P = 0.008, r = -0.42)\) dream reports (see Table 2 and Fig. 2). There were no differences between the settings in the number of PE \((Ps > 0.05)\). In home dream reports there were significantly more NE than PE \((n = 18, Z = -3.18, P < 0.001, r = -0.53)\). In contrast, there were no differences in the number of PE and NE in laboratory dream reports \((Ps > 0.05)\). The pattern of results was the same when analysing the number of PE and NE per 100 words (see Supporting information, Appendix S4).

### Exploratory analyses: discrete emotions

The occurrence of discrete emotions in a dream was calculated including only the 113 (74 home and 39 laboratory) emotional dream reports of 15 participants. The analysis was based on the 20 emotion categories of fmDES and the most frequently classified emotion items in the ‘Other’ category—confused and surprised (analysed together as a separate category).

The mean (and median) occurrence of each of the 21 emotion categories can be seen in Table 3. Dream reports collected in the two settings differed only with respect to one emotion category—home dream reports were rated to contain significantly more fear (category scared/fearful/afraid) than laboratory dream reports.

### DISCUSSION

This study compared the emotional content of dream reports collected at home upon morning awakenings with those collected in the laboratory upon early and late REM sleep awakenings.

Regarding emotionality, both the percentage of emotional dream reports as well as the number of emotions per dream report showed that home dream reports were more emotional.

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### Table 3 Number of discrete emotions per emotional dream

| Emotion category and item | Home Mean (Median, SD) | Laboratory Mean (Median, SD) | Wilcoxon's signed-rank test \((n = 10)\) |
|--------------------------|------------------------|-----------------------------|----------------------------------|
| NE1 Angry/irritated/annoyed | 0.33 (0.38, 0.25) | 0.31 (0.20, 0.32) | \(-0.18, 0.914, -0.04\) |
| NE10 Stressed/nervous/overwhelmed | 0.31 (0.31, 0.17) | 0.13 (0.00, 0.20) | \(-1.84, 0.070, -0.41\) |
| NE9 Scared/fearful/afraid | 0.26 (0.25, 0.18) | 0.03 (0.00, 0.10) | \(-2.02, 0.047, -0.45\) |
| Other Confused/surprised | 0.11 (0.00, 0.17) | 0.32 (0.33, 0.29) | \(-1.68, 0.102, -0.38\) |
| NE4 Disgust/distaste/revulsion | 0.09 (0.00, 0.15) | 0.02 (0.00, 0.06) | \(-1.84, 0.125, -0.41\) |
| NE3 Contemptuous/scomfult/disdainful | 0.08 (0.00, 0.14) | 0.02 (0.00, 0.06) | \(-1.62, 0.313, -0.27\) |
| NE5 Embarrassed/self-conscious/blushing | 0.08 (0.00, 0.11) | 0.04 (0.00, 0.12) | \(-0.37, 0.875, -0.08\) |
| PE8 Love/closeness/trust | 0.07 (0.00, 0.16) | 0.04 (0.00, 0.08) | \(0.00, 1.00, 0.00\) |
| NE7 Hate/distress/suspicion | 0.05 (0.00, 0.14) | 0.04 (0.00, 0.09) | \(0.00, 1.00, 0.00\) |
| PE1 Amused/fun-loving/giggly | 0.04 (0.00, 0.12) | 0.09 (0.00, 0.13) | \(-1.22, 0.250, -0.27\) |
| PE6 Interested/alert/curious | 0.04 (0.00, 0.10) | 0.00 (0.00, 0.00) | \(-1.00, 1.00, 0.00\) |
| PE2 Awe/wonder/amazement | 0.03 (0.00, 0.09) | 0.02 (0.00, 0.06) | \(0.00, 1.00, 0.00\) |
| NE2 Ashamed/humiliated/disgraced | 0.03 (0.00, 0.08) | 0.00 (0.00, 0.00) | \(0.00, 1.00, 0.00\) |
| NE8 Sad/downhearted/unhappy | 0.03 (0.00, 0.07) | 0.06 (0.00, 0.16) | \(-0.37, 0.875, -0.08\) |
| PE7 Joyful/glad/happy | 0.03 (0.00, 0.06) | 0.19 (0.00, 0.30) | \(-1.37, 0.219, -0.31\) |
| PE3 Grateful/appreciative/thankful | 0.02 (0.00, 0.09) | 0.00 (0.00, 0.00) | \(0.00, 1.00, 0.00\) |
| PE9 Proud/confident/self-assured | 0.02 (0.00, 0.05) | 0.09 (0.00, 0.09) | \(-1.21, 0.313, -0.27\) |
| NE6 Guilty/repentant/blameworthy | 0.01 (0.00, 0.04) | 0.00 (0.00, 0.00) | \(-1.00, 1.00, 0.00\) |
| PE10 Serene/content/peaceful | 0.01 (0.00, 0.02) | 0.09 (0.00, 0.16) | \(-1.00, 0.250, -0.36\) |
| PE4 Hopeful/optimistic/encouraged | 0.00 (0.00, 0.00) | 0.00 (0.00, 0.00) | \(0.00, 1.00, 0.00\) |
| PE5 Inspired/ uplifted/elevated | 0.00 (0.00, 0.00) | 0.02 (0.00, 0.08) | \(-1.00, 1.00, -0.22\) |

PE: positive emotion; NE: negative emotion; SD: standard deviation.
than laboratory early REM dream reports, but not more emotional than laboratory late REM dream reports. This finding suggests that the difference in emotionality between home and laboratory dream reports obtained from serial REM awakenings (as in Foulkes, 1979, study 4; Okuma et al., 1975; St-Onge et al., 2005) is not due to environmental setting per se, but depends upon what time of night laboratory REM reports are collected.

Nevertheless, home dream reports were more densely packed with emotions than laboratory dream reports, irrespective of the time of night. This finding may also be explained by the different reporting procedures of home (written) and laboratory (verbal) dream reports, as it has been suggested that written reports have higher lexical density compared to verbal reports (Casagrande and Cortini, 2008). Whether the difference in emotion density reflects a true difference between home and laboratory dream reports or results from different reporting procedures remains to be determined in future studies.

Concerning valence, home dream reports were more negative than laboratory early or late REM dream reports. However, differences between home and laboratory early REM dream reports were larger ($r = 0.56$) than those between home and late REM reports ($r = 0.39–42$). Moreover, as demonstrated by post-hoc analyses, dream reports obtained in the laboratory upon awakenings from the latest REM period resembled home dream reports more closely ($r = 0.29–32$; see Supporting information, Appendix S5). Furthermore, it cannot be ruled out that the lower negativity of laboratory late REM dream reports resulted from the relatively short time spent in a sleep stage (5 min into REM).

Using home dream reports, it has been demonstrated that dreams tend to progress towards increased negativity (Merritt et al., 1994). Also, the duration of late REM sleep periods and dream reports from these periods are longer than early REM sleep periods and dream reports, respectively (Casagrande et al., 1996; Cipolli et al., 2015; Stickgold et al., 2001). Hence, awakenings after a longer time into REM might have led to increased negativity of laboratory, especially late REM, dream reports and to smaller differences between these and home dream reports. Thus, the question whether the greater negativity of home dream reports and dream emotions is due to differences in sleep environment or in the time spent in a sleep stage remains open, and stresses the need to carry out studies directly investigating this issue.

As for discrete emotions, such emotion categories as angry/irritated/annoyed, stressed/nervous/overwhelmed and confused/surprised were among the most frequently detected emotions in both home and laboratory dream reports. This is in line with several studies that have used external ratings of dream reports (e.g. Hall and Van de Castle, 1966; Schredl and Doll, 1998). The finding that home dream reports were rated to contain more fear (category scared/fearful/afraid) than laboratory dream reports corroborates the results of Foulkes (1979, study 4).

The results should be considered in light of the limitations that can be addressed in future research. First, as the study employed dream report collection procedures used in typical home and laboratory studies, the sampling of reports in the two settings differed. Whereas laboratory dream reports were obtained upon forced awakenings after a fixed time in each REM stage, home dream reports were obtained upon spontaneous morning awakenings after an unspecified time in REM or NREM stage. Therefore, future studies should control not only for the time of night (early versus late sleep period), but also for sleep stage (REM versus NREM), time spent in sleep stage (fixed versus unspecified) and method of awakenings (forced versus spontaneous) in both home and laboratory settings. Secondly, whereas home dream reports were written down, laboratory dream reports were reported verbally. As emotions may be represented differently in written versus verbal discourse, in future studies both home and laboratory reports should be collected using the same procedure (e.g. audio-recorded). Thirdly, because home dream reports were collected before laboratory sessions, the results may have been influenced by the systematic order effect. Thus, future studies should use a counterbalanced order for collecting home and laboratory reports. Fourthly, because participants did not rate emotions in their home dream reports, only external ratings (by judges) of dream emotions were compared. It has been demonstrated that with self-ratings, compared to external ratings, both home (Schredl and Doll, 1998; Sikka et al., 2017) and laboratory (Sikka et al., 2014) dreams are rated to be more emotional and more positive. As a result, with external ratings dream reports appear to be (relatively) more negative than with self-ratings. This might explain the preponderance of negative dreams and emotions in the current study, specifically in the home setting. To determine whether and to what extent differences in who rates dream emotions may affect differences found between the two settings, future studies should include both self- and external ratings of dream emotions. Lastly, it can be argued that by having filled in the emotion rating scale in the evening and after the first awakenings during the first laboratory night, participants may have understood the aim of the study and, as such, reported more emotions in subsequent reports. However, additional analyses showed that this is unlikely (see Supporting information, Appendix S6).

To conclude, this study contributes to the very limited body of research on the differences in the emotional content of dream reports collected in the home compared to the laboratory setting. It demonstrates that when conducting or interpreting studies, it is important to consider not only where (i.e. setting), but also when (i.e. time of night; sleep stage; time spent in sleep stage) and how (i.e. method of awakenings; reporting modality) dream reports are collected.

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**AUTHOR CONTRIBUTIONS**

PS and KV conceptualized the study; PS, KV and AR contributed to the study design; PS and KV collected the data; NS and JT scored the dream reports; PS analysed the data and drafted the first manuscript; all authors contributed to the final version of the manuscript.

**CONFLICT OF INTEREST**

No conflicts of interest declared.

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**SUPPORTING INFORMATION**

Additional Supporting Information may be found online in the supporting information tab for this article:

- **Appendix S1** Inter-rater reliability for identifying and classifying dream emotions
- **Appendix S2** Comparison of laboratory nights
- **Appendix S3** Length and number of emotions per dream report
- **Appendix S4** Density of positive and negative emotions per dream report
- **Appendix S5** Exploratory analyses: laboratory latest REM dream reports
- **Appendix S6** Possible influence of emotion ratings on reporting and rating subsequent dreams

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