Title: LUCID DREAMS AND OUT-OF-BODY EXPERIENCES REPORTS: DIFFERENCES IN EMOTIONAL CONTENT, DREAM AWARENESS, AND DREAM CONTROL

Abbreviated title: Lucid Dreams & OBE: Emotion, Awareness and Control

Francisco T Gallo[1,2*], Nerea L Herrero[1,2], Antonela Tommasel[2,3], Daniela Godoy[2,3], Ignacio Spiousas[2,4,5], Miguel Gasca-Rolin[6], Rodrigo Ramele[7], Pablo M Gleiser[8], Cecilia Forcato[1]

1 Laboratorio de Sueño y Memoria, Departamento de Ciencias de la Vida, Instituto Tecnológico de Buenos Aires (ITBA), Iguazú 341, (1437) Capital Federal, Buenos Aires, Argentina.

2 Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET), Godoy Cruz 2290, (1425) Capital Federal, Buenos Aires, Argentina.

3 Instituto Superior de Ingeniería de Software Tandil (CONICET/UNCPBA), Pinto 399 7000, Tandil, Bs. As., Argentina.

4 Sensorimotor Dynamics Lab (LDSM), CONICET, Universidad Nacional de Quilmes, Calle Roque Sáenz Peña 352, Bernal, Argentina.

5 Laboratorio Interdisciplinario del Tiempo y la Experiencia (LITERA), CONICET, Universidad de San Andrés, Vito Dumas 284, Victoria, Argentina.

6 Asociación Internacional de Onironautas. Carmelo Betore Bergua 2 casa 6 9c, (50014) Zaragoza, Spain.

7 Centro de Inteligencia Computacional, Instituto Tecnológico de Buenos Aires (ITBA), Iguazú 341, (1437) Capital Federal, Buenos Aires, Argentina.

8 Laboratorio de Neurociencia de Sistemas Complejos, Departamento de Ciencias de la Vida, Instituto Tecnológico de Buenos Aires (ITBA), Iguazú 341, (1437) Capital Federal, Buenos Aires, Argentina.

Corresponding authors:

Francisco Gallo, frgallo@itba.edu.ar

Cecilia Forcato, cforcato@itba.edu.ar

The authors declare that they do not have competing financial interests. However, CF, RR, and PMG are co-founders of Cognitio, a startup aimed at improving brain oscillations during sleep.

Acknowledgments: The authors would like to thank Guido Lax and Alejandro Vische for helping with the scorings. This work was funded by a grant from the Instituto Tecnológico de Buenos Aires (ITBA) to CF and RR (ITBACyT Interdisciplinario 2020).

Author contributions

FTG and CF contributed substantially to the conception and conceptualization of the work. FTG performed the research. NLH, and FTG acquired the data. DG and AT processed the text, and performed the NLP analysis. FTG wrote the paper. FTG did the manual scoring. IS and FTG did the statistical analysis. FTG, MG, RR, PMG and CF contributed to revising it critically. CF and RR contributed in funding acquisition and CF contributed to project administration.

ABSTRACT

Lucid dreams (LDs) and out-of-body experiences (OBEs) are phenomena characterized by the return of higher cognitive abilities during sleep, including reflective self-awareness and abstract thought. Given the similarities in reflective self-awareness between LDs and OBEs, some authors consider them variations of the same phenomenon. This study aimed to compare the differences in content between non-LDs, LDs, and OBEs obtained from 60 participants over a two-month period, with 916 dream reports collected. The dream reports were analyzed using automatic methods based on Lexicons such as NRC Emotion Lexicon and Empath, and were scored based on Hall and Van de Castle's dream content scoring system with variations and additional measures. Results showed that OBE dreams were characterized by higher occurrences of negative emotions compared to both lucid and non-lucid dreams as measured by automatic and manual scoring systems. Also, more OBE dream reports contained words related to agency and insight, higher manual scoring of dream control-related expressions, and more total sensations, dream activities, reference to prospective memory evocations, spatial and body references, and more difficulties with movement within the dream environment, than lucid dreams. The findings support the idea that OBEs represent unique experiences distinguished from lucid dreams.

Key words: Lucid dreams, Out-of-body experiences, Emotional content, Dream awareness, Dream control

1. Introduction

Lucid dreams (LDs) and out-of-body experiences (OBEs) are phenomena characterized by the return of higher cognitive abilities during sleep, including reflective self-awareness and abstract thought (Dresler, 2014). LDs, in addition, involve dreamers recognizing that they are dreaming and often having some control over the dream (Laberge, 1981; Holzinger & Mayer, 2020). These experiences mainly occur during rapid eye movement (REM) sleep and they are accompanied by an increase in low gamma oscillatory activity (40 Hz) in the frontal and temporal regions of the brain (Voss et al., 2009). The OBEs, on the other hand, involve the sensation of being outside of one's physical body and viewing the world from an external perspective (Sheils, 1978; Blackmore, 1982; Irwin, 1988; LaBerge et al., 1988; de Sá and MotaRolim, 2016; Herrero et al., 2022; Cheyne, 2003). OBEs are often reported as extremely vivid and can have the qualities of veridical perception (Blackmore, 1982; Herrero et al., 2022). The sleep stage as well as the predominant EEG oscillations involved in OBEs are still unknown. However, it is thought to occur during sleep paralysis (SP), which is characterized by an inability to move voluntarily and a feeling of awareness of one's surroundings (Hishikawa et al., 1995). SP occurs during the transition between REM sleep and wakefulness (Terzaghi et al., 2012) and it is associated with mixed alpha and theta brain waves (Mainieri et al., 2021). Thus, although OBEs are thought to occur during SP, the categorization of OBEs is still a topic of debate among scientists, with some classifying them as a type of LD (Laberge, 1985; Levitan et al., 1999; LaBerge & DeGracia, 2000), while others view them as a related phenomenon to LD (Yu & Shen, 2020; Holzinger & Mayer, 2020). Some authors even do not make any distinction between LD and OBE reports (Dodet et al., 2015). Despite the potential implications, the low frequency of occurrence of these experiences makes them challenging to study in a laboratory setting (particularly OBEs).

It is important to highlight that subtle variations in brain oscillations during sleep can determine very different experiences such as dreaming or not dreaming. In 2017 Siclari et al. contrasted the presence and absence of dreaming using EEG, showing that reports of dream experience were associated with local decreases in low-frequency activity in posterior cortical regions and that high-frequency activity correlated with specific dream content. Taking this into account, we hypothesize that the differences in brain activity patterns during LDs and SP are reflected in the dream content of LDs and OBEs. To test this, we compare the dream content of individuals who have never experienced either LDs nor OBEs (non-lucid dreamers), those who have experienced LDs but not OBEs (lucid dreamers), and those who have experienced both LDs and OBEs (OBE dreamers). 916 dream reports of 60 individuals were analyzed using automatic and manual analysis methods, providing a comprehensive examination of the experiences reported by each group.

2. Methods

Participants had a virtual interview on Google Meet about their sleep and dreams. After giving consent for the study, they were given an instruction manual and a Google Drive link to upload their dreams. Participants were divided into three groups: non-lucid dreamer (never experienced a LD nor an OBE), lucid dreamer (lucid dreamer who never experienced an OBE), and OBE dreamer (has experienced OBEs during sleep paralysis at least once in their life times, with or without LDs). The study was approved by the Biomedical Research Ethics Committee of Alberto C. Taquini Institute for Translational Medicine Research (IATIMET), in accordance with the principles expressed in the Declaration of Helsinki.

2.1 Dream journal

Participants were asked to complete a sleep journal for two months. They were instructed to write after each dream, regardless of whether it was lucid or not, the time and date, their level of awareness during the dream, a detailed description of the dream, and how they gained lucidity (if applicable).

2.2 Dream classification.

Two independent experimenters determined the type of dream based on the description provided in the dream journal. A dream was considered to be lucid if the dreamer manifested awareness during the dream, either directly (e.g. "I became conscious") or indirectly (e.g. "I changed the content of the dream because I did not like it"). An OBE was considered to have occurred if the dreamer manifested leaving the body, either directly or indirectly, or if they described the aura (reported in Herrero et al., 2022). In cases where there was no agreement on the type of dream, the dream was discarded. Out of the total number of dream reports, 14 were discarded for being vague or unspecific, leaving a sample of 916 dreams (731 non-lucid, 117 lucid dreams, and 68 OBE dreams).

2.3 Text Processing and Analysis for Dream Reports

The text of dream reports was processed using Natural Language Processing techniques and using the spaCy library (https://spacy.io/) with pre-trained models for Spanish. Tokenization was performed to split the text into meaningful elements (tokens or words), followed by Part-of-speech (POS) tagging to mark words with a specific part of speech. The final step was lemmatization, which grouped different forms of words into a single element (the lemma), allowing words with the same lemma to be analyzed together as a single concept. For sentiment and content analysis, the NRC Emotion Lexicon (Mohammad & Turney, 2010) and Empath (Fast et al., 2016) lexicons were used. NRC Emotion Lexicon provides intensity scores for words in eight basic emotions (anger, anticipation, disgust, fear, joy, sadness, surprise, and trust) and two sentiments (positive and negative), while Empath covers 200 emotional and topical categories validated by humans. To accommodate the Spanish language, Empath lexicon was translated, taking gender considerations into account. The authors checked the resulting words and categories for consistency. The clues found in each dream were summarized into a single value, providing a comprehensive analysis of the dream. This made it possible to analyze the proportion of words referring to each category and the intensity scores of words in each emotion category, enabling a thorough analysis of the emotional and conceptual content of the dream reports.

We also calculated the unique word count (WC) and total word count, as WC is a crucial aspect to take into account when examining text (Rosenlicht et al., 1994; Urbina, 1981; Schredl, 1999; 2011; Röver & Schredl, 2017) when evaluating dream reports.

2.4 Oneiric content analysis.

A manual scoring analysis was conducted to analyze dream content, based on the Hall and Van de Castle dream content scoring system (Domhoff, 1996). Relevant categories were retained and additional parameters were added to fit our approach. The scoring system included emotions, sensations, lucidity, dreamer activities, spatial or motor references,

memory type references, and descriptions. The analysis was conducted by quantifying the number of expressions per report for each category. The reports had no significant group differences in length (in *Results*). Emotions were quantified by selecting expressions that directly or indirectly revealed anger, apprehension, sadness, confusion, or happiness. For sensations, expressions referring to physical sensations were counted and an "other" category was added for expressions referring to non-physical sensations. Descriptions of oneself, objects, the environment, or characters in the dream were quantified, as well as spatial references. Lucidity was quantified by counting metareferences, effective dream control, and strangeness recognition. Memory evocations were also quantified. Embodiment was analyzed by counting references to the dreamer's own body and difficulties in movement within the dream. Finally, the different types of activities carried out in the dream, such as physical and non-physical actions, thoughts, verbalizations, and expressed intentions, were also quantified. The manual scoring in this study was performed blindly to avoid any bias. Additionally, the scoring was corroborated by two independent individuals who analyzed a percentage of the dreams (15% of the total). No significant discrepancies between the three scorers were observed.

2.5 Agency and Insight

We used the category-level analysis of KH Coder 3 Software (Higuchi, 2016), creating two categories based on the idea of Mallet et al. (2022). We created “Agency” and “Insight”, since they are considered proxies for lucid dreaming. To do so, the Agency category was formed by the agency category from the Big Two dictionary (Pietraszkiewicz et al., 2019) and Insight was formed by the insight category from the Linguistic Inquiry and Word Count 2015 (Pennebaker et al., 2015) dictionary, both categories with our own adaptations to the Spanish language.

2.6 Statistical analysis

The analysis was performed in two parts, one for "type of dream" (NN, LL and OO compared) and another for "type of dreamer"(NN, NL and NO compared). The mean and standard error of the mean were calculated for each dream type and weighting was applied to the values to correct for the imbalance between dreamers who contributed more or fewer dreams as the logarithm of the number of dreams contributed by each dreamer (log(N+1)). Linear regression models were then fitted to the dream type and dreamer type data using the "type of dream" variable as the predictor (weighted). The F-test was performed to assess the significance of the model, and pairwise comparisons were conducted (Tukey corrected) using the "emmeans" function from the emmeans package to compare the means of the different dream types. The parameters of the models and the results of the F-test and pairwise comparisons are presented in supplementary tables, including the parameters of the models, p-values for the pairwise comparisons (corrected for multiple comparisons using the Tukey method), and effect sizes for each comparison.

In order to compare the lucid and OBE dreams, a linear regression model was fitted with the score as the dependent weighted variable and "type of dreamer" as the predictor. The resulting parameters and F-test for the model are displayed in supplementary tables.

3. Results

We first analyzed the typical dream reports of each dreamer, that is, the non-lucid dream (non-LD) reports of non-lucid dreamers (NN), the LD reports of lucid dreamers (LL), and the OBE dream reports of OBE dreamers (OO) (Figure 1). The NRC Emotion Lexicon analysis showed that the OO reports had higher negative emotions scores than the NN and LL reports but no significant differences were found for negative score between NN and LL reports (Figure 1A, $F(2, 44) = 6.24$, $P = 0.004$; multiple comparisons: $P_{OOvsNN} = 0.038$, $P_{OOvsLL} = 0.003$, $P_{NNvsLL} = 0.42$). On the contrary, there were no significant differences for the positive emotions score (Figure 1A, $F(2, 44) = 1.49$, $P = 0.23$). We further analyzed with NRC Emotion Lexicon the scores of specific emotions. Score for sadness and disgust were significantly higher in OO reports than in NN and LL reports, with no differences between the last two (Figure 1B; sadness: $F(2, 44) = 14.09$, $P < 0.0001$; multiple comparisons: $P_{OOvsNN} = 0.002$, $P_{OOvsLL} < 0.0001$, $P_{NNvsLL} = 0.102$; disgust: $F(2, 44) = 10.64$, $P = 0.0001$; multiple comparisons: $P_{OOvsNN} = 0.0005$, $P_{OOvsLL} = 0.0006$, $P_{NNvsLL} = 0.91$). Fear emotion score was significantly higher in OO reports compared to both NN and LL reports, but no difference was found between NN and LL reports ($F(2, 44) = 22.28$, $P < 0.0001$; multiple comparisons: $P_{OOvsNN} < 0.0001$, $P_{OOvsLL} < 0.0001$, $P_{NNvsLL} = 0.047$).

The analyses of emotions using the Empath tool showed no significant difference in the negative and positive emotion scores (Figure 1C, negative: $F(2, 44) = 0.47$, $P = 0.62$; positive: $F(2, 44) = 3.12$, $P = 0.054$). However, when we analyze the specific type of emotions, higher expressions of fear and disgust were observed for OO reports compared to the other groups, but no differences were observed between NN and LL reports (Figure 1D, fear: $F(2, 44) = 15.34$, $P < 0.0001$; multiple comparisons: $P_{NNvsOO} < 0.0001$, $P_{LLvsOO} = 0.002$, $P_{NNvsLL} = 0.54$; disgust: $F(2, 44) = 5.17$, $P = 0.009$; multiple comparisons: $P_{NNvsOO} = 0.03$, $P_{LLvsOO} = 0.03$, $P_{NNvsLL} = 0.98$). Suffering score was lower in LL than in OO and NN reports,

but no difference was observed between OO and NN reports ($F(2,44) = 6.03$, $P = 0.005$; multiple comparisons: $P_{LLvsOO} = 0.003$, $P_{NNvsLL} = 0.03$, $P_{NNvsOO} = 0.43$). OO reports also had higher scores for anticipation and aggression compared to NN reports but LL scores did not differ from NN nor OO reports (anticipation: $F(2, 44) = 6.21$, $P = 0.004$; multiple comparisons: $P_{NNvsOO} = 0.002$, $P_{LLvsOO} = 0.18$, $P_{NNvsLL} = 0.42$; aggression: $F(2, 44) = 4.83$, $P = 0.013$; multiple comparisons: $P_{NNvsOO} = 0.013$, $P_{LLvsOO} = 0.79$, $P_{NNvsLL} = 0.15$). Regarding sadness, LL reports showed less score than OO reports, but no significant differences were found between the other type of reports ($F(2, 44) = 4.65$, $P=0.015$; multiple comparisons: $P_{NNvsOO} = 0.26$, $P_{LLvsOO} = 0.01$, $P_{NNvsLL} = 0.16$).

Furthermore, taking into account that OBE and LD experiences involve physical sensations, movement, and the nighttime environment (Herrero et al., 2022), we analyze additional categories from Empath associated with relevant themes, such as "movement", "body, and "night" (Figure 1E). We found that, OO reports had higher scores for expressions related to the body and movement than NN and LL reports but no differences were found between NN and LL reports (body: $F(2, 44) = 16.17$, $P < 0.0001$; multiple comparisons: $P_{NNvsOO} < 0.0001$, $P_{LLvsOO} < 0.0001$, $P_{NNvsLL} = 0.68$; movement: $F(2, 44) = 13.65$, $P < 0.0001$; multiple comparisons: $P_{NNvsOO} < 0.0001$, $P_{LLvsOO} < 0.0001$, $P_{NNvsLL} = 0.93$), which is in line with the nature of OBEs (Blackmore, 1982; Herrero et al., 2022). Additionally, both LDs and OBEs had higher values for the category "night," compared to NN reports but no significant differences were found between LL and OO reports ($F(2, 44) = 12.81$, $Ps < 0.0001$; multiple comparisons: $P_{NNvsOO} = 0.0027$, $P_{NNvsLL} < 0.0001$, $P_{LLvsOO} = 0.41$), which could be related to the nature of the dream world and metareferences expected in lucid experiences (Baird et al., 2019; Stumbrys et al., 2014; Mallett et al., 2021; Mallet, 2022; Voss et al., 2013; Windt and Metzinger, 2007). It is important to highlight that the three conditions had similar total word count (NNs: 217.3 ± 53.2 words, LLs: 327.5 ± 97.38 words, OOs: 274.3 ± 92.1 words; $F(2,$

248 44) = 1.63, P = 0.20; multiple comparisons: P_{NNvsOO} = 0.60, P_{LLvsOO} = 0.70, P_{NNvsLL} = 0.18).
249 Overall, OBE reports are more negatively emotionally charged than LDs and non-LDs, as
250 they have higher scores for negative emotions and lower scores for positive emotions in a
251 broad sense.
252 In order to control that the differences found were due to the distinctive type of experiences
253 and not to disparities in how each type of dreamer described the dream content, we analyzed
254 the non-LDs reports of each type of dreamer. That is, the non-LD reports of non-lucid
255 dreamers (NN), the non-LDs reports of lucid dreamers (NL), and non-LDs reports of OBE
256 dreamers (NO). We found no significant difference in emotions calculated with the NRC
257 emotion lexicon (Figure 1F, supplementary tables 1) nor in the Empath analysis (Figure 1G,
258 supplementary tables 2). In addition, there was no significant difference in the total word
259 count (Figure 1H, NN: 217.3 ± 53.2 words, NL: 234.5 ± 44.4 words, NO: 169.7 ± 46.3
260 words; F(2, 53) = 2.15, P = 0.12; multiple comparisons: P_{NNvsNO} = 0.37, P_{NLvsNO} = 0.11, P_{NNvsNL}
261 = 0.87).

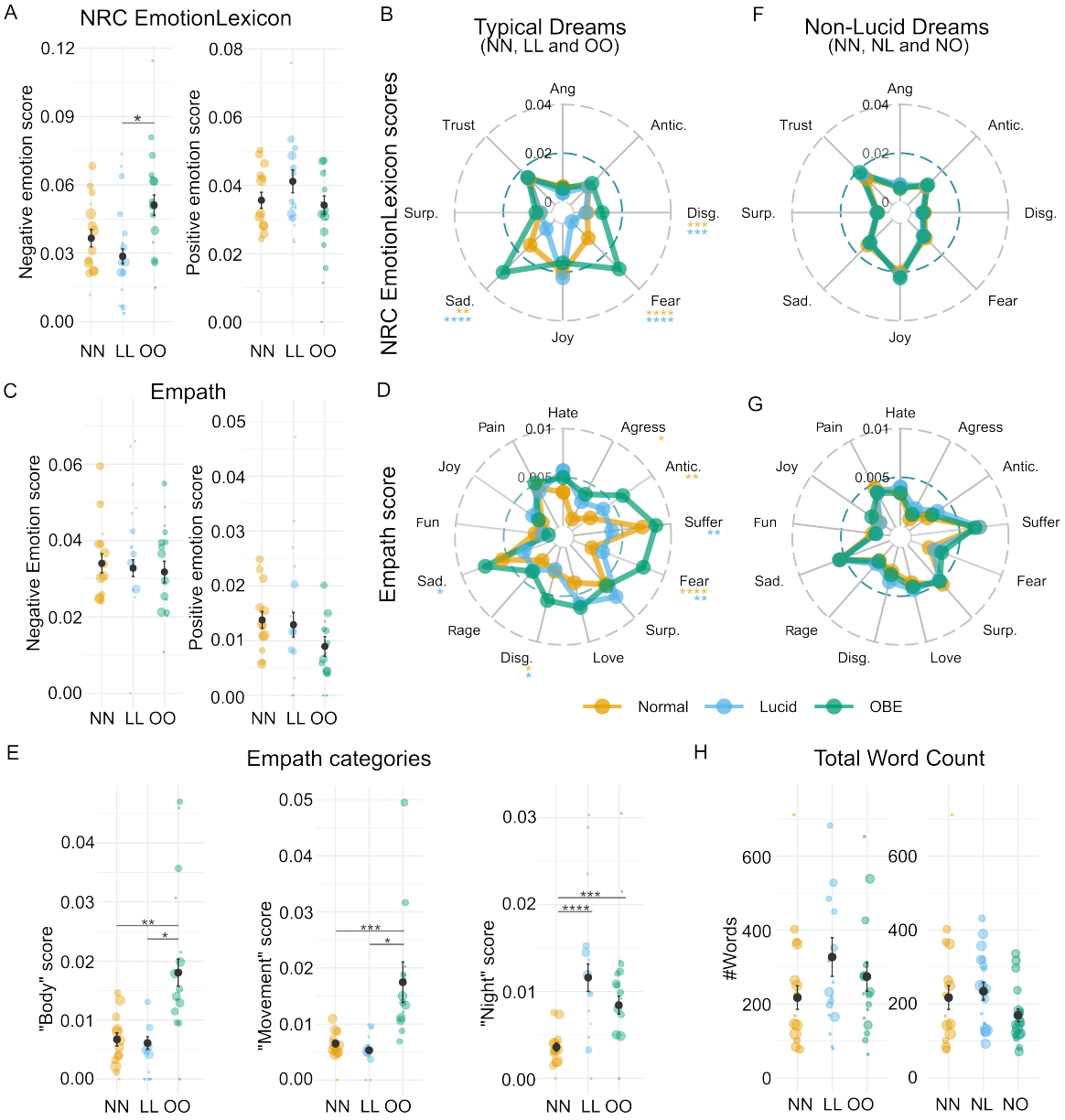


Figure 1: Analysis of dream content using emotion lexicons. A. NRC Emotion Lexicon calculation of negative (left) and positive (right) emotions score for typical dream comparison. **B**. Comparison of specific emotions and feelings score for typical dreams using the NRC Emotion Lexicon analysis. **C**. Empath categories score for negative and positive emotions only for type of dreams. **D**. Comparison of specific emotions and feelings score for typical dreams using the Empath category analysis. **E**. Empath categories score of "body," "movement," "death," and "night" for type of dreams only. **F**. Comparison of specific

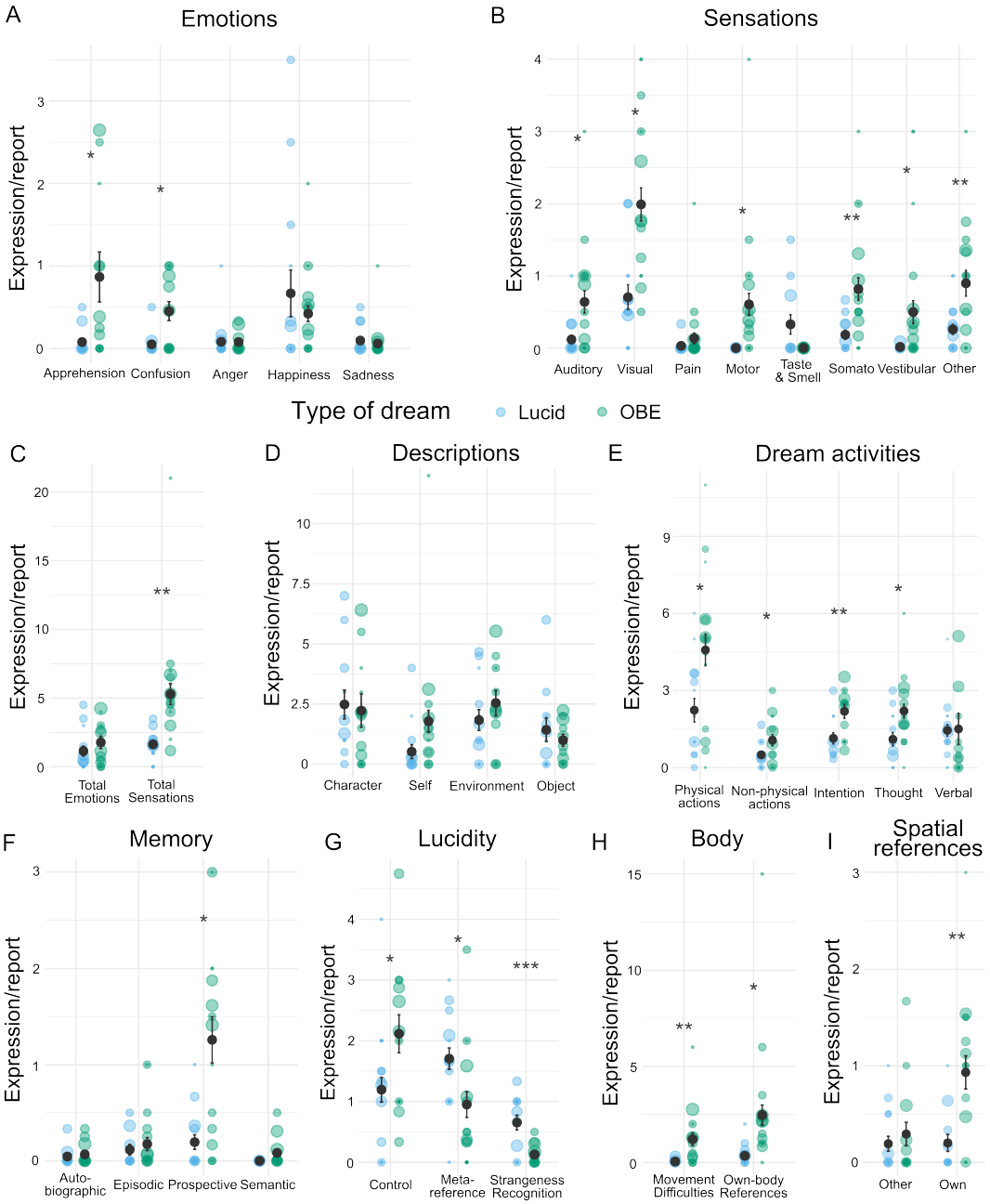
emotions and feelings score for non-LDs using the NRC Emotion Lexicon analysis. **G**. Comparison of specific emotions and feelings score for non-LDs using the Empath category analysis. **H.** Total word count for typical dreams (left) and non lucid dreams (right). Asterisks show Tukey corrected multiple comparisons, *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$, ****: $P < 0.0001$. The color of the asterisks shows against which group the OBE group is being compared to.

In addition, we created two categories related to dream awareness and dream control, named "Insight" and "Agency", respectively, two cognitive notions that are widely accepted as typical components of lucid dreams (Baird et al., 2019; Stumbrys et al., 2014; Mallett et al., 2021; Mallet, 2022; Voss et al., 2013; Windt and Metzinger, 2007). Thus, to analyze dream reports based on these categories, we used the KH Coder 3 category-level analysis (similar to Mallet et al., 2022). For both categories we found that more OO reports had related words for these categories than the NN and LL reports and more LL reports had related words than NN (words related to Insight in, 39.90% of NNs, 54.90% of LLs and 90.57% of OOs; Kruskal-Wallis statistic 43.54, $P < 0{,}0001$; corrected multiple comparison, $P_{NNvsOO} < 0.0001$, $P_{LLvsOO} = 0.0004$, $P_{NNvsLL} = 0.120$; words related to Agency in, 57.14% of NNs, 66.67% of LLs, and 96.23% of OOs, Kruskal-Wallis statistic 28.34, $P < 0{,}0001$; corrected multiple comparison, $P_{NNvsOO} < 0.0001$, $P_{LLvsOO} = 0.0016$, $P_{NNvsLL} = 0.201$).

We finally conducted a manual scoring using a simplified version of Hall and Van de Castle's dream content scoring system (Domhoff, 1996). This analysis focused specifically on LL and OO reports (Figure 2). We observed that emotions such as confusion and apprehension were reported more often in OBEs than LDs (Figure 2A, $F(1,27) = 10.55$, $P = 0.003$; $F(1,27) = 5.48$, $P = 0.02$, respectively, supplementary table 3). Moreover, OBE reports had significantly more expressions per report related to visual, auditory, motor, somatosensory, vestibular and

"other" (Figure 2B, Fs(1, 27) > 6.79, Ps < 0.014, supplementary table 3) sensations. We found no differences in pain (F(1, 27) = 0.83, P = 0.36) nor in "taste and smell" (F(1, 27)= 3.39, P = 0.076). Interestingly, total sensations were higher in OBEs (Figure 2C, F(1, 27) = 11.84, P = 0.001) than in LDs. We did not find significant differences in descriptions of any kind, either of themselves, characters, environment or objects (Figure 2D, F(1, 27) > 0.027, P > 0.33, supplementary table 3). Of all the dream activities that we quantified, we recorded a higher number of expressions in OBEs compared to LDs for thoughts, physical activities, non-physical activities and intentions (Figure 2E, F(1, 27) > 4.29, P < 0.047, supplementary table 3), but no differences were found for verbalizations as a dream activity. Regarding mnemonic references (Figure 2F), we quantified the expressions that referred to some retrieval that occurred during the experience. OBEs reports showed greater amounts of prospective memory expressions (F(1, 27) = 7.26, P = 0.016) than LDs, and there were no differences in other types of memory (F(1, 27) > 2.67, P > 0.056, supplementary table 3). In terms of lucidity (Figure 2G), LDs had more metareferences, references to the dreamer's awareness of being in a dream (F(1, 27) = 6.64, P = 0.015), and recognition of strange occurrences during the dream than OBEs (F(1, 27) = 18.87, P = 0.00017). In contrast, OBEs were more likely to involve effective control of the dream (F(1, 27) = 5.13, P = 0.031), and presented more references to the dreamer's own body (F(1, 27) = 7.27, P = 0.011) and more references to difficulties in movement within the dream environment (Figure 2H; F(1, 27) = 7.27, P = 0.005), indicating challenges in navigating or moving around within the dream space. Additionally, there were significant differences in the spatial references addressed to oneself, indicating that individuals tended to refer to themselves using more expressions such as "to my left" or "behind me" than in LDs (Figure 2I; F(1, 27) = 12.16, P = 0.0016) but no significant differences were found in the spatial references addressed to other characters in the dream (F(1, 27) = 0.419, P = 0.52).

320 –



321 FIGURE 2 INSERTION–

322 **Figure 2: Results of the manual scoring of dream content comparing Lucid Dreams and**
323 **OBEs.** Panels A to I show quantified expressions per report in different categories. **A.**
324 emotions. **B.** Physical sensations and "others" (panel B). **C.** Total quantification of emotions
325 and sensations. **D.** Descriptions. **E.** Dream activities. **F.** Type of memories. **G.** Lucidity
326 elements. **H.** Body-related elements. **I.** and spatial references. Asterisks show P values for the
327 F-test, *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$.

4. Discussion

Here we showed that OBE reports can be distinguished from reports of both lucid and non-lucid dreams in several ways. These include variations in emotional scoring, the sense of agency and insight, and the categories of dream elements such as "body," "movement," and "night." Additionally, differences were observed in the sensory experiences, dream activities, memory references, aspects of lucidity, and the body and spatial references utilized in the reports.

First, OBE dreams were characterized by a higher incidence of words related to negative emotions, such as fear, disgust, suffering, anticipation, and aggression (Figure 1). This suggests that OBE dreams tend to be more emotionally intense overall, with a greater prevalence of negative emotions. The observed increase in negative emotions could be related to the fact that OBEs occur during SP. Recently, Herrero et al. (2022) compared the perceived emotions during the SP episodes with and without OBE episodes. SP episodes without OBE had more negative and less positive emotions than OBE episodes. Similar results were published by Kliková et al. (2021) who showed that vestibular-motor hallucinations during SP generate more pleasant experiences than other SP hallucinations such as the Intruder or Incubus.

Second, more OBE dream reports contained words related to agency and insight than lucid and non-lucid dream reports. Agency and insight are crucial elements of lucid dreaming as they indicate dream awareness and control, respectively. These concepts are commonly found in the literature on lucid dreaming, and are considered necessary components of such dreams (Baird et al., 2019; Stumbrys et al., 2014; Mallett et al., 2021; Mallet, 2022; Voss et al., 2013; Windt and Metzinger, 2007). This result suggests that OBE experiences may involve even greater control and self-awareness than lucid dreams. Additionally, OBE dreamers reported more total sensations, as well as specific sensations (excluding "pain" and "taste and smell"

that were not significant; Figure 2B and 2C). They also reported more dream activities (Figure 2E) and more references to prospective memories (Figure 2F), which is in line with higher dream control, as well as more spatial (Figure 2I) and body references and difficulties with movement in the dream environment (Figure 2H). Out-of-body experiences (OBEs) can manifest in different states of consciousness, such as wakefulness (Ehrsson, 2007), sleep (Blackmore, 1982), and dreaming (Irwin, 1988; LaBerge et al., 1988; de Sá and Mota-Rolim, 2016, Mota-Rolim et al., 2020). It is reasonable to suggest that if OBEs during sleep involve the activation of the same cortical regions as those during wakefulness, the temporoparietal cortex may also play a role in sleep-related OBEs. This could account for the greater number of sensations and level of dream control reported by OBE dreamers, indicating a heightened level of awareness and engagement with the dream environment. The temporo-parietal junction is a versatile brain region that combines various sensory information and contributes to self-awareness and internal body imaging (Blanke & Mohr, 2005). Therefore, according to our results, OBE dreams can be viewed as a more actively experienced form of dreaming than non-lucid and lucid dreams. OBE dreams are characterized by an increased frequency of bodily and spatial references, as well as difficulties with movement, which emphasize physical sensations and spatial orientation, as our analysis reveals.

Here we found that OBE dreams and lucid dreams share some similarities, such as a heightened level of awareness and greater control over the dream environment. However, the unique sensations, references, and difficulties with movement found in OBE dreams strongly suggest that these experiences are not simply a variation of lucid dreams.

Furthermore, it is important to note that in our comparisons, we also analyzed non-lucid dreams from a variety of dreamers and found no differences between them, which suggests that the differences observed between different types of dreams are not due to individual factors, as the same individuals had both the non-lucid and OBE dreams analyzed. These

findings suggest that OBE dreams and lucid dreams may involve different cognitive processes and may be experienced differently. Further research is needed to fully understand the distinctions between these two phenomena and their implications for studying human consciousness and sleep-dependent processes.

5. References

Baird et al., (2019). The cognitive neuroscience of lucid dreaming, Neuroscience and Biobehavioral Reviews. 10.1016/j.neubiorev.2019.03.008

Blackmore S.J., (1982). “Out-of-body experiences, lucid dreams, and imagery: Two surveys. - PsycNET,” pp. 301–317. https://psycnet.apa.org/record/1983-31509-001

Blanke, O., and Mohr, C. (2005). Out-of-body experience, heautoscopy, and autoscopic hallucination of neurological origin implications for neurocognitive mechanisms of corporeal awareness and self consciousness. Brain Res. Rev. 50, 184–199. doi: 10.1016/j.brainresrev.2005.05.008

Cheyne, J. A. (2003). Sleep paralysis and the structure of waking-nightmare hallucinations. Dreaming, 13(3), 163–179. https://doi.org/10.1023/A:1025373412722

de Sá & Mota-Rolim, (2016). Sleep paralysis in Brazilian folklore and other cultures: A brief review. Frontiers in Psychology, 7, Article 1294. https://doi.org/10.3389/fpsyg.2016.01294

Dodet, Pauline, et al. (2015). "Lucid dreaming in narcolepsy." Sleep 38.3: 487-497. doi: 10.5665/sleep.4516

Domhoff, G.W. (1996). The Hall/Van de Castle System of Content Analysis. In: Finding Meaning in Dreams. Emotions, Personality, and Psychotherapy. Springer, Boston, MA. https://doi.org/10.1007/978-1-4899-0298-6_2

Dresler M et al., (2014). “Volitional components of consciousness vary across wakefulness, dreaming and lucid dreaming,” Front. Psychol., vol. 4. https://doi.org/10.3389/fpsyg.2013.00987

406 Ehrsson HH. (2007). The experimental induction of out-of-body experiences. Science. Aug
407 24;317(5841):1048. doi: 10.1126/science.1142175. PMID: 17717177.

408 Fast Ethan, Binbin Chen, and Michael S. Bernstein. (2016). Empath: Understanding Topic
409 Signals in Large-Scale Text. Association for Computing Machinery, New York.
410 https://doi.org/10.1145/2858036.2858535

411 Gabbard, Glen & Twemlow, Stuart (1985).With the eyes of the mind. New York: Praeger.

412 N. Herrero et al. (2022). "Spontaneous and induced out-of-body experiences during sleep
413 paralysis: Emotions, "AURA" recognition, and clinical implications", Journal of Sleep
414 Research. http://dx.doi.org/10.1111/jsr.13703

415 Higuchi, Koichi (2016). "A Two-Step Approach to Quantitative Content Analysis: KH Coder
416 Tutorial using Anne of Green Gables (Part I)" Ritsumeikan social sciences review 52(3): 77-
417 91. http://www.ritsumei.ac.jp/file.jsp?id=325881

418 Hishikawa Y, Shimizu T. (1995). Physiology of REM sleep, cataplexy, and sleep paralysis.
419 Advances in Neurology. ;67:245-271. PMID: 8848973.

420 Holzinger & Mayer (2020). "Lucid Dreaming Brain Network Based on Tholey's 7
421 Klartraum Criteria",Front. Psychol. https://doi.org/10.3389/fpsyg.2020.01885

422 Irwin, H. J. (1988). Out-of-body experiences and attitudes to life and death. Journal of the
423 American Society for Psychical Research.

424 Kliková, M., Sharpless, B. A., & Bušková, J. (2021). Could sleep paralysis be pleasant?.
425 Journal of sleep research, 30(3), e13154. https://doi.org/10.1111/jsr.13154
426 Laberge S.P., "Lucid Dreaming: an exploratory of consciousness during sleep" 1981.
427 [Online]. https://elibrary.ru/item.asp?id=7302445.

LaBerge, Stephen (1985). “Lucid dreaming”. Los Angeles: Tarcher.

LaBerge, S. (1988). The Psychophysiology of Lucid Dreaming. In: Gackenbach, J., LaBerge, S. (eds) Conscious Mind, Sleeping Brain. Springer, Boston, MA. https://doi.org/10.1007/978-1-4757-0423-5_7

LaBerge, S. & DeGracia, D.J. (2000). Varieties of lucid dreaming experience. In R.G. Kunzendorf & B. Wallace (Eds.), Individual Differences in Conscious Experience (pp. 269-307). Amsterdam: John Benjamins.

Levitan, L., LaBerge, S., DeGracia, D.J. & Zimbardo, P.G. (1999). "Out-of-body experiences," dreams, and REM sleep. Sleep and Hypnosis, 1(3), 186-196.

Mainieri G, Maranci JB, Champetier P, Leu-Semenescu S, Gales A, Dodet P, Arnulf I. (2021). Are sleep paralysis and false awakenings different from REM sleep and from lucid REM sleep? A spectral EEG analysis. J Clin Sleep Med. doi: 10.5664/jcsm.9056

Mallett, R. et al., (2021). Exploring the range of reported dream lucidity. Philosophy and the Mind Sciences, 2, 1–23. https://doi.org/10.33735/phimisci.2021.63

Mallett & Ashokkumar, (2022). “A large corpus of lucid and non-lucid dream reports”, (Preprint). https://drive.google.com/file/d/1e9OZME_hAf2SA8b44tTBA4he7Xlq716o/view?usp=sharing

Mota-Rolim SA, Bulkeley K, Campanelli S, Lobão-Soares B, de Araujo DB and Ribeiro S (2020) The Dream of God: How Do Religion and Science See Lucid Dreaming and Other Conscious States During Sleep? Front. Psychol. 11:555731. doi: 10.3389/fpsyg.2020.555731

Saif Mohammad and Peter Turney. 2010. Emotions Evoked by Common Words and Phrases: Using Mechanical Turk to Create an Emotion Lexicon. In Proceedings of the NAACL HLT

2010 Workshop on Computational Approaches to Analysis and Generation of Emotion in Text, pages 26–34, Los Angeles, CA. Association for Computational Linguistics.

Pennebaker, J.W., Boyd, R.L., Jordan, K., & Blackburn, K. (2015). The development and psychometric properties of LIWC2015. Austin, TX: University of Texas at Austin.

Pietraszkiewicz, Agnieszka and Formanowicz, Magdalena and Gustafsson Sendén, Marie and Boyd, Ryan L. and Sikström, Sverker and Sczesny, Sabine (2019) The big two dictionaries:Capturing agency and communion in natural language. European Journal of Social Psychology, 49 (5). pp. 871-887. ISSN 0046-2772. https://doi.org/10.1002/ejsp.2561

Rosenlicht, N., Maloney, T., & Feinberg, I. (1994). Dream report length is more dependent on arousal level than prior REM duration. Brain research bulletin, 34(2), 99–101. https://doi.org/10.1016/0361-9230(94)90004-3

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. https://doi.org/10.11588/ijodr.2017.1.34565

Schredl M. (1999). The problem of dream length in analysis of content. Perceptual and motor skills, 88(2), 434–436. https://doi.org/10.2466/pms.1999.88.2.434

Schredl, M. (2011). Dream research in schizophrenia: Methodological issues and a dimensional approach. Consciousness and Cognition: An International Journal, 20(4), 1036–1041. https://doi.org/10.1016/j.concog.2010.05.004

Siclari, F., Baird, B., Perogamvros, L., Bernardi, G., LaRocque, J. J., Riedner, B., Boly, M., Postle, B. R., & Tononi, G. (2017). The neural correlates of dreaming. Nature neuroscience, 20(6), 872–878. https://doi.org/10.1038/nn.4545

Sheils, D. (1978). A Cross-cultural Study of Beliefs in out-of-the-body Experiences, Waking and Sleeping. Journal of the Society for Psychical Research, 49, 697–741.

Stumbrys, T., Erlacher, D., Johnson, M., & Schredl, M. (2014). The phenomenology of lucid dreaming: an online survey. The American journal of psychology, 127(2), 191–204. https://doi.org/10.5406/amerjpsyc.127.2.0191

Tart, Charles T. (1968). A psychophysiological study of out-of-the-body experiences in a selected subject. Journal of the American Society for Psychical Research,66, 3-27.

Terzaghi M, Ratti PL, Manni F, Manni R. (2012). Sleep paralysis in narcolepsy: more than just a motor dissociative phenomenon? Neurol Sci. Feb;33(1):169-72. doi: 10.1007/s10072-011-0644-y.

Urbina, S. P. (1981). Methodological issues in the quantitative analysis of dream content. Journal of Personality Assessment, 45(1), 71–78. https://doi.org/10.1207/s15327752jpa4501_14

Voss, U., Holzmann, R., Tuin, I., & Hobson, J. A. (2009). Lucid dreaming: a state of consciousness with features of both waking and non-lucid dreaming. Sleep, 32(9), 1191–1200. https://doi.org/10.1093/sleep/32.9.1191

Voss, U., Schermelleh-Engel, K., Windt, J., Frenzel, C., & Hobson, A. (2013). Measuring consciousness in dreams: the lucidity and consciousness in dreams scale. Consciousness and cognition, 22(1), 8–21. https://doi.org/10.1016/j.concog.2012.11.001

Windt, J. M., & Metzinger, T. (2007). The philosophy of dreaming and self-consciousness: What happens to the experiential subject during the dream state? In D. Barrett & P. McNamara (Eds.), The new science of dreaming: Vol. 3. Cultural and theoretical perspectives (pp. 193–247). Praeger Publishers/Greenwood Publishing Group.

Yu C and Shen H (2020) Bizarreness of Lucid and Non-lucid Dream: Effects of Metacognition. Front. Psychol. 10:2946. doi: 10.3389/fpsyg.2019.02946