



OPEN Comparing psychedelic and meditation experience reports with natural language processing

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Psychedelics and meditation are known for their potential to induce personally meaningful and even transformative experiences. However, it is unclear how similar these experiences are, or how they differ from each other. This explorative study used natural language processing (NLP) methods to compare reports of personally meaningful subjective experiences facilitated by either psychedelic substances or meditation. Participants ($N=197$) wrote open-ended narrative reports about their most meaningful experience facilitated either with psychedelics ($n=134$) or meditation ($n=63$). These reports were analysed with text similarity analyses, topic modeling and sentiment analysis. The semantic and lexical contents of the reports were highly similar and both groups expressed positive emotions on average. However, psychedelic experience reports were more emotionally charged, showing higher levels of positive and negative sentiments compared to more neutral meditation experiences. These results suggest that the two types of subjective experiences might be quite similar in general, but emotional intensity could be a distinguishing factor between them. Challenges with the NLP methods and the dataset limit the conclusions that can be drawn from the study. However, it offers new hypotheses and suggestions for future research on transformative experiences.

Keywords Psychedelics, Hallucinogens, Meditation, Transformative experience, Natural language processing, Text similarity analysis, TF-IDF, Topic modeling, LDA, Sentiment analysis

Humans have long sought out experiences that are deeply meaningful, impactful, and potentially transformative¹. These powerful experiences can take many forms—from spiritual and religious encounters to intense psychological insights. What they share is their ability to profoundly affect an individual, often leading to lasting changes in beliefs, values, identity, and behaviour². Transformative experiences have been defined as “brief experiences, perceived as extraordinary and unique, entailing durable and/or irreversible outcomes, which contribute to changing individuals’ self-conception, worldviews, and view of others, as well as their own personality and identity” (p. 14)¹. They typically involve an epistemic expansion—gaining new knowledge or insight about oneself and the world—as well as heightened emotional complexity and intensity¹. Among many practices that can lead to transformative experiences, two have gained particular scientific and cultural interest in recent years: psychedelic use and meditation^{3,4}.

Psychedelic and meditation experiences have been argued to share phenomenological similarities^{5–7} but have rarely been directly compared to each other. In this study, we used natural language processing (NLP) to compare open reports of personally meaningful experiences, facilitated by either psychedelics or meditation. The aim was to examine similarities and differences between the two types of reports, and also to examine the usefulness and value of NLP in this context.

Psychedelics have been used for centuries for their mystical, spiritual and therapeutic properties, and scientific interest in these substances has grown dramatically during the recent years. Many of these substances have deep indigenous and ceremonial roots—for instance, psilocybin-containing mushrooms, ayahuasca, and mescaline-bearing cacti such as peyote have long been used in ceremonial and healing contexts by various Indigenous cultures of the Americas. The term “psychedelic” literally means “mind-revealing” and refers to a class of substances that can induce dramatic changes in perception, self-awareness, and inner experience^{8,9}. While “classical” psychedelics (e.g., psilocybin, LSD, DMT, ayahuasca) are defined based on their common mechanism of action as agonists of serotonin 2A (5-HT_{2A}) receptors¹⁰, recent research has begun to consider a broader range of substances that can induce psychedelic-like experiences through diverse mechanisms. Ketamine acts as an NMDA receptor antagonist, producing detachment and perceptual alterations. It may

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share a common therapeutic mechanism with classical psychedelics through glutamate-driven neuroplasticity⁹. MDMA, primarily affecting serotonin release and reuptake, produces empathogenic effects and mild perceptual changes¹¹. Psychoactive variants of the cannabis plant contain tetrahydrocannabinol (THC) that acts as an agonist on the endocannabinoid receptor CB1 and can produce psychedelic-type effects, including mystical-type experiences¹². Philosopher Aidan Lyon has argued that whether a substance counts as a psychedelic depends primarily on its psychoactive effects, and thus a broad range of substances can be considered as psychedelic¹³. This hypothesis is supported by qualitative data that various psychoactive substances have psychedelic-type effects¹⁴. Therefore, we have adapted a wide definition of psychedelics that encompasses substances capable of inducing significant alterations in consciousness, regardless of their primary mechanism of action.

Current research on psychedelics has mainly focused on treating mental health disorders^{3,9,14–16}, since this is an area where these substances hold great potential. However, the therapeutic mechanism and the phenomenological content of the psychedelic experience are still areas where our knowledge is limited. It has been argued that the subjective effects are necessary for the therapeutic benefits of psychedelics^{17–19}, and this encourages us to study the phenomenological content of the experiences further.

Meditation, on the other hand, has been practiced for millennia and is also known to induce altered states of consciousness, which can be personally meaningful and even transformative¹. It can be defined as a set of practices which aim to control one's cognitive processes, especially those related to the self and attention²⁰, and it can alter the sense of self, time and space even in laboratory settings^{21,22} or produce mystical-type experiences and insights²³. Meditation programs have been shown to have small to moderate well-being effects on multiple dimensions of psychological stress, such as anxiety and depression⁴.

These meditation practices consist of many techniques, including silent sitting or lying down, breathwork, voicework, such as chanting or mantra repetition and bodywork such as body scan practices. Laukkonen and Slagter²⁴ categorize meditation practices into three fundamental types: focused attention (FA), open monitoring (OM), and non-dual awareness (ND). FA meditation involves sustaining attention on a specific object, such as the breath, to reduce mind-wandering. OM meditation expands awareness to observe all present-moment experiences without judgment. Mindfulness meditation, which has gained significant popularity in recent years, often combines elements of both FA and OM, emphasizing non-judgmental awareness of one's thoughts, feelings, and sensations²⁵. ND meditation differs from the other practices by aiming to dissolve the subject-object distinction entirely, potentially revealing a state of “pure awareness” without conceptual content²⁴.

Laukkonen and Slagter²⁴ propose that these practices gradually decrease the “temporal depth” of mental processing, bringing attention closer to immediate sensory experience and away from abstract thinking about past and future, potentially leading to alterations in one's sense of self and reality. Their theory is based on predictive coding framework, according to which the brain continually generates and updates models of the world to minimize prediction errors between expectations and sensory input²⁶. Meditation is proposed to progressively reduce reliance on such predictive models, allowing perception to be less shaped by prior expectations and more directly grounded in present experience. Neuroimaging studies further indicate that meditation modulates large-scale brain networks (e.g., the default mode, salience, and executive control networks) and produces structural and functional changes in regions involved in attention, emotion regulation, and self-awareness²⁷.

The states induced by psychedelics and meditation have been compared before, but the studies have concentrated more on the changes in brain activity^{28,29} and well-being effects³⁰ than the phenomenology of the experiences. Also, some studies have examined the well-being effects⁵ and phenomenological effects³¹ of combining psychedelic use with meditation. However, as far as we are aware, prior to the collection of the present dataset, so far no one has empirically compared the phenomenology of psychedelic experiences to meditation. This study aims to fill this gap by exploring how reports of personally meaningful experiences from psychedelic use compare with those from meditation practice. The objective is to uncover what these experiences share in common and how they differ, focusing on narrative reports from individuals who have used psychedelics or practiced meditation in natural settings.

The present dataset included a fully open question where the participant was asked to describe all aspects of the experience, as well as three thematic questions, including one about insight experiences. The latter were previously qualitatively analysed by Jylkkä et al.³². In that study, the insights were classified into three main types: mystical-type, psychological, and philosophical-existential (including value insights). Mystical-type insights were slightly more common in meditation reports and value insights were more frequent in psychedelic reports; otherwise, the reports were very similar. Here, we take a different approach and apply NLP methods to the complete narrative reports to provide a more comprehensive comparison of the experiences. The main difference to the previous qualitative analysis is that the NLP approach can be considered as less driven by the researcher's subjective conceptions and interpretations of the data. The nature of this study is explorative and therefore no hypotheses were set beforehand.

NLP refers to a set of methods for analysing textual information with computers. NLP methods are often very well fitted for exploratory text analysis, and they offer speed, efficiency, scalability and consistency over traditional qualitative text analysis by humans³³. NLP can be viewed as bridging the gap between quantitative and qualitative approaches: like qualitative methods, it can capture nuanced meanings and themes in text, while offering the systematic, reproducible analysis typical of quantitative methods. Therefore, NLP methods were chosen for comparing the narrative reports about psychedelic and meditation experiences. More specifically, the participants' open narrative reports were analysed using text similarity analyses, topic modeling and sentiment analysis. These methods, when applied together, should provide a comprehensive way to examine the content, common themes, and emotional aspects of the participants' written experiences.

Methods

Procedure

Two online surveys were distributed internationally with the aim to recruit people with a personally meaningful experience facilitated by psychedelic substances or meditation practice. The survey language was English. The two surveys were identical in every other part, except for one asked about a psychedelic experience and the other about meditation. The study recruited participants through a combination of targeted outreach to psychedelic and meditation societies, as well as social media-based snowball sampling. To qualify for participation, individuals needed to be at least 18 years old and have experienced a personally highly meaningful event facilitated by either a psychoactive substance or meditation. Psychoactive substances were broadly defined as any compounds capable of inducing altered states of consciousness, including but not limited to LSD, psilocybin, cannabis, MDMA, ketamine, and ibogaine. This was done to focus on experiences that the participants considered as personally meaningful or transformative, irrespective of which type of psychoactive substance or meditation they were facilitated by.

Materials

The structure of the surveys was as follows: first the participants answered background questions about their demographics and history of psychedelic use and meditation practice. To probe their current psychological state, the participants were asked to fill in standardised questionnaires about psychological well-being, peace of mind, body appreciation, psychological flexibility and values (these data are reported elsewhere, here the focus is on comparing the experience reports). Then they were asked about one experience with psychedelics or meditation that they considered to be the most meaningful to them. This focus was deliberate, as it aligns directly with the objective to analyse meaningful personal experiences. The section included an open narrative report where the participants were instructed to describe their experience in detail. Moreover, the survey included thematic open questions about insights³², body-related experiences, and experiences related to sense of connection or alienation (reported elsewhere).

Finally, the participants were asked to evaluate their experience with the Mystical Experience Questionnaire (MEQ30), a validated survey designed to measure the intensity and qualities of mystical experiences, often associated with psychedelic use or deep meditative states³⁴. The MEQ30 questionnaire results are reported in order to provide a psychometrically valid reference point for the present NLP analyses. The MEQ30 assesses various aspects of mystical-type experiences, including feelings of unity, transcendence of time and space, ineffability, and positive mood, providing a way to operationalise deeply subjective spiritual or mystical states³⁴.

Several other studies were conducted on this dataset, and therefore multiple questionnaires mentioned here are excluded from the current study. We are focusing only on the participants' open narrative reports and reporting the MEQ scores as a psychometrically valid reference point. The instruction for the narrative report was as follows:

Please write down everything you experienced during the session/experience (what happened, where, who was present, thoughts, feelings, images, scenarios) as accurately and in as much detail as possible. Remember that every detail is important. Do not attempt to make the experience more structured, organized, logical, or complete than how you remember it. Do not change the description with omissions, additions, conclusions, or embellishments. In case you would like to comment on the experience (e.g., explain how the experience relates to your everyday life, etc.), please write those comments in parentheses so that the comments are clearly separated from the description of the actual experience you had.

This study was approved by the Research Ethics Committee of Åbo Akademi University (#15092022). Informed consent was obtained from all participants prior to their involvement in the study. The eligibility criteria were being over 18 years of age and having a previous personally meaningful experience, facilitated by psychedelics or meditation. The survey was anonymous, and participation was voluntary. No compensation was given for participants. The study adhered to the EU General Data Protection Regulation (GDPR) in its handling and processing of research data, and the Declaration of Helsinki regarding research ethics.

Analyses

The open narrative reports were analysed within a Jupyter Notebook using the Python programming language along with many open-source packages. All the analyses presented here were performed within the same notebook which is available online (see Data and code availability). The study was preregistered at the Open Science Framework (<https://osf.io/5pa8f>) where it was mentioned that NLP methods will be used to analyse the data, however, the details of the analyses were not decided beforehand.

This study involved text similarity analyses, topic modeling, and sentiment analysis to analyse the similarity of reported personally meaningful psychedelic and meditation experiences. These narrative reports were analysed separately for the psychedelic and meditation groups. In the NLP context, individual open-ended responses are typically referred to as "documents," while a collection of such responses is termed a "corpus." This paper adheres to this standard NLP terminology.

Mystical experience questionnaire

MEQ30 total scores between the groups were compared to provide a psychometrically valid reference point to the present NLP analyses. Since the scores were not normally distributed, a Mann–Whitney U-test was used for comparison.

Preprocessing

Before the actual analyses, the narrative reports were first spell checked automatically using Google Sheets' spell checker functionality and misspelled words were corrected manually by the authors. The reports were also pre-processed using Python's NLTK library³⁵, which contains widely used tools for natural language processing. Pre-processing included stop word removal and lemmatization of the words inside the documents. Stop words are words which are considered not to contain any value for the actual analysis (e.g. "the", "of", "from"). Lemmatization is a process where each word is reduced to its root form. For example, "singing" becomes "sing" in the process. This helps to consolidate different forms of the same word, which should improve the accuracy of the analysis.

Text similarity analyses

Several similarity analyses were conducted to recognise the most common words and themes from the narrative reports. First, we simply checked the relative word frequencies in both corpora to see which are the most common words that the participants in the psychedelic and meditation groups have used. This provides a baseline understanding of the most common concepts in each group's experiences, allowing for direct comparison between the groups. We assessed the lexical similarity of the two corpora by calculating the lexical overlap of the unique words and by comparing the relative frequencies of the individual words using the log-likelihood test.

To compare the semantic similarity of the reports, we used semantic textual similarity analysis, which quantifies how similar two pieces of text are in meaning rather than just word overlap. We employed one of the leading embedding models, OpenAI's text-ada-002³⁶, for transforming the documents into vector embeddings in a high-dimensional space. These embeddings represent the semantic content of the reports, capturing contextual and relational meanings beyond simple word matching. The embeddings were aggregated for calculating the cosine similarity index³⁷ across and within the groups.

Term frequency-inverse document frequency (TF-IDF) analysis was performed in order to find the words which distinguish the two corpora. TF-IDF is a numerical statistic that weighs a word's relevance in a document against its commonness across all documents, highlighting words that are uniquely significant to each document³⁸. It consists of two components: term frequency (TF) and inverse document frequency (IDF). TF measures how often a word appears in a document while IDF shows how unique a word is across all documents in a corpus. IDF is calculated as the logarithm of the ratio of the total number of documents in the corpus to the number of documents containing the word. TF-IDF score simply multiplies these two components and the formula for word w would look like this:

$$tf - idf(w) = \frac{\text{incidence of } w \text{ in a document}}{\text{total words in a document}} \times \log_{10} \left(\frac{\text{total number of documents}}{\text{number of documents with } w} \right)$$

In order to find distinguishing words from both corpora, the psychedelic and meditation narrative reports were combined into one corpus with two documents. The first document contained all the psychedelic reports concatenated into one long string, and the second document contained all the meditation reports. In this way, if a word was included in both psychedelic and meditation reports, the IDF component became zero, and thus the whole TF-IDF score was zero for this particular word. Therefore, TF-IDF analysis ends up emphasising the words which appear many times in either psychedelic or meditation reports, but not in both.

Topic modelling

Latent Dirichlet Allocation (LDA) is an unsupervised learning algorithm that is used to identify topics present in a set of documents. In the context of text modeling, the idea is to summarise longer texts by representing them as a set of underlying latent topics. LDA is based on probabilistic graphical models and assumes that documents consist of mixtures of topics and that each topic consists of a mixture of words. This algorithm helps in discovering what topics are present in a corpus and the degree to which each document exhibits these topics³⁹.

The selection of the parameter k (number of topics) is a challenging and somewhat arbitrary task with multiple approaches that often provide conflicting results⁴⁰. Therefore, some kind of trial-and-error process is usually needed for finding the best k for any practical use case. We determined appropriate k -value through experimentation and following Wheeler and colleagues⁴¹ simulation study guidelines on statistical performance of LDA based on sample size and response length. Their approach suggested five to six topics for psychedelic documents and two for meditation documents. We chose five topics for both groups to ensure analytical consistency and facilitate direct comparisons between psychedelic and meditation experiences.

Sentiment analysis

The documents from the two different groups were also analysed in terms of their expressed sentiments. This was done in Python with the popular Valence Aware Dictionary and Sentiment Reasoner (VADER) model for sentiment analysis⁴². VADER is a lexicon and rule-based approach, which allows for accurate sentiment scoring without extensive training datasets. We chose VADER for sentiment analysis because it has been shown to outperform other lexicon-based approaches by producing consistent results across different datasets⁴³. VADER recognises three classes of sentiments—positive, neutral, and negative—and provides scores for them ranging from 0 to 1. These three sentiments are also combined into a compound score which ranges from -1 (extremely negative) to 1 (extremely positive). The sentiment scores were calculated for each document in the corpus, and the aggregate statistics were compared between the psychedelic and meditation groups. The sentiment scores were not normally distributed, so we used the Mann–Whitney U test to compare the distribution of sentiments across the groups. Effect sizes were calculated using the rank-biserial correlation. False discovery rate (FDR) was controlled due to multiple comparisons, following the procedure recommended by Benjamini and Hochberg⁴⁴.

We do not share the original narrative reports to protect participant anonymity. Moreover, we do not present example snippets from the original reports because, unlike qualitative content analysis which examines selected text segments, NLP methods analyse patterns across entire corpora. Presenting isolated quotes would therefore be arbitrary and could give readers a misleading impression of the reports, as such excerpts would not represent the overall patterns that NLP methods detect. However, example snippets from the insight reports can be found in Jylkkä et al.³².

Results

213 participants from various countries answered the structured online survey about psychedelic or meditation experiences. 10 participants answered the survey, but didn't write the open reports, so they were excluded from the analyses. Also, six responses were excluded, because three participants responded multiple times to the survey. Therefore, 197 respondents' answers were analysed in the study—134 in the psychedelics group and 63 in the meditation group. Participants' characteristics and their prior experience of psychedelics or meditation are presented in Tables 1, 2, 3 and 4.

Participants in the meditation group were typically older ($M=51.4$ years, $SD=14$) compared to the psychedelic group ($M=39.27$ years, $SD=13.04$). In terms of gender distribution, 63.43% of the psychedelic group participants were male, while in the meditation group the gender distribution was more balanced (50.79% male). The experiences occurred in different settings, with psychedelic experiences often taking place in familiar settings and with other people present, while meditation experiences predominantly occurred in ceremonial spaces/retreats (50.79%) and alone (49.21%).

Psychedelic experiences were most commonly facilitated by classical psychedelics (psilocybin, LSD, ayahuasca, DMT, 5-MEO-DMT and mescaline), with various other substances used less frequently. However, also MDMA and cannabis were quite common in the psychedelic group. For meditation, silent sitting or lying down was the most common technique for inducing the meaningful experience.

The MEQ30-total scores were analysed as a psychometrically valid³⁴ reference point to the NLP analyses. The score was found to be relatively high on average (maximum score is 150): $M=97.39$, $SD=32.94$ for the psychedelic group and $M=97.18$, $SD=34.2$ for the meditation group. The results indicated no significant difference between the groups regarding their questionnaire responses ($U=3900.5$, $p=1.0$).

Document length was measured for both groups, and these results are presented in the histograms below (Fig. 1). The average lengths of answers in words were 400.69 ($SD=444.78$) and 270.49 ($SD=271.78$) for psychedelics and meditation groups respectively. As we can see from the histogram, the word distribution was heavily skewed to the right—most of the participants wrote relatively short reports, but some wrote also multiple times more than the average.

Text similarity analyses

The raw frequency analyses showed which words were most common in the psychedelic and meditation documents. Top 20 most common words are shown for both groups in Figs. 2 and 3 below. The numbers presented are relative to the number of total words in both datasets in order to make the figures easier to compare for the reader.

	Psychedelics				Meditation			
	M	SD	Max	Min	M	SD	Max	Min
Demographics								
Age	39.27	13.04	79	18	51.4	14	80	27
Income level [1–5] ^a	3.26	1.07	5	1	2.95	1.25	5	1
Education level [1–7] ^b	5.98	1.68	7	1	6.46	1.24	7	2
Previous experience								
Frequency [0–6] ^c	4.31	1.45	6	0	4.87	0.89	6	2
Meditation history [0–6] ^d	3.58	2.51	6	0	5.7	0.98	6	1

Table 1. Psychedelic and meditation group characteristics. ^aIncome level was measured on an ordinal scale from 1 to 5, estimating difference to the average in one's home country (1 = Much below average, 2 = Below average, 3 = Average, 4 = Above average, 5 = Much above average). ^bEducation level was measured on an ordinal scale from 1 to 7 (1 = Primary education; 2 = Lower Secondary education, 3 = Higher Secondary education, 4 = Vocational education, 5 = University: Bachelor's degree, 6 = University: Master's degree, 7 = University: Doctoral degree). ^cFrequency of previous psychedelic experiences was measured on an ordinal scale from 0 to 6 (0 = Never, 1 = Once, 2 = Twice, 3 = 3–5 times, 4 = 6–10 times, 5 = 10–50 times, 6 = Over 50 times). Frequency of meditation practice was measured on an ordinal scale from 0 to 6 with the question "Do you practice meditation?" (0 = No, 1 = I have tried once or twice but do not practice regularly, 2 = Few times per year, 3 = Few times per month, 4 = Every week, 5 = Daily, 6 = Several times a day). ^dHistory of meditation practice was measured on an ordinal scale from 0 to 6 with the question "For how long have you practiced meditation?" (0 = I do not meditate, 1 = Less than a month, 2 = 1–6 months, 3 = 7–12 months, 4 = Between 1 and 2 years, 5 = Between 2–5 years, 6 = Over 5 years). This question was also asked from the psychedelics group.

	Psychedelics		Meditation	
	N	%	N	%
Gender				
Male	85	63.43	32	50.79
Female	48	35.82	28	44.44
Other	1	0.75	3	4.76
Region				
Nordic countries	63	47	20	31.70
Other Europe	39	29.10	17	27
North America	21	15.70	17	27
Other (Asia, Africa, South America & Oceania)	9	6.70	9	14.30
Setting of the Experience				
Home	54	40.30	22	34.92
Ceremonial space/retreat	22	16.42	32	50.79
Friend's home	21	15.67	0	0
Nature	18	13.43	3	4.76
Public space	9	6.72	3	4.76
Other private space	7	5.22	2	3.17
Therapeutic space	3	2.24	1	1.59
Who was present				
One other person	47	35.07	1	1.59
Several people, all familiar	35	26.12	6	9.52
Alone	28	20.90	31	49.21
Several people, some unfamiliar	24	17.91	25	39.68

Table 2. Psychedelics and meditation groups' gender and region distributions, and settings of the Experience.

Experience facilitated by*	Count	Percentage
Psilocybin	64	47.76
LSD	47	35.07
Cannabis	30	22.39
MDMA	24	17.91
Ayahuasca	12	8.96
5-MEO-DMT	10	7.46
DMT	10	7.46
Ketamine	6	4.48
Mescaline	4	2.99
Other	4	2.99
Salvia	1	0.75

Table 3. Psychedelic group: substances used to facilitate the Experience. *Please note that some participants used multiple substances to facilitate the Experience, and the percentages do not therefore add up to 100%.

These figures indicate that there is overlap in the most common words. Expanding the analysis to all words used, 27.78% (1405 out of 5058 unique words) were shared between the two corpora. When analysing each unique word separately with the log-likelihood test, only 440 words (8.70%) showed statistically significant ($p < .05$) differences in usage between the two groups. This low percentage of significant differences, even without correcting for multiple comparisons, suggests a high degree of similarity in word usage between the psychedelic and meditation groups.

The analysis of the document vector embeddings revealed a high degree of similarity between the psychedelic and meditation groups. The cosine similarity between the average embeddings for each group was 0.972 (theoretical range from -1 to 1), indicating that the average embeddings of the two groups are very similar in the high-dimensional space. Cosine similarity was also used to calculate within-group similarities to assess the consistency of the meaning of documents within each group. The average cosine similarity was 0.839 within the psychedelics group and 0.838 within the meditation group.

To analyze which words are different between the groups, we used TF-IDF analysis. The words with the greatest TF-IDF scores are presented in the Figs. 4 and 5 for psychedelic and meditation groups respectively.

Experience facilitated by*	Count	Percentage
Silent sitting or lying down	34	53.97
Other technique	17	26.98
Mindfulness	15	23.81
Breathwork	5	7.94
Voicework	4	6.35
Bodywork	3	4.76

Table 4. Meditation group: techniques used to facilitate the Experience. *Please note that some participants used multiple meditation techniques to facilitate the Experience, and the percentages do not therefore add up to 100%.

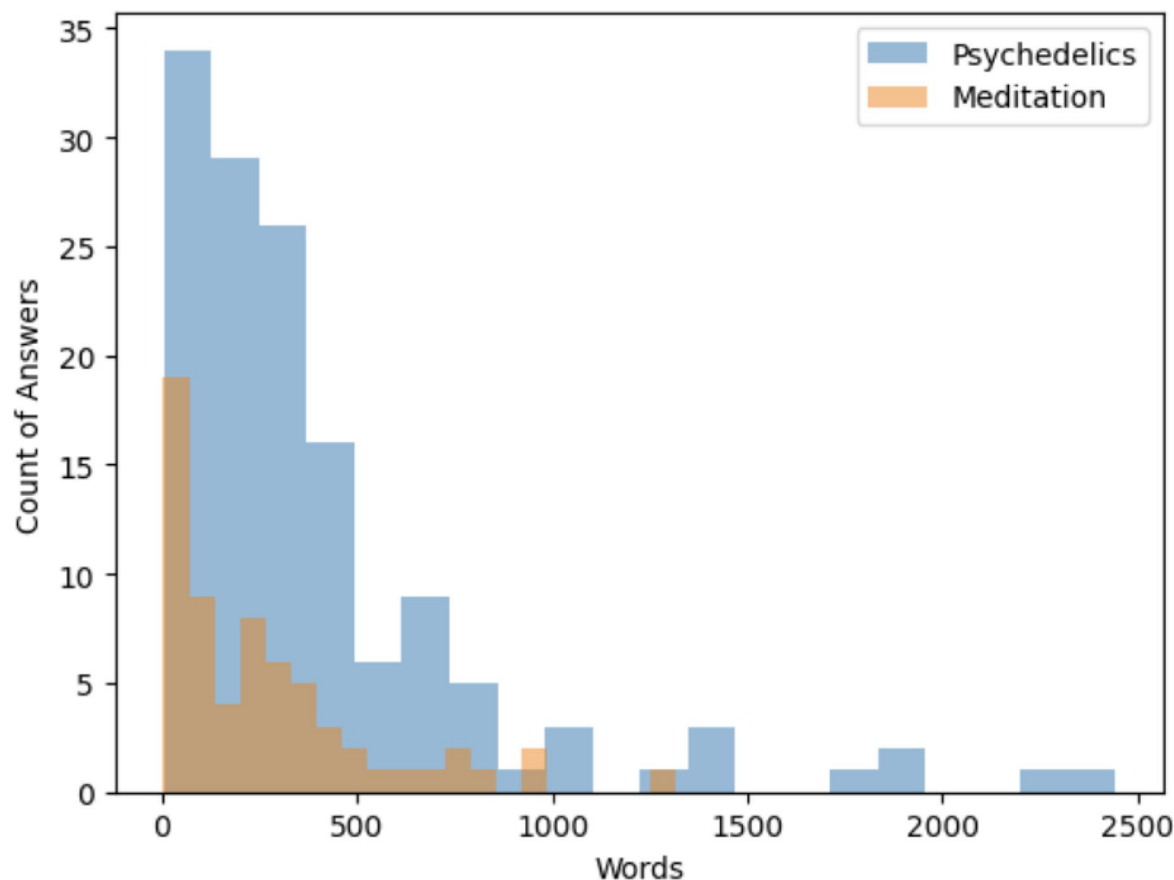


Fig. 1. Histogram of the document length in words for psychedelic and meditation groups.

The TF-IDF analysis highlights unique words in each group. In the psychedelic group, terms related to substance use and effects were emphasised, such as “trip”, “lsd”, “mushroom”, “hallucination” and “visuals”. Words indicating dosage (“dose”, “gram”) were present as well. For the meditation group, words specific to meditation practices and traditions were highlighted, including “nyams”, “dzogchen” and “ngondro”. Words related to spiritual concepts (“divinity”, “prayer”) and practice settings (“garden”, “roof”) were also notable.

Topic modeling (LDA)

As described in the Methods section, the number of topics parameter was set to $k=5$ for both groups. The resulting five topics for both groups along with the 10 most important words within each topic are presented below in Figs. 6 and 7. The most important words per topic were chosen according to descending β , the probability of a word contributing to the given topic. Topics are sorted by their average contributions (γ). γ is a metric which describes how much each topic contributes to each document in the corpus, and by averaging these values, we can see how much these topics contribute on the level of the whole corpus.

The psychedelic group’s topics focused on personal experiences and interactions, with Topic 4 contributing most significantly. The meditation group’s topics, particularly Topic 5, centred on practice-related terminology and personal experiences.

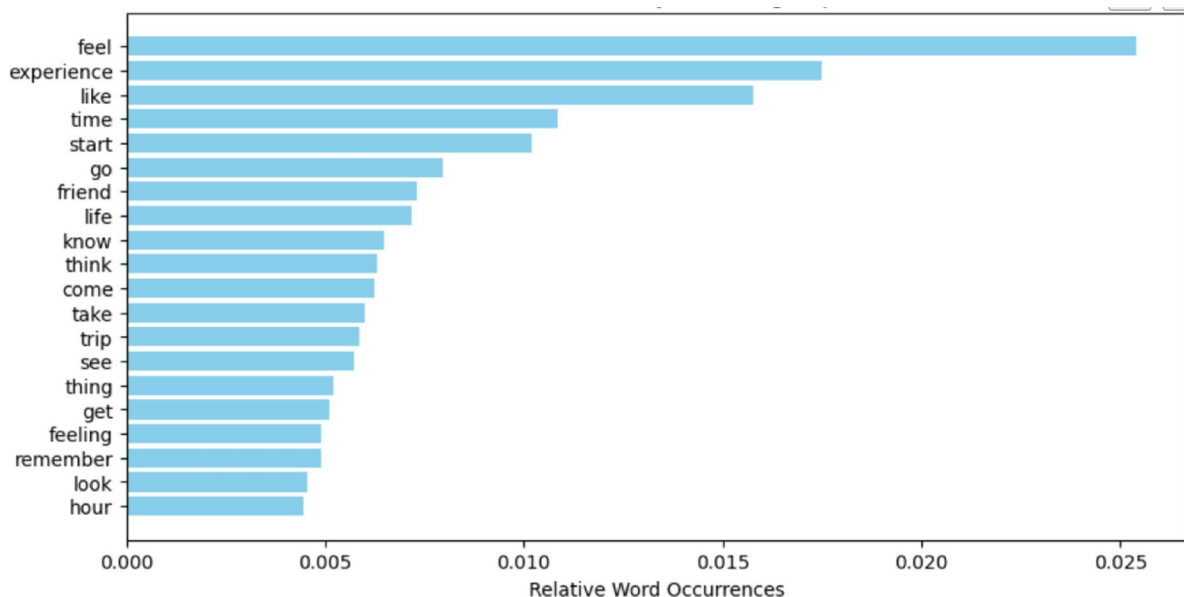


Fig. 2. Most common words in the psychedelic group and their relative occurrences.

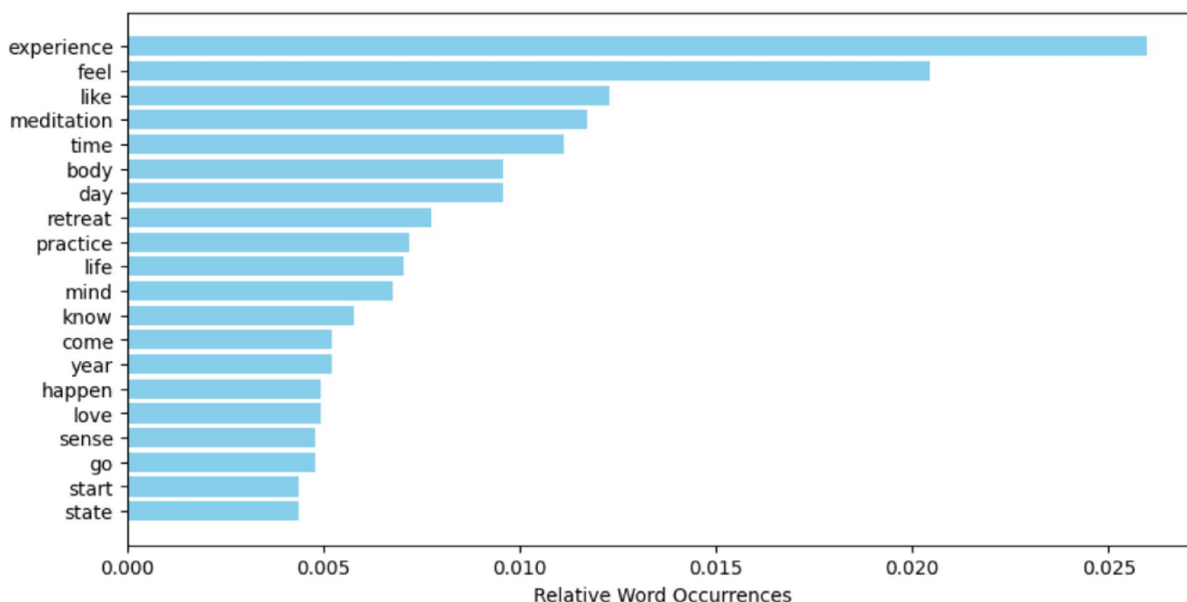


Fig. 3. Most common words in the meditation group and their relative occurrences.

Sentiment analysis

To analyse the sentiment of each document in both groups, the VADER package in Python was used. VADER provides four outputs: positive, neutral, negative, and compound scores. The positive, negative, and neutral scores represent the proportion of the text that falls into those categories. By contrast, the compound score is a normalized and weighted composite score that calculates the sum of all the lexicon ratings, which have been normalized between -1 (extreme negative) and +1 (extreme positive). This score can be interpreted as a measure of the overall sentiment of the text. Box plots of compound sentiment scores for both groups are presented in Fig. 8 and the complete results from the sentiment analysis are shown in Table 5 below.

The psychedelic group showed slightly higher presence of negative sentiments ($M=0.07$, $SD=0.05$) than the meditation group ($M=0.06$, $SD=0.07$), and the difference remained significant after correcting for multiple comparisons ($U=5265$, $p<.01$, $p_{FDR}<.05$, $r=.20$). The positive sentiment scores were also slightly higher for the psychedelics group ($M=0.15$, $SD=0.08$) compared to the meditation group ($M=0.13$, $SD=0.08$), and also this result remained significant after correction ($U=5097.5$, $p<.05$, $p_{FDR}<.05$, $r=.17$). On the other hand, quite logically, the meditation group showed a higher tendency toward neutral sentiments ($M=0.81$, $SD=0.09$)

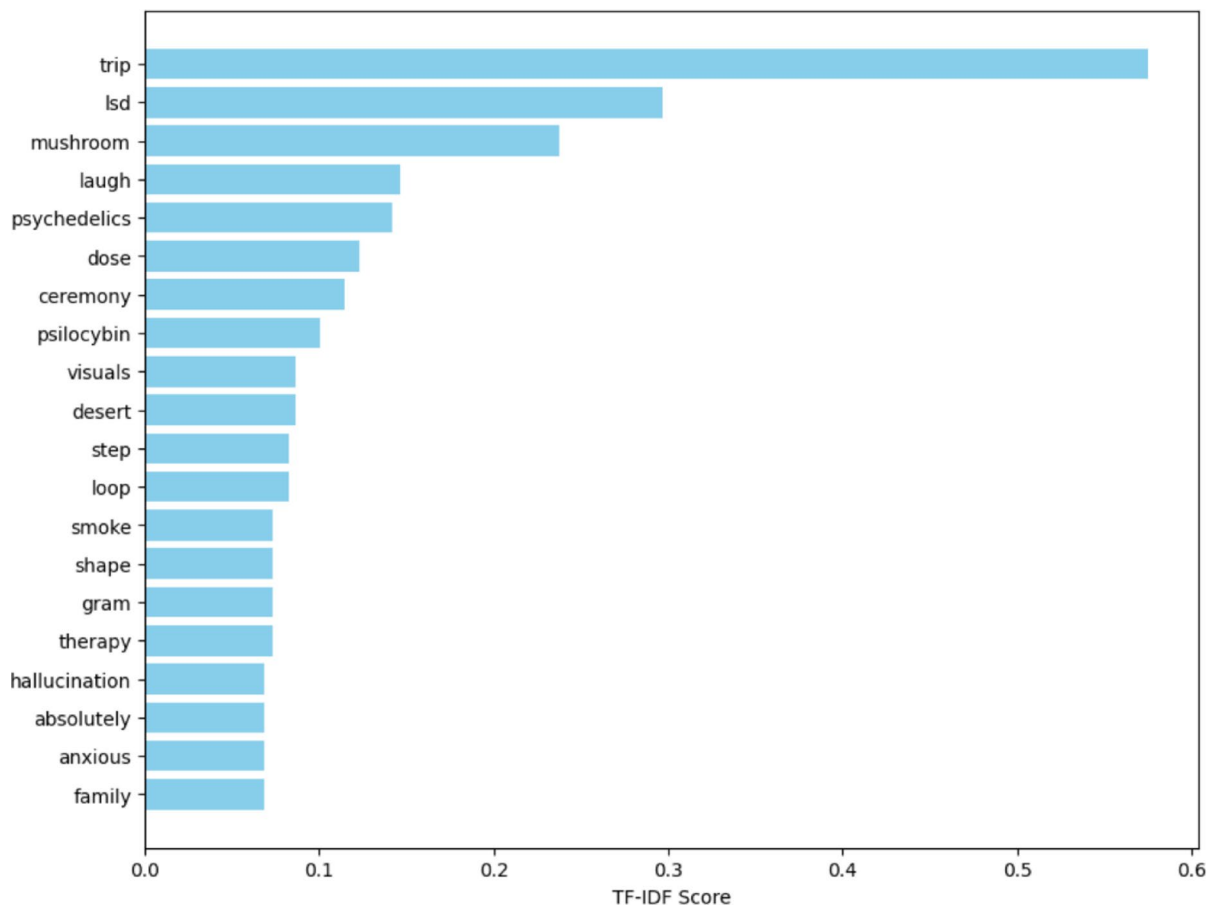


Fig. 4. Psychedelic group top 20 words with the greatest TF-IDF scores.

compared to the psychedelics group ($M=0.78$, $SD=0.09$); difference remaining significant after correcting for multiple comparisons ($U=3270.5$, $p<.05$, $p_{FDR}<.05$, $r=-.18$). There was no significant difference in the compound sentiment scores between the groups ($U=49,170$, $p=.062$, $p_{FDR}=.062$, $r=.13$).

Discussion

Previous research indicates neurocognitive similarities between psychedelic and meditation experiences⁵, and both practices have been argued to be capable of facilitating personally meaningful or even transformative experiences¹. However, research is limited comparing the phenomenology of these two types of experiences. In this study, we analysed and compared narrative reports of personally meaningful psychedelic and meditation experiences using NLP methods, in order to examine their similarities and differences.

The results from the text similarity analyses revealed commonalities between psychedelic and meditation experience reports. Most notably, the vector embeddings showed very high semantic similarity (cosine similarity=0.972) between the average representations of each group. In practical terms, this means that when considering the overall semantic content and themes across all documents, the “average” experience reports across the groups were very similar in meaning and the concepts they discussed. The within-group document-level similarity was also on a high, albeit lower level: 0.839 and 0.837 for psychedelic and meditation reports respectively. This lower within-group similarity likely reflects greater individual variation in how experiences are described within each group, while the higher between-group similarity captures shared broad themes that emerge when averaging across reports, as the aggregation process tends to smooth out individual differences and highlight common semantic elements. The semantic textual similarity analyses were corroborated by the lexical analysis, where only 8.87% of words showed significant differences in usage between groups. Also, the fact that the TF-IDF analysis—designed to highlight differences between corpora—only revealed superficial vocabulary distinctions related to induction methods, not experiential differences, further supports the similarity of the actual experiences.

These findings provide empirical support for Chirico’s and colleagues¹ theoretical framework of transformative experiences. While they identify different methods of inducing transformative experiences—including but not limited to meditation and psychedelics—they suggest these experiences share fundamental phenomenological features such as epistemic expansion and emotional complexity. Our results align with this theoretical framework, demonstrating that despite different induction methods, the subjective experiences show remarkable semantic and lexical overlap. The higher semantic variation found in individual reports compared

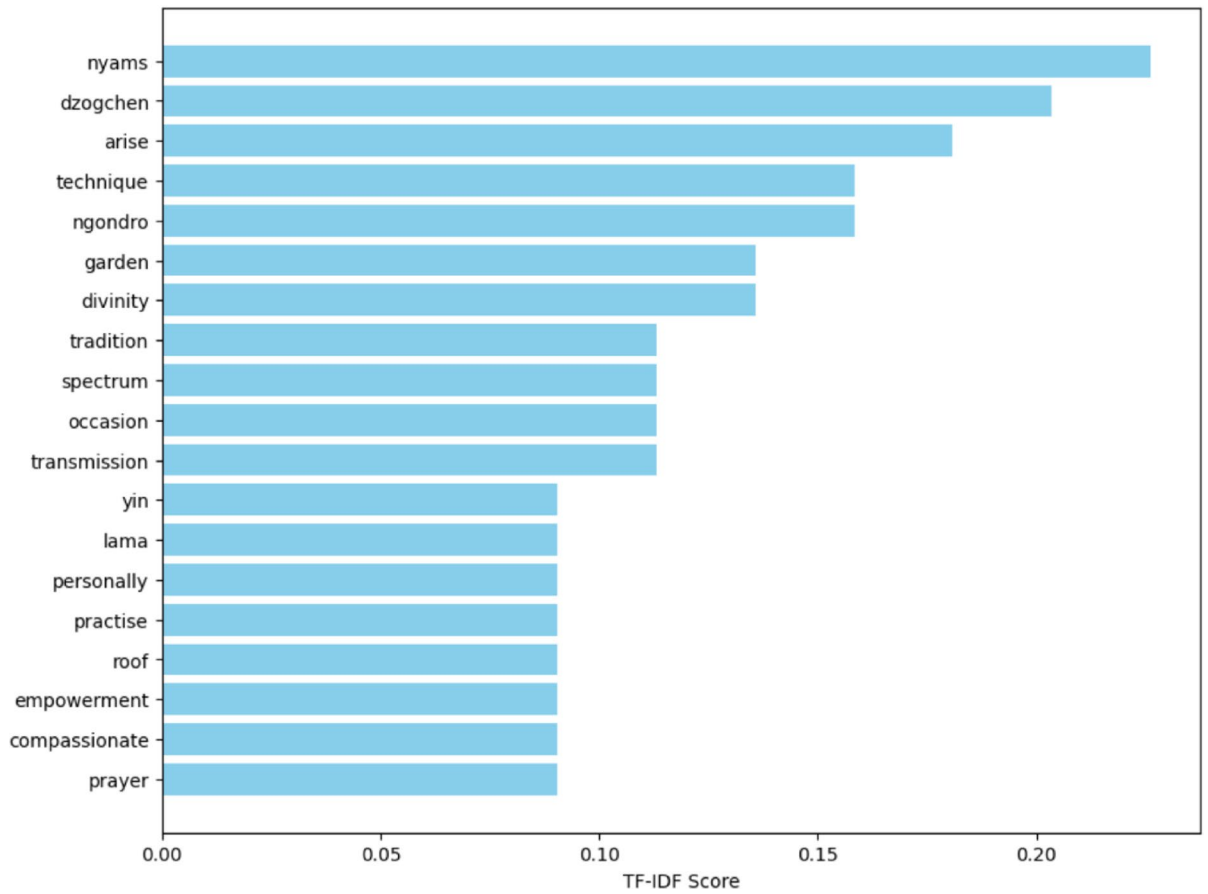


Fig. 5. Meditation group top 20 words with the greatest TF-IDF scores.

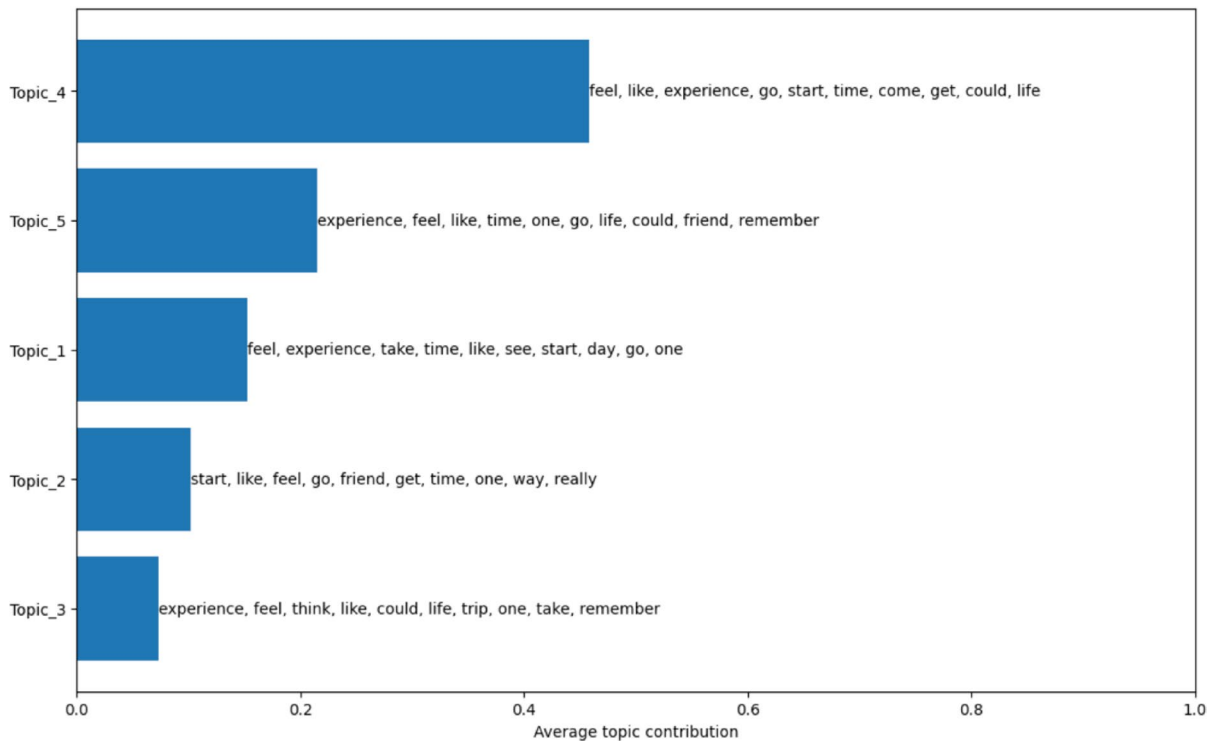


Fig. 6. Psychedelic group topics ordered by average topic contribution along with their most important words.

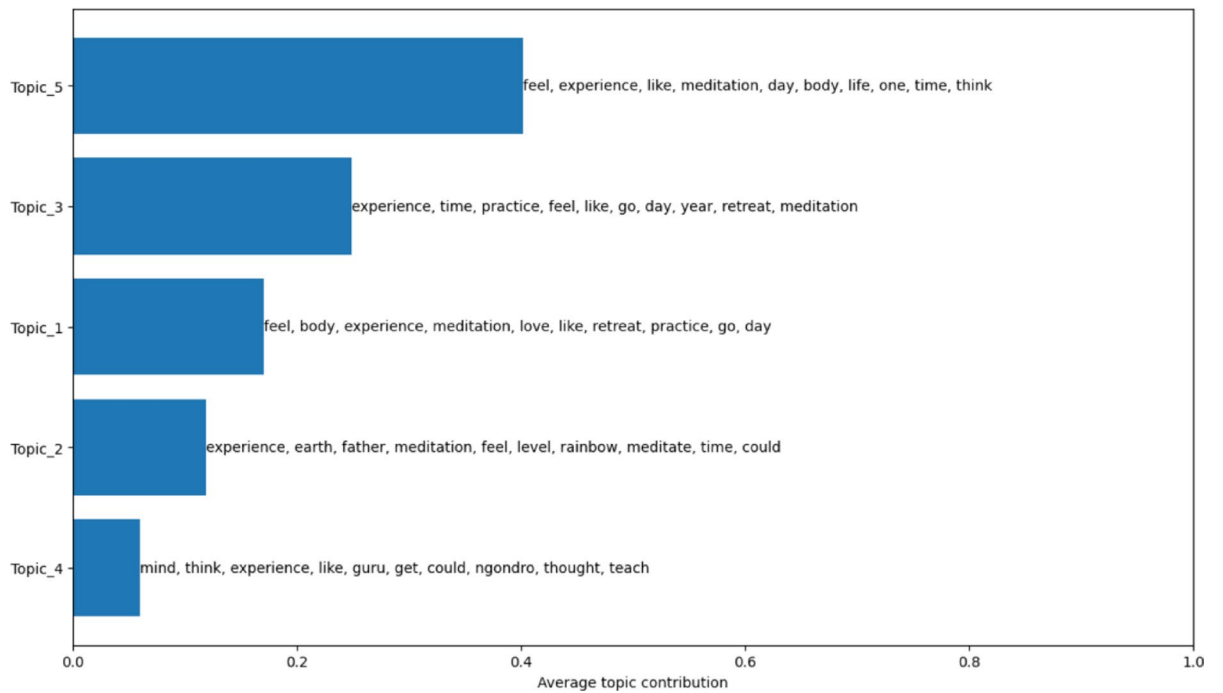


Fig. 7. Meditation group topics ordered by descending average topic contribution along with their most important words.

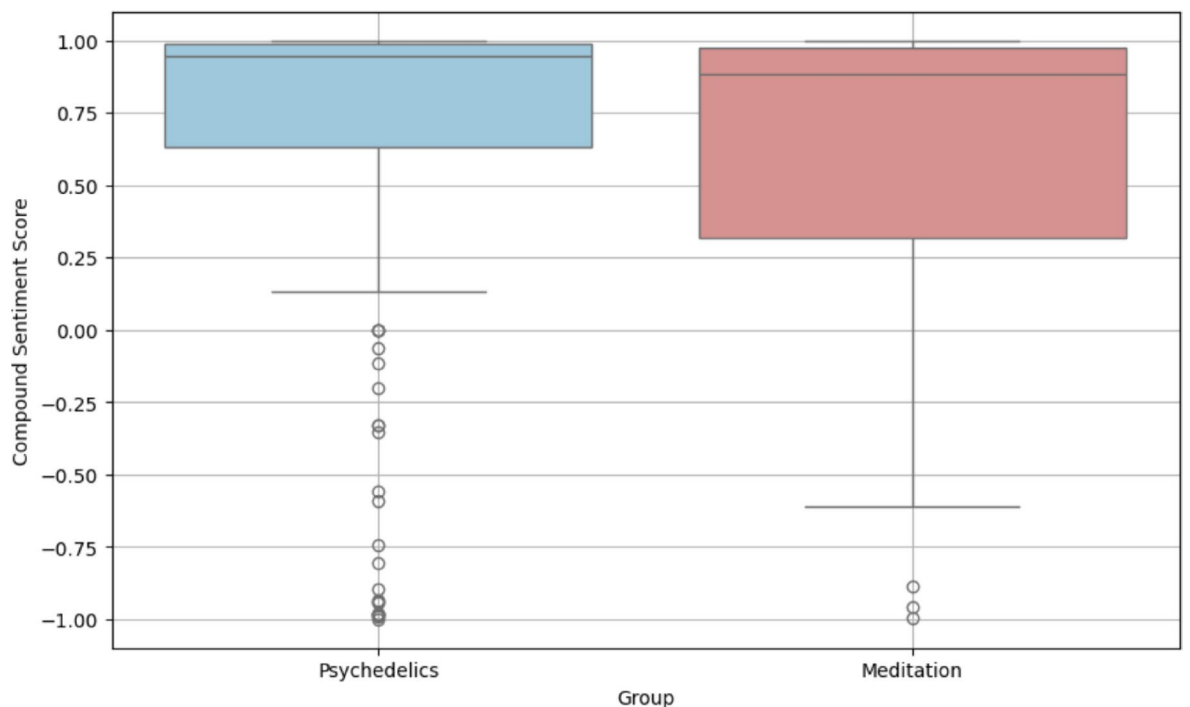


Fig. 8. Box plots of compound sentiment scores for both groups.

to group averages also supports the observation of Chirico et al.¹ that while transformative experiences have universal features, they retain distinct individual characteristics.

While Latent Dirichlet Allocation (LDA) has been shown to perform better than other topic models in human evaluation⁴⁵ and theoretically offers advantages in summarizing large text datasets, its application to psychedelic and meditation experience reports proved challenging. Our analysis revealed that the highest-contributing topics across both psychedelic and meditation reports contained largely the same important words in different

Sentiment type	Psychedelics mean (SD)	Meditation mean (SD)	Mean difference	U-statistic	Initial <i>p</i> value	Adjusted <i>p</i> value	Effect size (<i>r</i>)
Compound	0.63 (0.61)	0.56 (0.59)	0.07	4917	.062	.062	.13
Positive	0.15 (0.08)	0.13 (0.08)	0.02	5097.5	.019*	.025*	.17
Negative	0.07 (0.05)	0.06 (0.07)	0.01	5265	.005*	.021*	.20
Neutral	0.78 (0.09)	0.81 (0.09)	-0.03	3270.5	.011*	.022*	-.18

Table 5. Sentiment scores between groups.

orders, primarily emphasizing emotional, temporal and social themes that were already captured by word frequency analyses. This redundancy with simpler analyses, combined with the lack of distinct interpretable themes, raises questions about LDA's added value in this context. This limitation can be also observed from study by Qiu and Minda⁴⁶, which compared experience reports about different psychedelic substances. This suggests that LDA may be less effective for analysing these types of open-ended experiential narratives compared to more structured texts, such as scientific publications⁴⁷.

According to the present sentiment analysis, both psychedelic and meditation experiences were highly positive on average, though psychedelic experiences showed greater emotional variance. The key difference was that psychedelic reports contained both higher positive and negative sentiment scores, whereas meditation reports were more emotionally neutral. Though effect sizes were small, the results are consistent with previous research showing increased emotional lability with psychedelics, particularly LSD⁴⁸, while meditation research typically reports increased positive affect without corresponding emotional variability^{49,50}. This emotional intensity difference may be explained by increased cognitive entropy caused by the psychedelic substances⁴⁸ and could be important given that emotional intensity during psychedelic experiences predicts positive wellbeing outcomes⁵¹. Even though these findings are based on indirect sentiment analysis with a modest sample size, they suggest that emotional lability might be at least one key difference between the psychedelic and meditation experiences.

The current results—high similarity in the general content of the narrative reports, but differences in the emotionality—are quite aligned with two predictive coding theories about psychedelics⁵² and meditation²⁴. Both theories focus on the relaxation of high-level priors and top-down predictions which in turn leads to increased bottom-up signalling in the brain during the psychedelic and meditation experiences. If these models are accurate, it could show as similar narrative reports between the two groups, which was the result here. Also, the differences in the sentiment analysis can be explained by the differences in these models. The REBUS model by Carhart-Harris and Friston⁵² suggests that the relaxation of top-down constraints in brain processing allows for more varied and intense emotional experiences. On the other hand, Laukkonen and Slagter²⁴ suggest that meditation gradually brings practitioners closer to immediate sensory experience and away from abstract thinking. This gradual process might result in a more balanced emotional state, consistent with the less extreme sentiment scores observed in the meditation group.

Chirico et al.¹ identify mystical experience as one of the subtypes of transformative experience. According to them, these experiences can be induced both with psychedelics and meditation. This is interesting in relation to our results, since both groups received high and almost identical MEQ30-total scores on average: $M = 97.39$ in the psychedelic group and $M = 97.18$ in the meditation group. The similarity in these scores between the groups aligns with the text similarity analyses. However, the MEQ30 questionnaire and the whole mystical experience construct have been criticised for inviting study participants to interpret their experience through this mystical lens⁵³. The MEQ30 contains some metaphysically loaded wordings, which might bias the respondents to use similar terms while describing their experience. Our study tried to avoid this by administering MEQ30 as the very last questionnaire of the whole survey, so that the participants would not use the terminology of the questionnaire in the open reports. Nevertheless, both groups still received high and similar scores from the questionnaire.

The convergence we observe—both in MEQ30 scores and semantic similarity of narrative reports—demonstrates that within our sample of predominantly Western participants, psychedelic and meditation experiences were described in remarkably similar ways. However, this cannot be directly interpreted as evidence for universal, context-independent mystical states. The high semantic similarity we found could indicate genuinely overlapping phenomenology between psychedelic and meditation experiences, but it could also partly be explained by the fact that participants were describing their most meaningful experience with psychedelics or meditation. This may have led them to write about similar themes of transformation regardless of the specific qualities of the experiences themselves. In addition, since the most participants are from Western countries and all of them have answered the survey in English, they might be inclined to use similar cultural terminologies to explain their experiences.

Millière and colleagues⁷ have theorized that both psychedelics and meditation can disrupt the brain processes related to self-consciousness, potentially leading to a variety of experiences that are often described with the term self-loss. The changes in self-consciousness in psychedelic and meditative states are also emphasized in the predictive coding models about these states^{24,52}. Therefore, it's interesting to notice that in the present NLP analyses, these changes in self-consciousness are not emphasized at all in the present results. However, this might be due to the limitation of the NLP methods. Experiences of self-loss could be described using diverse vocabulary and metaphors that may not be captured by the present NLP analyses.

The present results can be compared to a previous study on the same dataset that utilised qualitative content analysis to identify insights in the psychedelic and meditation reports. Jylkkä et al.³² identified three main insight

themes across the reports: mystical-type, psychological, and compassion-related. The insight themes occurred equally frequently in the two types of reports, with only two exceptions: mystical-type insights were more frequent in the meditation reports, and value insights were more common in the psychedelic group. Moreover, no differences in the insights were found depending on which type of drug was used to facilitate the experience (classic psychedelic, non-classic psychedelic, or combination of the two). The authors propose that the higher frequency of value insights in the psychedelic reports could be due to higher emotional salience of psychedelic experiences, given the close link between values and affect⁵⁴. The results of our sentiment analysis support this hypothesis. Moreover, Jylkkä et al.³² speculated that the higher occurrence of mystical-type insight in the meditation reports could be an artefact, given that the meditators often framed their reports using meditation-specific technical terms, which often have metaphysical meanings. This hypothesis is supported by the present TF-IDF analysis where the main differentiating factors were mainly trivial psychedelic- or meditation related words. Finally, regarding the lack of phenomena related to self-loss in the current analyses, it is noteworthy that these aspects were discovered in the qualitative analysis by Jylkkä et al.³², suggesting that failing to find this phenomenon in the current NLP analysis reflects a limitation of this method. However, in sum, the results from the previous qualitative analysis are in line with the present NLP results, supporting the hypothesis that personally meaningful psychedelic and meditation experiences are quite similar.

Limitations

The nature of the collected dataset and the study design pose some challenges for drawing conclusions from the analyses. The psychedelic and meditation groups were quite different in terms of their size and demographic factors (see Tables 1, 2) and the small sample size precluded statistical control for these potential confounders in the NLP analyses. Moreover, the reports were collected retrospectively with independent samples design. This means that many other potential confounding factors could not be controlled for and recall bias might be common among the participants. They might not accurately remember their experiences at the time of reporting and could interpret the experiences in the light of their current knowledge and beliefs, further distorting their reports. Furthermore, the sample size was relatively small for NLP analyses, especially in the meditation group, which could amplify the impact of outliers and reduce the statistical robustness of the findings. Finally, the number of self-report questionnaires about the content of the experience was limited, since only MEQ30 about mystical experiences³⁴ was administered. For instance, including the Awe Experience Scale⁵⁵ or the PIQ scale on insights⁵⁶ could have offered a more nuanced and multidimensional assessment of participants' experiences to support the NLP analyses.

In addition to the matching problems, lack of standardisation within the groups poses challenges for interpreting the data. Psychedelic group included experiences induced with a wide variety of substances and the meditators had used several different techniques. Even though some researchers have argued that personally meaningful experiences can be qualitatively similar across multiple substances with different mechanisms of action^{1,9,13,14}, it would be optimal to have data where the groups were more homogeneous. For example, one potentially useful approach could be to compare experiences facilitated by classical psychedelics with sitting meditation. In the present study this could not be done since the samples would have become too small for robust analyses. Therefore, the present study does not allow inferences to be made about specific substances or meditation techniques used by the participants.

Despite these challenges, the systematic survey used in this study provides a significant improvement over less structured data sources like those freely accessible on the Internet (e.g., Erowid; <https://www.erowid.org/>) which have been previously used for gathering information about psychedelic experiences^{46,57}. Gathering data directly from internet forums has many disadvantages, such as lack of demographic data and lack of instructions for writing the report. Compared to analysing reports from Internet forums, the current survey ensures that all participants are responding to the same prompts, reducing variability in the answers.

The present study could be criticised for neglecting negative or challenging experiences that can be facilitated by both psychedelics⁵⁸ and meditation⁵⁹. The study explicitly sampled "personally meaningful experiences", which could have led to a positivity bias, given that most such experiences are positive. It is noteworthy that in the sentiment analysis some of the reports showed very high negative sentiment scores, which could indicate negative experiences. However, the sentiment analysis ignores the context of the sentiment words, thus we cannot draw conclusions about the presence of negative experiences.

A final limitation worth noting pertains to the NLP methods used. While vector embeddings can capture semantic relationships between words and phrases, the black-box nature of these models makes it challenging to fully understand how they arrive at these results³⁷. On the other hand, more understandable traditional NLP approaches that rely on exact word matching can be criticized for missing semantic meanings of words. However, qualitative analysis using human raters has its own limitations, particularly researcher subjectivity in interpretation⁶⁰. Therefore, combining computational and human-based approaches could provide complementary insights, leveraging the systematic nature of NLP while maintaining the nuanced understanding that comes from human interpretation.

Conclusions

This study employed NLP methods to compare reports of personally meaningful experiences facilitated by psychedelics and meditation. Analyses of word frequencies, distinctive terms (TF-IDF) and semantic similarities revealed strong similarity between the two, with substantial overlap in common words and themes. Additionally, both groups expressed predominantly positive sentiments, though psychedelic reports were more emotionally charged, displaying higher levels of both positive and negative sentiment, while meditation reports tended to be more neutral. These findings align with a previous qualitative content analysis of the same dataset³². While sentiment analysis and vector embeddings provided useful insights, the NLP approach as a whole did not provide

very deep understanding of the reports, since distinct themes could not be recognized from the LDA topic models. Despite the limitations, this study serves as foundation for future research, which should focus on larger, matched samples with standardized substances and meditation techniques. Future studies can use NLP as a complementary tool alongside structured questionnaires and qualitative analysis to enhance our understanding of these complex experiences.

Data and code availability

Data is available per request to the authors. The GitHub repository containing the Jupyter Notebook used for performing the analyses can be found from: https://github.com/konstakm/psychedelics_vs_meditation_nlp.

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Author contributions

JJ conceptualized the study design and supervised the project. KK conducted the analyses and wrote the first draft of the manuscript. RS contributed to the linguistic and natural language processing components of the manuscript and took part in revising the manuscript. The final manuscript was written by KK and revised by RS and JJ.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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