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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's 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*=203) wrote open-ended narrative reports about their most meaningful experience facilitated either with psychedelics (*n*=138) or meditation (*n*=65). These reports were analysed with word frequency analyses, LDA topic modeling and sentiment analysis. The frequency analyses did not find statistically significant differences between the word distributions in the two groups and qualitative outlook on the results supported the similarity of the experiences. Both experiences expressed positive emotions on average, but psychedelics seemed to be more emotionally charged, showing higher levels of positive and negative sentiments compared to the meditation reports. Psychedelic experiences were also more socially oriented. These results suggest that the two types of subjective experiences might be quite similar in general, but emotional intensity and social contexts could be distinguishing factors between them. Challenges with the dataset, such as heterogeneous and small samples, limit the conclusions that can be drawn from the study. However, it offers new hypotheses and suggestions for future research on transformative experiences.

Key words: psychedelics, meditation, transformative experience, natural language processing, frequency analysis, TF-IDF, topic modeling, LDA, sentiment analysis

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1 Background

Humans have long sought out experiences that are deeply meaningful, impactful, and potentially transformative (Chirico et al., 2022). These powerful experiences can take many forms - from spiritual and religious encounters to intense psychological insights. What they share in common is their ability to profoundly affect an individual, often leading to lasting changes in beliefs, values, identity, and behavior (Yaden et al., 2017). Transformative experiences (TEs) 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" (Chirico et al., 2022, p. 14). They typically involve an epistemic expansion - gaining new knowledge or insight about oneself and the world - as well as heightened emotional complexity and intensity (Chirico et al., 2022). Among many practices that can lead to transformative experiences, two have gained particular scientific and cultural interest in recent years: psychedelic use and meditation (Galvão-Coelho et al., 2021; Goyal et al., 2014).

1.1 What are psychedelics?

Psychedelics have been used for centuries for their mystical, spiritual, and therapeutic properties and the scientific interest in these substances has grown dramatically during the recent years. 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 (Carhart-Harris & Goodwin, 2017; Vollenweider & Kometer, 2010).

While “classical” psychedelics (psilocybin, LSD, DMT, ayahuasca) are defined based on their common mechanism of action as agonists of serotonin 2A (5-HT2A) receptors (Nichols, 2016), recent research has begun to consider a broader range of substances that can induce psychedelic-like experiences through diverse mechanisms. Dissociative anesthetics like ketamine act as NMDA receptor antagonists, producing detachment and perceptual alterations (Vollenweider & Kometer, 2010). Salvinorin A, found in Salvia divinorum, acts on kappa opioid receptors, causing intense, brief consciousness changes (Roth et al., 2002). MDMA, primarily affecting serotonin release and reuptake, produces empathogenic effects and mild perceptual changes (Nichols, 1986). Cannabinoids in cannabis, primarily THC and CBD, act on the endocannabinoid system via CB1 and CB2 receptors. While not typically classified as

a psychedelic, cannabis can induce altered perceptions, enhanced pattern recognition, and changes in thought processes, especially at higher doses. Some users report experiences of depersonalization, time distortion, and even mystical-type phenomena similar to classical psychedelics. (Bostwick, 2012)

Vollenweider and Kometer (2010) have proposed that even though many psychedelics have different primary mechanisms of action in the brain, their therapeutic effect might be based on a common factor: glutamate-driven neuroplasticity. They argue that different psychedelic substances (such as psilocybin and ketamine) indirectly increase the glutamate levels in the brain and the brain's adaptation to these changes is crucial for the therapeutic effects. Furthermore, Breeksema et al. (2020) advocate for a more inclusive definition of psychedelics in their systematic review. They justify this approach by pointing to the shared phenomenology of these experiences and the potential for various substances to treat similar mental health conditions. For instance, they note that substances as diverse as psilocybin, LSD, ayahuasca, and ketamine have all been studied for their potential to treat depression. This broader perspective on psychedelics allows researchers to explore common underlying mechanisms and effects across a range of consciousness-altering substances. It acknowledges that while these compounds may have distinct pharmacological profiles, they can induce alterations in consciousness that may lead to personally meaningful and even transformative experiences.

The current research has mainly focused on treating mental health disorders (Breeksema et al., 2020; Galvão-Coelho et al., 2021; Luoma et al., 2020; Romeo et al., 2020; Vollenweider & Kometer, 2010), 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 (Ko et al., 2022; McCulloch et al., 2022; Yaden & Griffiths, 2021) and this encourages us to study the phenomenological content of the experiences further.

1.2 Meditation

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 transformative (Chirico et al., 2022). It can be defined as a set of practices which aim to control one's cognitive processes, especially those related to the self and attention (Dahl et al., 2015).

People have been able to use meditation for altering their sense of self, time and space even in laboratory settings (Berkovich-Ohana et al., 2013; Wahbeh et al., 2018). 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 & Slagter (2021) categorise 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, like the breath, reducing 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 sensations (Hölzel et al., 2011). 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 content (Laukkonen & Slagter, 2021).

Laukkonen and Slagter (2021) claim 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 the idea of predictive coding in cognitive processing: the brain constantly forms predictions about the world and these predictions affect how we interpret different sensory information in top-down manner. The underlying idea is based on the free-energy principle (Friston, 2010), which states that the brain (or any living organism) aims to always minimize the difference between its predicted states and the actual sensory information (known as “free energy”). This prediction error is optimized by updating the internal models of the world, but also by fitting the sensory data into the existing top-down models. According to Laukkonen & Slagter (2021), meditation practices gradually reduce the brain's reliance on these predictive models, especially those involving abstract or temporally distant concepts. This reduction in predictive processing allows practitioners to experience reality more directly, with less influence from their prior expectations, leading to changes in consciousness and perception.

1.3 Comparing psychedelic and meditation experiences

Both psychedelics and intensive meditation can sometimes induce what individuals describe as deeply meaningful, even life-changing experiences. These may involve a sense of ego

dissolution, feelings of unity with the universe, and insights that participants consider personally important (Chirico et al., 2022; Millière et al., 2018). Understanding the commonalities and differences in how these transformative experiences unfold across psychedelics and meditation could provide valuable insights into the nature of human consciousness and personal growth.

Carhart-Harris & Friston (2019) have suggested that also psychedelics can loosen the high-level priors of the brain and the mind. Their REBUS model is similar in many ways to the many-to-(n)one model by Laukkonen & Slagter (2021). Both theories are based on the same idea of predictive processing and how psychedelics and meditation can disrupt the brain's normal predictive processes, leading to altered states of consciousness. However, there are still some differences between them. According to Carhart-Harris & Friston (2019), precision weighting of high-level priors is relaxed under psychedelics, which leads to increased bottom-up signalling and informational entropy. In their model, this altered state of cognitive processing often leads to significant, sometimes abrupt insights and emotional breakthroughs. On the other hand, Laukkonen & Slagter (2021) concentrate more on the predictions that our brain is making about the world and their temporal depth rather than informational entropy. More temporal depth means more high-level brain processes and more abstractions away from the sensory information. They suggest that different styles of meditation gradually bring the practitioner into the present moment by reducing the temporal depth of the predictions, leading to changes in the perception of self and reality. In contrast to the abrupt insights and emotional lability in the REBUS model, many-to-(n)one model seems to be emphasising the "pure awareness" events that can arise through gradual reduction of predictive processing.

One of the clearest similarities between experiences from psychedelics and meditation might be related to the sense of self or ego: many meditation traditions aim at dissolving the sense of self while psychedelics are known to sometimes produce a phenomenon called drug induced ego-dissolution (Millière et al., 2018). In both experiences, the individual loses the sense of themselves as a separate entity, often described as a merging with the surrounding environment. However, the dissolution of ego is not the only outcome of psychedelic or meditation experiences, and it does not happen to all individuals (Millière et al., 2018). It's still an open question how frequently ego dissolution occurs with psychedelics compared to meditation.

The states induced by psychedelics and meditation have been compared before, but the studies have concentrated more on the changes in brain activity (Moujaes et al., 2023; Timmermann et al., 2023) and well-being effects (Heuschkel & Kuypers, 2020) than the phenomenology of the experiences. Also, some studies have examined the well-being effects (Holas & Kamińska, 2023) and phenomenological effects (Azmoodeh et al., 2023) of combining psychedelic use with meditation. However, as far as the author is aware, so far no one has empirically compared the phenomenology of psychedelic experiences to meditation.

1.4 The objective and methods of this study

While previous studies have compared the brain activity and well-being effects of psychedelics and meditation, there's been little research comparing the subjective experiences they induce. This study aims to fill this gap by exploring how 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 subjective narrative reports from individuals who have used psychedelics or practiced meditation in natural settings. The nature of this study is explorative and therefore no hypotheses were set beforehand.

Natural Language Processing (NLP) refers to a set of methods for analysing textual information with computers. NLP methods are often very well fitted for explorative text analysis, and they offer speed, efficiency, scalability and consistency over traditional qualitative text analysis by humans (Wang et al., 2022). 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, I chose to use NLP for comparing the narrative reports about psychedelic and meditation experiences. More specifically, the participants' open narrative reports were analysed using frequency analyses, topic modeling and sentiment analysis. Frequency analyses involve counting how often specific words or phrases appear in the text, providing a descriptive summary of the reports for the reader. Word frequency distributions can also be used to compare the reports across the psychedelic user and meditator groups. Topic modeling is a statistical technique that discovers abstract topics within a collection of reports, grouping related words together to reveal underlying themes. It was hoped that this method would help to recognise the common and distinct themes between the groups. Sentiment analysis, on the other hand, is a method used to determine the

emotional tone of a piece of text, categorizing it as positive, negative, or neutral. It was selected for its ability to convert text into numerical format, which helps to directly compare the two experiences based on their emotional valence. These three methods, when applied together, should provide a comprehensive way to examine the content, common themes, and emotional aspects of the participants' written experiences. However, psychedelic and meditation experiences are known to be sometimes even ineffable in their nature (Azmoodeh et al., 2023; Millière et al., 2018), so this study will also show how applicable the NLP methods are in this context.

2 Methods

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 as supplemental material (see Appendix 1). 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.

2.1 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 highly meaningful personal 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.

The structure of the surveys was following: first the participants answered background questions about their demographics and history of psychedelic use (or meditation practice). To probe their current psychological states, 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 insights, body-related experiences, and experiences related to sense of connection or alienation (reported elsewhere). Finally, the participants were asked to evaluate

their experience with MEQ30 structured survey that measures mystical experiences (Barrett et al., 2015). Several other studies are being conducted on this dataset, and therefore multiple questionnaires mentioned here are excluded from the current study. I am focusing only on the participants' open narrative reports and reporting the MEQ scores as a psychometrically valid reference point. The narrative reports were (hopefully) written according to following instructions:

> "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."

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.

2.2 Ethical considerations

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. Participants were provided with comprehensive information about the study's purpose, content, and procedures. This included details about the types of questions they would be asked, the expected time commitment (30-60 minutes), and the focus on their most meaningful psychedelic or meditation experience. Anonymity and confidentiality were strictly maintained throughout the study. The survey was designed to be completely anonymous, with no collection of personal identifiable information or IP addresses.

Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without providing a reason. The minimum age for participation was set at 18 years to ensure all participants were adults capable of providing informed consent. Given the potentially sensitive nature of discussing psychedelic experiences, which may involve illegal activities in some jurisdictions, extra care was taken to protect

participants' anonymity. No questions were asked about the legality or procurement of substances.

The study adhered to the EU General Data Protection Regulation (GDPR) in its handling and processing of research data. Participants were provided with a link to Åbo Akademi University's data processing policies for further information.

Lastly, a clear disclaimer was included stating that the researchers do not recommend the use of any psychoactive drugs and acknowledging the potential psychological or physiological risks associated with their use. This was done to ensure that the study was not perceived as promoting or encouraging drug use.

2.3 Pre-processing

Before the actual analyses, the narrative reports were first spell checked automatically, i.e., Google Sheets' spell checker functionality was used to reveal potentially misspelled words, and these were corrected manually by the author when needed. The reports were also pre-processed using Python's NLTK library (Loper & Bird, 2002), which contains widely used tools for natural language processing. Pre-processing included stop word removal and lemmatisation 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"). Lemmatisation 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.

2.4 Analyses

This study involved frequency analyses, topic modeling, and sentiment analysis to analyse the similarity of reported personally meaningful psychedelic and meditation experiences. Also, the MEQ30 questionnaire results are reported in order to provide a psychometrically valid reference point for the present NLP analyses. This is a standardized questionnaire designed to measure the intensity and qualities of mystical experiences, often associated with psychedelic use or deep meditative states. It assesses various aspects of these experiences, such as feelings of unity, transcendence of time and space, ineffability, and positive mood, providing a way to operationalise deeply subjective spiritual or mystical states. (Barrett et al., 2015)

2.4.1 Frequency analyses

Several frequency analyses were conducted to recognise the most common words and themes from the narrative reports. First, I simply checked the relative word frequencies in both corpora – 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 psychedelic and meditation groups. The word frequency distributions of 20 most common words in both groups were compared with the Kolmogorov-Smirnov test and the frequencies of each individual word in both groups were analysed with the log-likelihood test. I also calculated the lexical overlap of the words in the two groups. This involves finding what percentage of the total vocabulary is shared between both types of reports. More specifically, I identified the words that appear in both meditation and psychedelic reports, and then divided this number by the total number of unique words across all reports.

In order to give some more context to the words, the most common bigrams were calculated as well, i.e. combinations of two adjacent words. It's good to note that lemmatisation wasn't done for the bigram analysis, because I wanted to keep the meaning of the bigrams intact. Bigrams were not compared statistically like the word frequencies, because they occur much less frequently than individual words, making robust statistical analysis challenging. Instead, they were used qualitatively to better understand the context and meaning of the words used in the reports.

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 document (Rajamaran & Ullman, 2011). 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:

$$tf - idf(w) = \frac{\text{incidence of w in a document}}{\text{total words in a document}} \times log10\left(\frac{total\ number\ of\ documents}{number\ of\ documents\ with\ w}\right)$$

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.

2.4.2 Topic modeling

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 topics. (Blei et al., 2003)

The selection of the parameter *k*, which represents the number of topics, is always somewhat arbitrary task for the researcher. There are multiple approaches available for determining the optimal number for *k*, but these can provide conflicting results in many cases (Rüdiger et al., 2022). Therefore, some kind of trial-and-error process is usually needed for finding the best *k* for any practical use case. In this case, I experimented with different numbers for *k*, but the final decision was made by using Wheeler's and colleagues' (2021) simulation study as a guide in order to ground the decision in an empirical framework. They generated simulated text responses in order to analyse the statistical performance of the LDA algorithm and provided guidelines about the required sample size for different *k* values and average response lengths. In this case, sample size and average essay lengths were already fixed, so I used them to infer the number of topics *k* which has appropriate statistical performance according to Wheeler et al. (2021). Following their guidelines, psychedelic documents should be condensed into five or six topics and meditation documents into only two topics. In order to keep the number of topics equal for both groups for better comparisons, I decided to use five topics with both groups. In this way, the results are easier to interpret and compare across

groups, and the meditation topics don't provide an oversimplified picture of the narrative reports.

2.4.3 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 analysis (Hutto & Gilbert, 2014). VADER is a lexicon and rule-based approach, which allows for accurate sentiment scoring without extensive training datasets. I chose VADER for sentiment analysis because it has been shown to outperform other lexicon-based approaches by producing consistent results across different datasets (Ribeiro et al., 2016). 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.

3 Results

213 participants from various countries were recruited to answer the structured online survey about psychedelic or meditation experiences. 10 participants answered the survey, but didn't write the open reports, so they had to be excluded from this analysis. Therefore, 203 respondents' answers were analysed in this study – 138 of them were in the psychedelic group and 65 in the meditation group. Participants characteristics and their prior experience of psychedelics or meditation are presented in the Tables 1-4 below.

Table 1. Psychedelic and meditation group characteristics

	Psychedelics				**Meditation**			
Demographics	**M**	**SD**	**Max**	**Min**	**M**	**SD**	**Max**	**Min**
Age	39.32	13.04	79	18	51.23	14.14	80	27
Income level [1-5][1]	3.27	1.06	5	1	2.94	1.26	5	1
Education level [1-7][2]	5.98	1.68	7	1	6.41	1.3	7	1
Previous experience								
Frequency [0-6][3]	4.3	1.44	6	0	4.85	0.89	6	2
Time since last psychedelic use [0-7] [4]	3.43	2.37	7	0	-	-	-	-
Meditation history[5]	-	-	-	-	5.71	0.96	6	1

[1]Income 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).

[2]Education 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).

[3]Frequency 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).

[4]Time since previous intake of classical psychedelics was measured on an ordinal scale from 0-7 (0 = Over a year ago, 1 = 9-12 months ago, 2 = 6-9 months ago, 3 = 3-6 months ago, 4 = 1-3 months ago, 5 = 2-4 weeks ago, 6 = One week ago, 7 = Less than one week ago).

[5]History 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).

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

	Psychedelics		Meditation	
Gender	**N**	**%**	**N**	**%**
Male	87	63.04%	33	50.77%
Female	50	36.23%	29	44.62%
Other	1	0.72%	3	4.62%
Region				
Nordic countries	63	45.7%	20	30.8%
Other Europe	15	10.9%	13	20%
North America	19	13.8%	16	24.6%
Other (Asia, Africa, South America & Oceania)	41	29.7%	16	24.6%
Setting of the Experience				
Home	56	40.58%	22	33.85%
Friend's home	22	15.94%	0	0%
Ceremonial space/retreat	22	15.94%	34	52.31%
Nature	18	13.04%	3	4.62%
Public space	10	7.24%	3	4.62%
Other private space	7	5.07%	2	3.08%
Therapeutic space	3	2.17%	1	1.54%
Who was present				
One other person	50	36.23%	1	1.54%
Several people, all familiar	35	25.36%	7	10.77%
Alone	29	21.01%	31	47.69%
Several people, some unfamiliar	24	17.39%	26	40%

Table 3. Psychedelic group: substances used to facilitate the Experience

Experience facilitated by*	Count	Percentage
Psilocybin	65	47.10%
LSD	49	35.51%
Cannabis	29	21.01%
MDMA	25	18.12%
Ayahuasca	12	8.70%
5-MEO-DMT	10	7.25%
DMT	9	6.52%
Ketamine	6	4.35%
Mescaline	4	2.90%
Other	4	2.90%
Salvia	1	0.72%

*Please note that some participants used multiple substances to facilitate the Experience, and the percentages don't therefore add up to 100%.

Table 4. Meditation group: techniques used to facilitate the Experience

Experience facilitated by*	Count	Percentage
Silent sitting or lying down	34	52.31%
Voicework	4	6.15%
Breathwork	5	7.69%
Bodywork	3	4.62%
Mindfulness	15	23.08%
Other	19	29.23%

*Please note that some participants used multiple meditation techniques to facilitate the Experience, and the percentages don't therefore add up to 100%.

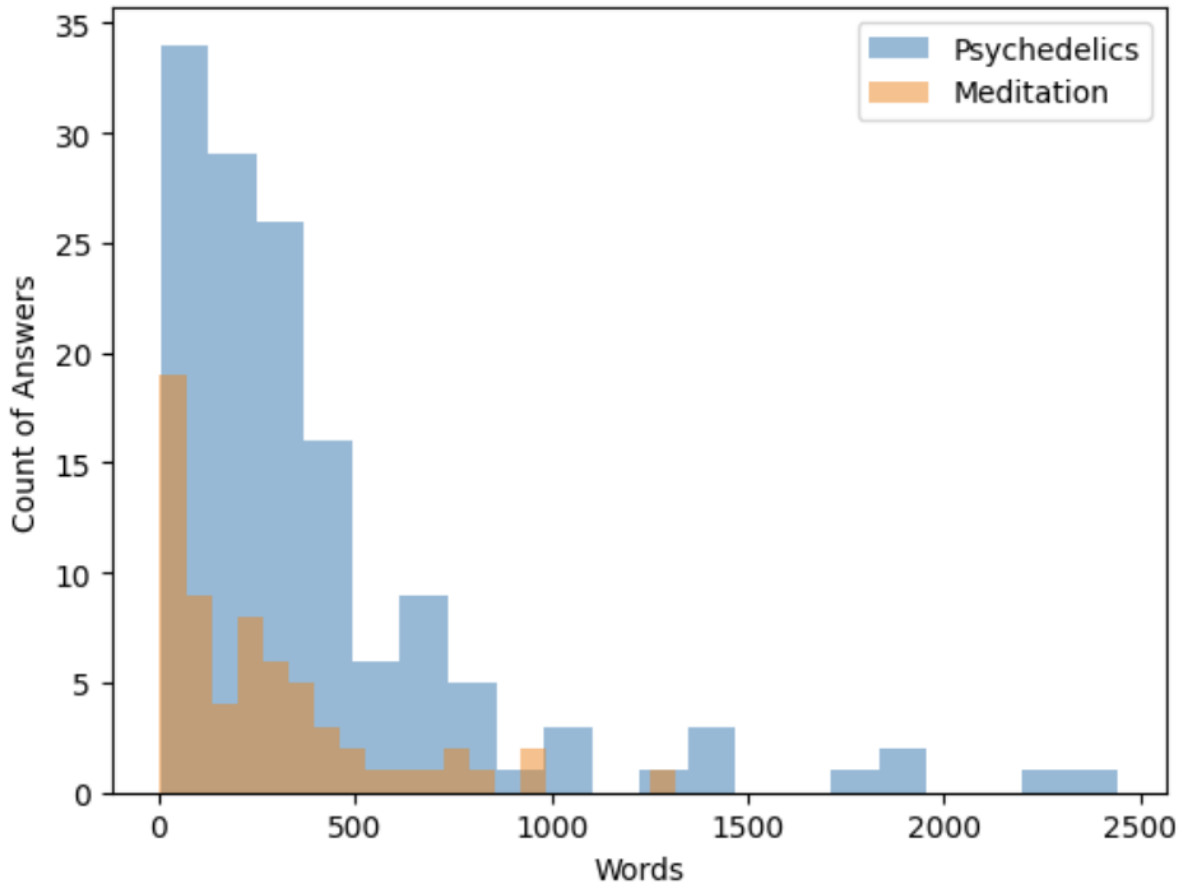
The sample characteristics showed the following patterns: the meditation group participants were typically older (M = 51.23 years, SD = 14.14) compared to the psychedelic group (M = 39.32 years, SD = 13.04). In terms of gender distribution, 63.04% of the psychedelic group participants were male, while in the meditation group the gender distribution was more balanced (50.77% 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 (52.31%) and alone (47.69%).

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 valid (Barrett et al., 2015) 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. Since the scores were not normally distributed, a Mann-Whitney U-test was used for comparison. 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 (Figure 1). The average length of answers in words were 400.41 (SD = 443.66) and 273.03 (SD = 274.86) 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.

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



3.1 Frequency 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 the figures 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.

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

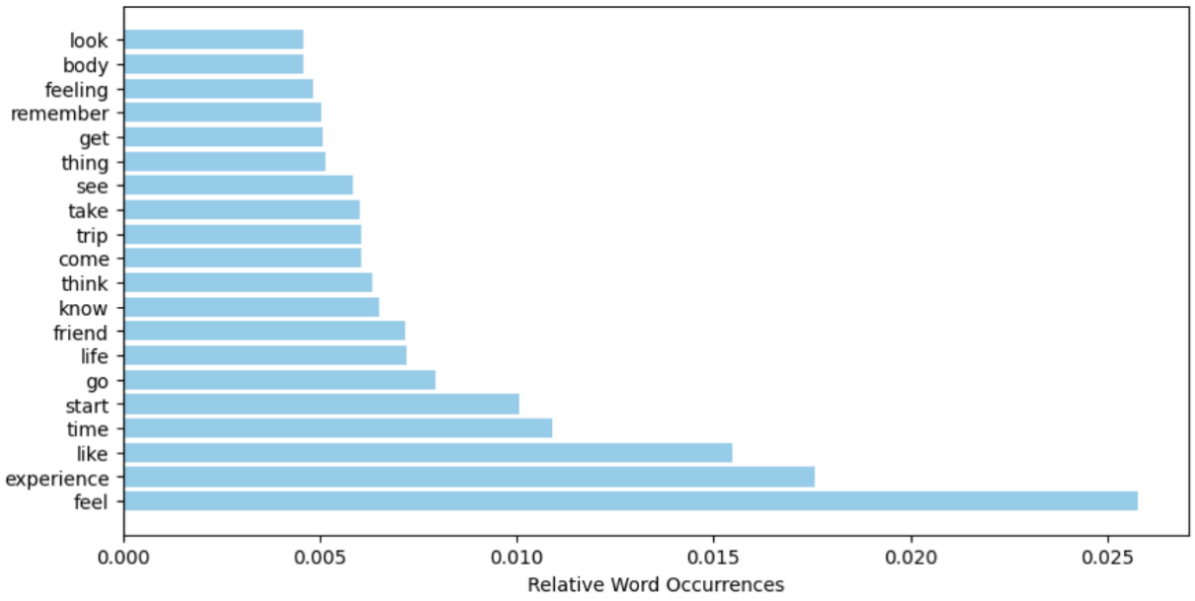
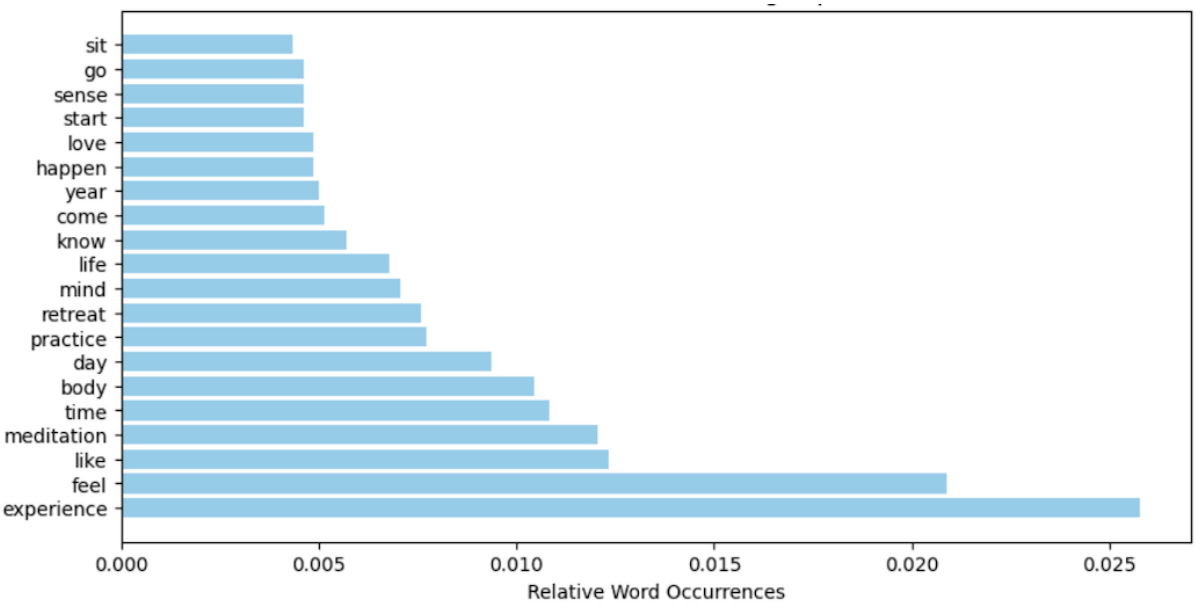


Figure 3 Most common words in the meditation group and their relative occurrences



These figures indicate that there is overlap in the most common words. Table 5 elaborates this further by showing which words are shared across the groups.

Table 5. Most common words in the psychedelic and meditation groups

Word category	Count	Percentage	Words
Shared	10	33.3%	feel, experience, like, time, go, life, know, come, start, body
Only psychedelics	10	33.3%	look, feeling, remember, get, thing, see, take, trip, think, friend
Only meditation	10	33.3%	sit, sense, love, happen, year, mind, retreat, practice, day, meditation
Total unique words	30	100%	-

When examining the 20 most common words from each group, 10 words appeared in both groups' top 20 lists (e.g., "feel", "experience" and "time"), resulting in 30 unique words total across both groups. The remaining words were unique to one of the groups: 10 words appeared only in psychedelic reports (e.g., "look", "trip", "friend"), while 10 different words were unique to meditation reports (e.g., "sit", "practice", "retreat").

A Kolmogorov-Smirnov test was performed to compare the relative frequencies of the 20 most common words from both groups. This test examines if two datasets come from the same distribution. The results indicate no differences between the distributions of most common words ($D=0.133$, $p=.958$). This suggests that not only are similar words used frequently in both types of experiences, but they are also used with comparable relative frequencies.

Expanding the analysis to all words used, 28.12% (1440 out of 5120 unique words) were shared between the two corpora. When analysing each unique word separately with the log-likelihood test, only 454 words (8.87%) 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.

Figures 4 and 5 present the most common bigrams in the two groups. It should be noted that in the context of bigrams, the words were not lemmatised in order to preserve the original meaning of the bigrams.

Figure 4. Most common bigrams in the psychedelic group

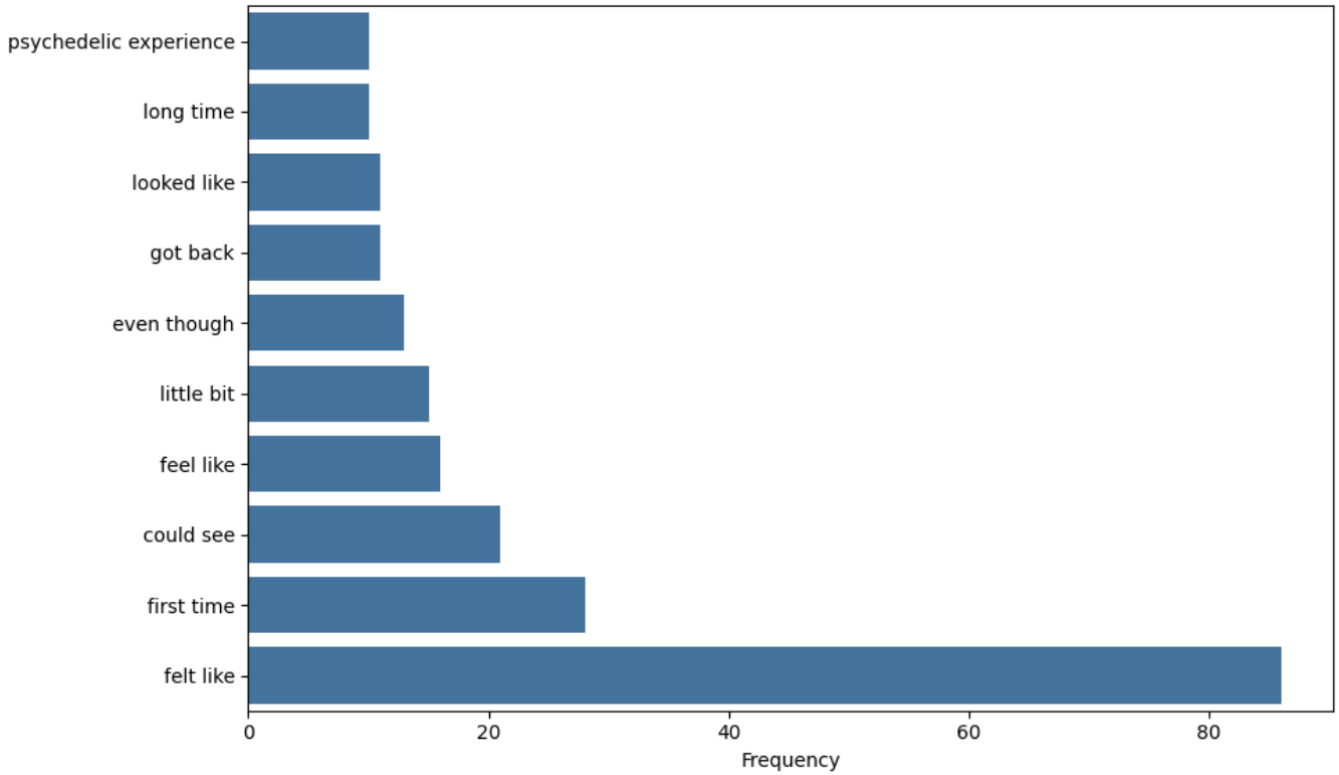
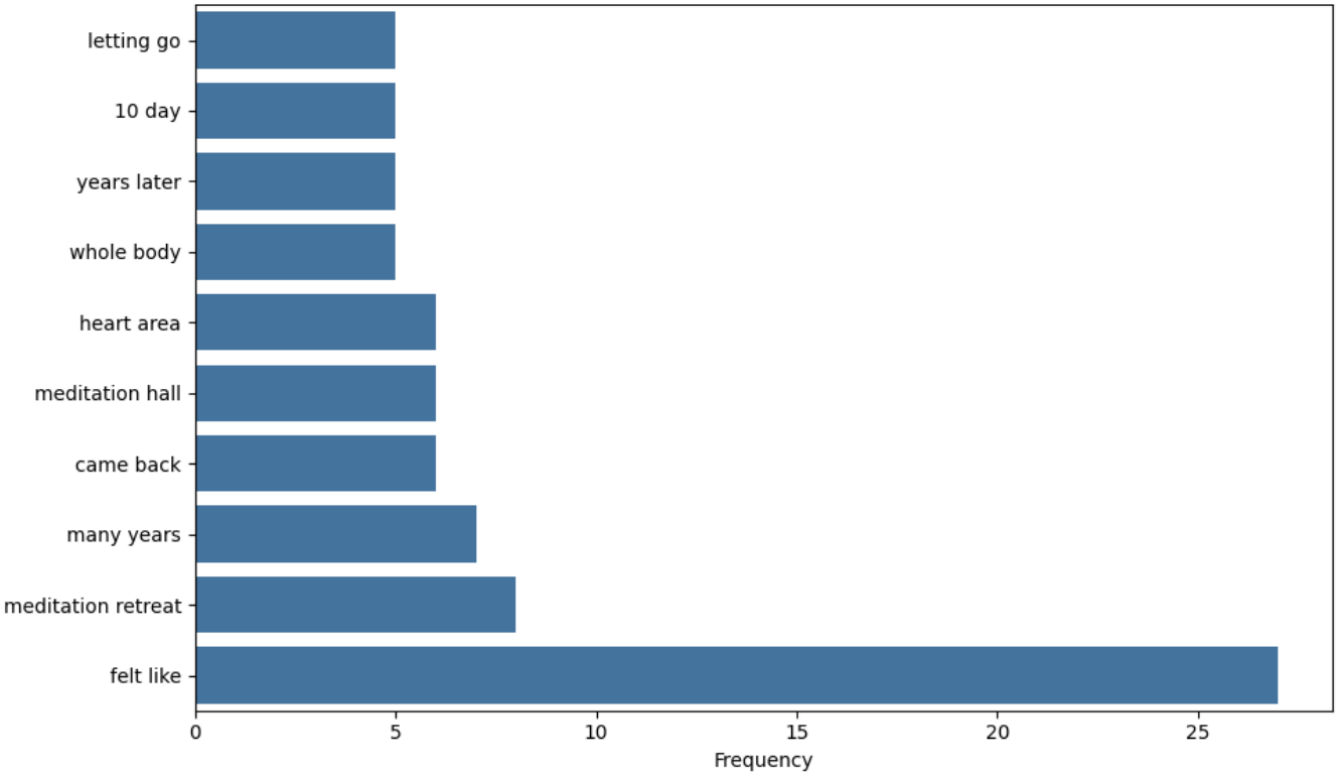


Figure 5. Most common bigrams in the meditation group



The bigram analysis revealed commonalities and distinctions between the psychedelic and meditation groups. "Felt like" was the most frequent bigram in both groups. Psychedelic reports often included bigrams related to visual perceptions ("could see", "looked like") and temporal aspects ("first time", "long time"). Meditation reports frequently contained bigrams referencing specific practices or settings ("meditation retreat", "meditation hall"), bodily sensations ("heart area", "whole body"), and time-related concepts ("many years", "years later", "10 day").

The words with the greatest TF-IDF scores are presented in the figures 6 and 7 for psychedelic and meditation groups respectively.

Figure 6. Psychedelic group top 20 words with the greatest TF-IDF scores

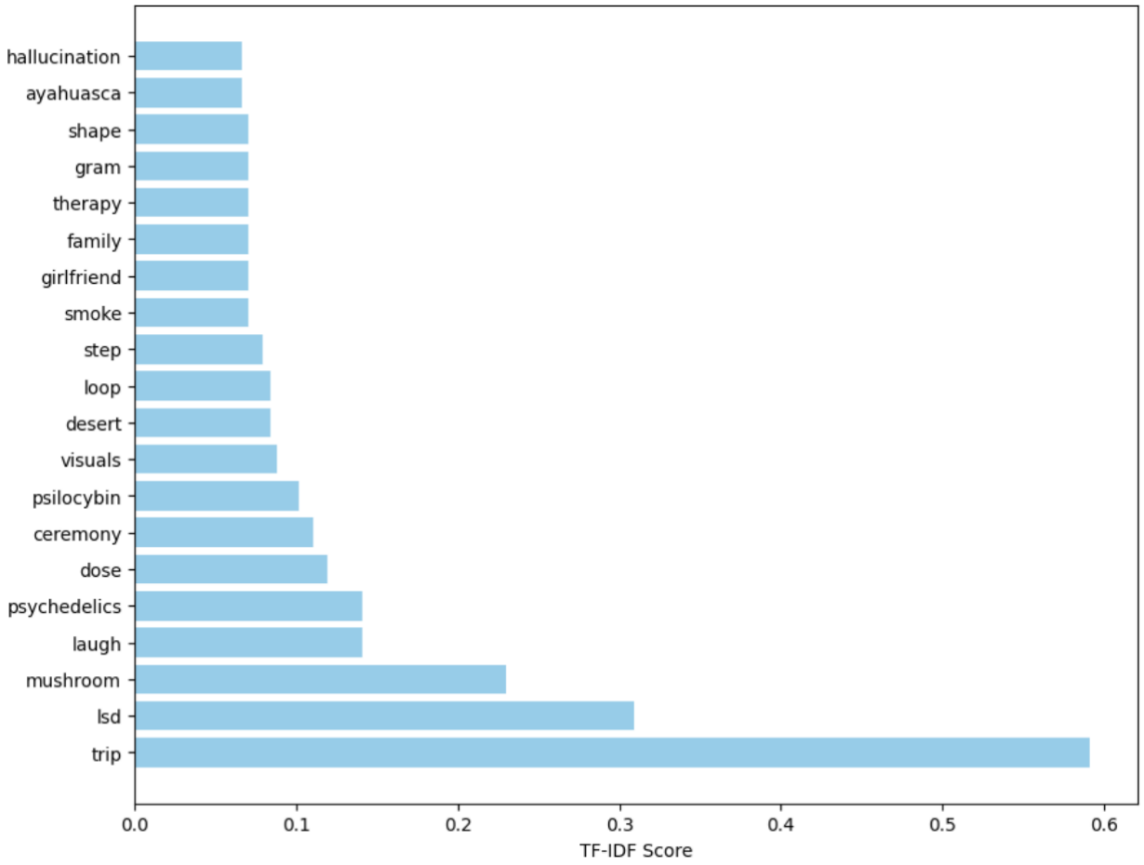
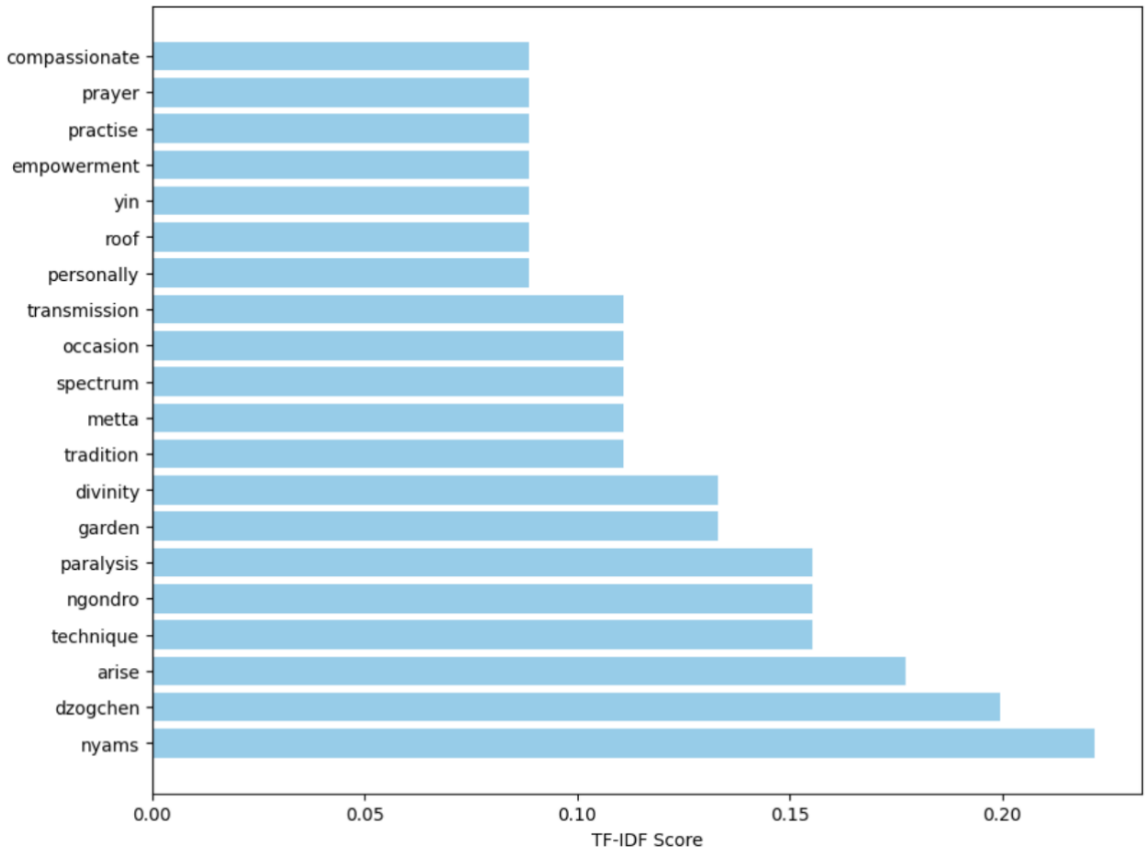


Figure 7. Meditation group top 20 words with the greatest TF-IDF scores



The TF-IDF analysis highlighted 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”) and social context ("family" and "girlfriend") were present as well. For the meditation group, words specific to meditation practices and traditions were highlighted, including "nyams", "dzogchen", "ngondro" and "metta". Words related to spiritual concepts ("divinity", "compassionate") and practice settings (“garden”, “roof”) were also notable.

3.2 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 the Figures 8 and 9. The most important words were chosen according to descending β, the probability of a word contributing to the given topic. Also, the average topic contributions (γ) are presented in the tables. 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.

Figure 8. Psychedelic group topics ordered by average topic contribution along with their most important words.

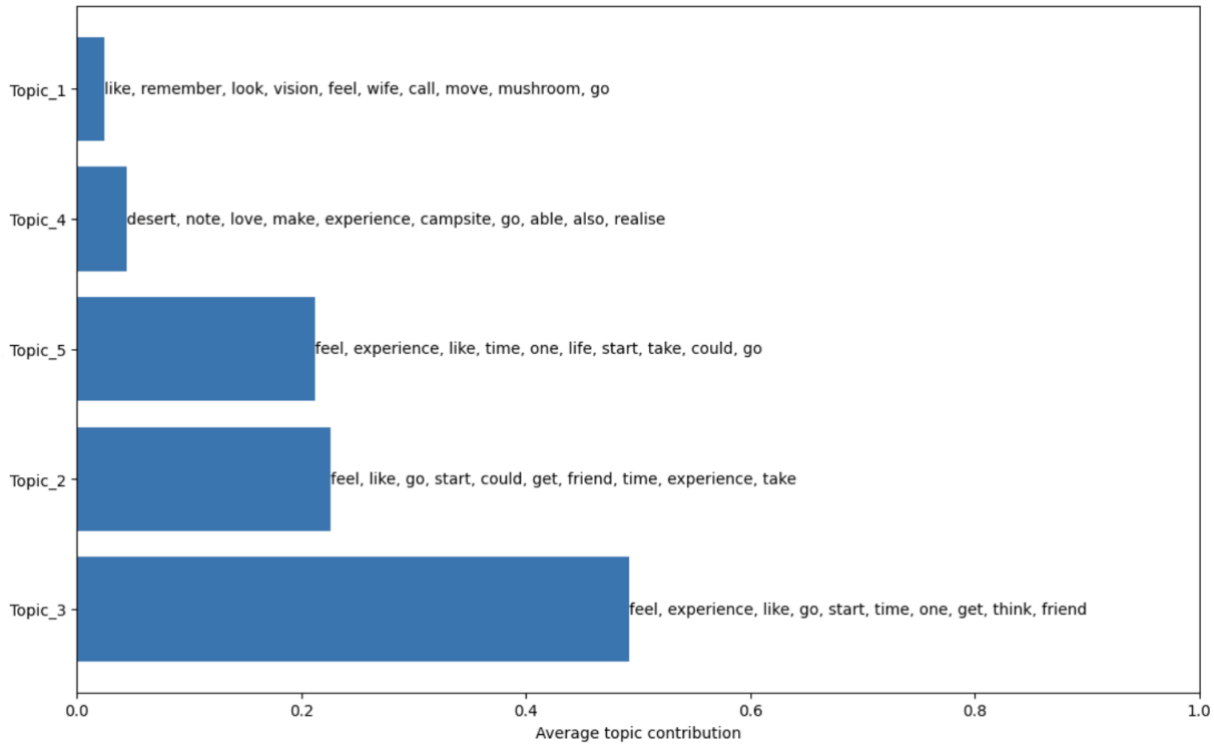
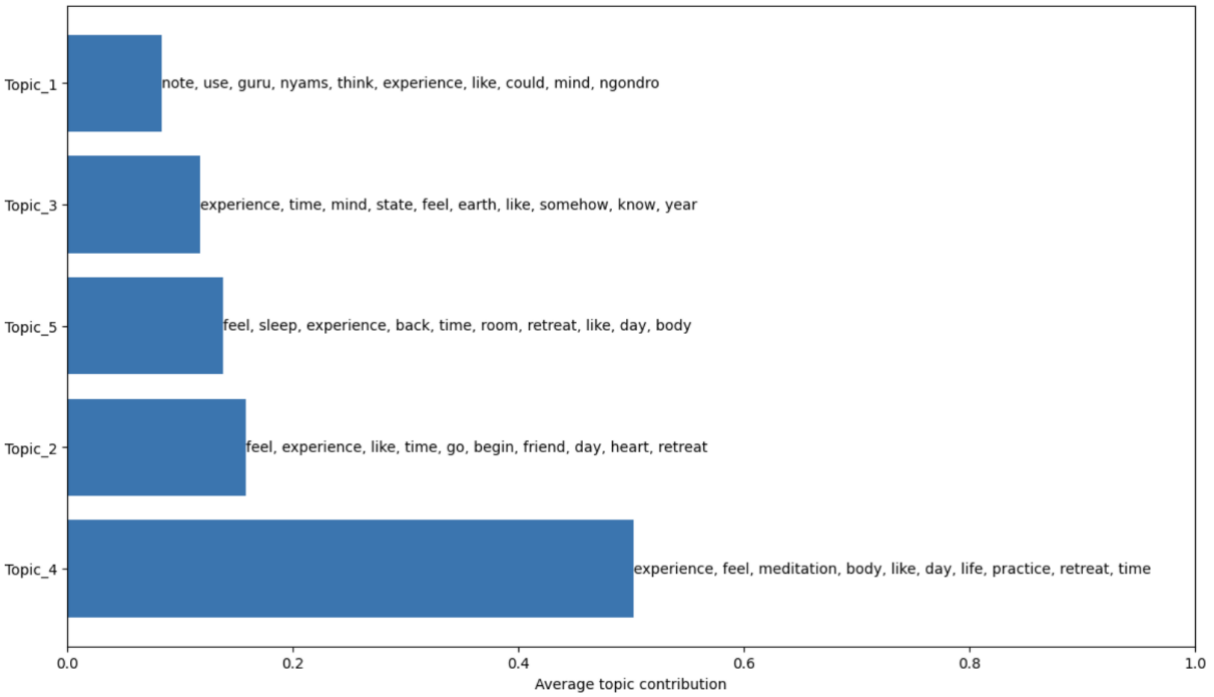


Figure 9. Meditation group topics ordered by descending average topic contribution along with their most important words.

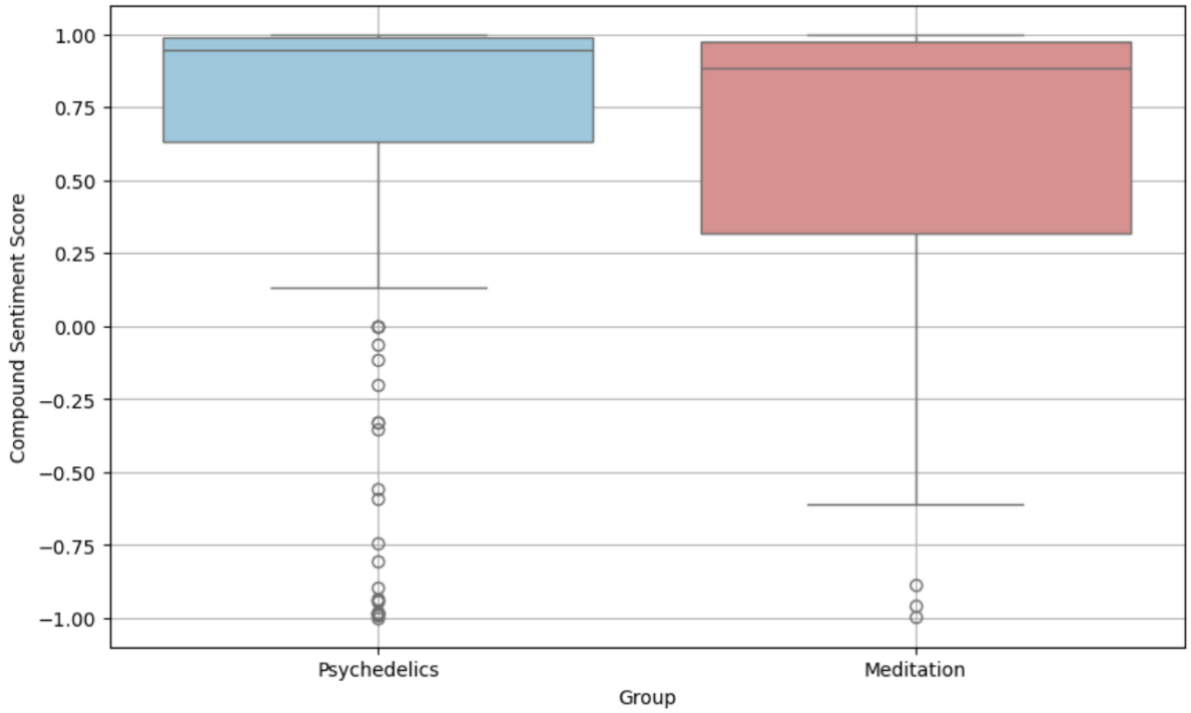


In the psychedelic group, the most contributing topic (Topic #3) included words related to feelings, experiences, time, and social interactions. Other topics encompassed various aspects of the psychedelic experience, including visual perceptions, emotions, and actions. For the meditation group, the highest contributing topic (Topic #4) contained words associated with the meditation experience, bodily sensations, and practice settings. Other topics reflected various elements of meditation practice, including mental states, time-related concepts, and specific meditation techniques.

3.3 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, while the compound score is a normalized, 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 the Figure 10.

Figure 10. Box plots of compound sentiment scores for both groups.



The sentiment scores were not normally distributed, so I used the Mann-Whitney U test to compare the distribution of sentiments across the groups. The results are shown in Table 3 below. False discovery rate (FDR) was controlled due to multiple comparisons, following the procedure recommended by Benjamini & Hochberg (1995). FDR was set to 0.05 and an online calculator at https://tools.carbocation.com/FDR was used to calculate the adjusted p-values. The analysis revealed some statistically significant differences in the sentiment scores between the psychedelic and meditation groups.

Table 5. Sentiment scores between groups

Sentiment Type	Psychedelics Mean (SD)	Meditation Mean (SD)	Mean Difference	U-Statistic	Initial P-value	Adjusted P-value	Effect size (r)
Compound	0.64 (0.6)	0.55 (0.58)	0.09	5184	.074	.074	0.126
Positive	0.15 (0.08)	0.13 (0.08)	0.02	5371	.023*	.031*	0.159
Negative	0.07 (0.05)	0.06 (0.07)	0.01	5594.5	.004*	.016*	0.199
Neutral	0.78 (0.09)	0.81 (0.09)	-0.03	3525.5	.014*	.028*	-0.172

The psychedelic group showed slightly higher presence of negative sentiments than the meditation group (psychedelics: M = 0.07, SD = 0.05; meditation: M = 0.06, SD = 0.07), and the difference remained significant even after correcting for multiple comparisons (U = 5594.5, $p < .01$, corrected $p < .05$, r = 0.199). 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 the Benjamini-Hochberg correction (U = 5371.0, $p < .05$, corrected $p < .05$, r = 0.159). On the other hand, quite logically, the meditation group showed a higher tendency toward neutral sentiments (M = 0.81, SD = 0.09) compared to the psychedelics group (M = 0.78, SD = 0.09); difference remaining significant after correcting for multiple comparisons (U = 3525.5, $p < .05$, corrected $p < .05$, r = -0.172). There was no significant difference in the compound sentiment scores between the groups (U = 5184.0, p = .074, r = 0.126).

4 Discussion

The purpose of this study was to analyse the similarities and differences between reports of personally meaningful psychedelic and meditation experiences. Narrative open-ended reports were collected about participants' most meaningful psychedelic and meditation experiences and analysed with Natural Language Processing (NLP) methods. In this way, I was able to compare the subjective experiences and evaluate the use of NLP methods in this context.

4.1 Frequency analyses

The results from the frequency analyses provide some evidence for the similarity of the narrative reports in the two groups. 28.12% of the unique words present in the reports were shared across the two groups and half of the most common 20 words were the same in both groups. Also, the fact that no statistically significant differences were found between the word frequency distributions speaks for the similarity of these experiences.

The most common bigrams and TF-IDF analysis provide qualitative support for the similarity of the groups. When it comes to bigrams, "felt like" was the most common in both psychedelic and meditation groups, which suggests a shared emphasis on subjective experiences and altered perceptions. TF-IDF analysis emphasises the differences between the groups by finding distinct words in both corpora. The results show that the differences were mostly trivial: TF-IDF highlighted names of substances and dosage in the psychedelic group, whereas meditation group included many words which are relevant only for the practitioners of a certain school of meditation, such as "nyams", "dzogchen" and "ngondro". These differing words tell more about the setting of the experience, rather than the actual phenomenological content.

This apparent similarity across the groups might be partially related to the formulation of the question in the survey – participants were asked to write about their most meaningful "experience", and this could have primed them to use the same word in both groups. However, the words "feel", and "time" suggest that participants in both groups have meaningful memories about the emotional and temporal aspects of their experiences. The most common bigram in both groups, "felt like", supports the focus on emotional content of the experience. These findings are consistent with earlier research which has shown that both psychedelics and meditation affect emotional processing (Vollenweider & Preller, 2020;

Sedlmeier et al., 2012) and perception of time (Wackermann et al., 2008; Berkovich-Ohana et al., 2013).

However, a qualitative outlook on the frequency analyses reveals also some differences between the experiences. One of the most interesting findings is that psychedelics seemed to be more social and more often shared with other people. The word “friend” was among the most common words in the psychedelics group, but not in the meditation group. Also, the words “family” and “girlfriend” were highlighted by the TF-IDF analysis to be present only in psychedelic reports. Psychedelics have been shown to affect social processing and even increase prosocial behaviour (Carhart-Harris & Friston, 2019), so it’s logical that people who are close to the participants (such as friends and family), are mentioned in the narrative reports. On the other hand, these words might appear in the reports due to the setting of the experience. Almost 80% of the participants in the psychedelic group had had their experience in the company of other people, most often with one other person. Meditation reports indicated that majority of the experiences (52%) took place on a meditation retreat, but the experiences themselves seemed to be less social than with psychedelics – around half of the experiences had happened alone. This is quite natural as the very nature of meditation is quite self-centred: the practitioners often observe their own thoughts, breathing and other bodily sensations.

4.2 Topic modeling with LDA

Latent Dirichlet Allocation (LDA) can be helpful method for summarising long pieces of text into a few topics that are often understandable for human readers, and it has been shown to perform better than other topic models in human evaluation (Chang et al., 2009). The method can help the reader to immediately understand what some text is about just by examining the leading words of the topics outputted by the algorithm. This provides speed and consistency for analysing large datasets of text. However, this is only true if the resulting topics form distinct themes that make sense to the human reader. While it's common for human evaluators to name the resulting topics, in this case, the topics didn't map into clear and distinct themes, making such naming challenging and potentially less informative. Essentially, this means that the LDA topic modeling failed in its purpose to provide a clear and easily interpretable summary of the text data.

We can see from the results of both groups that the three topics with the highest average contributions to the documents (narrative reports), mainly consist of the same most important

words, only in different order. The most important words are words which are the most likely to contribute to a given topic (Figures 8-9). The topics 3, 2 and 5 about psychedelic reports seem to highlight the same emotional, temporal and social themes as the frequency analyses. Also, the highest contributing topics (4, 2 and 5) about the meditation reports seem to emphasise the temporal and emotional aspects of the experiences just like the frequency analyses did. This raises the question whether the topic modeling brings any added value to the frequency analyses in this case, especially when the topics don't seem to represent distinct themes which would be easy to interpret for humans.

Qiu & Minda (2021) compared experiences between four different substances (DMT, psilocybin, LSD & MDMA) by creating topic models out of narrative trip reports found online. Even though they grouped the psychedelic experiences by the substance, they found some similar results in that trip experiences seemed to contain words about the social and emotional aspects of the trip, such as "friend" and "feeling". Consistently with the current study, all the topic models in Qiu & Minda (2021) included some aspect of the setting where the experience had happened. The resulting topic models provide some help for understanding the differences between psychedelic reports across substances, but also in their case, the topics didn't form clear and distinct themes that could be named or interpreted well by human readers. The authors didn't report the word frequencies, so it remains an open question whether word frequency analyses could have communicated the same differences between different psychedelic substances. In any case, it seems that LDA may be less effective in analysing psychedelic and meditation reports compared to its application to more conventional texts.

4.3 Frequency analyses and LDA in contrast to MEQ scores

The fact that topic modeling didn't give very meaningful results might be due to the nature of the psychedelic and meditation experiences. Both can bring about so-called "mystical" states (Griffiths et al., 2006; Millière et al., 2018), which are by definition ineffable at least to some extent (Barrett et al., 2015), and therefore difficult to interpret. In fact, 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. These scores are considered high because a "complete mystical experience" has previously been defined as scoring at least 60% of the maximum on at least six out of the seven subfactors of the MEQ43, a previous version of this Mystical Experience Questionnaire (Griffiths et al., 2006). In this study, a newer and more

refined version of the MEQ was used, namely MEQ30 developed by Barrett and colleagues (2015). This questionnaire has four subfactors instead of seven and the maximum total score is 150, which means that both groups exceed the 60% threshold on the total scores. Only the MEQ30-total scores were included in this study, because they have been shown to predict the MEQ subfactors (Barrett et al., 2015). Regardless of whether the experiences in the sample meet the criteria for "completely mystical," these high total scores indicate that participants in both groups had significant mystical experiences. The similarity in these scores between the groups aligns with the results from frequency analyses and topic modeling which didn't suggest major differences between the groups.

4.4 Sentiment analysis

In contrast to the more descriptive frequency analyses and LDA, sentiment analysis provides simple numerical results which enable easier comparisons between psychedelic and meditation groups. Before examining the differences in some sentiment scores, it's good to note that both psychedelic and meditation experiences were on average very positive (see Figure 10). Average compound sentiment scores were slightly higher among the psychedelic group, but the difference wasn't quite on statistically significant level ($p = .074$). When it comes to differences, psychedelic experiences tended to be more emotional in general. Positive and negative sentiment scores were higher in the psychedelic reports, whereas neutral sentiments were more common in the meditation group. The effect sizes of these differences were small, but the higher emotionality with psychedelics is consistent with previous research where at least LSD has been shown to increase emotional lability, but with a bias toward positive emotions (Carhart-Harris et al., 2016). On the other hand, meditation has been shown to acutely increase positive affect (Harte et al., 1995; Johnson et al., 2015), but the similar effects on emotional lability are not reported in the current literature. Carhart-Harris et al., (2016) speculate that the emotional lability in the psychedelic experience might be explained by increased cognitive entropy in the brain caused by the psychedelic substance. Even though the sample size was relatively small, and the emotional content of the experience was measured indirectly with sentiment analysis, the difference in emotionality might be interesting to explore in future studies, given that the higher emotionality during psychedelic experiences has been shown to predict positive well-being changes (Roseman et al., 2019). The difference in the emotional intensity of the experiences seems to be at least one key difference between psychedelics and meditation, which is an interesting hypothesis for more structured studies in the future.

It's important to note, that even though psychedelic experiences are generally evaluated positively, the substances can also lead to experiences which are perceived as very negative. Figure 10 shows that there were quite a few outliers where reported experiences showed extremely high negative sentiments. As Qiu & Minda (2021) also note, the clinical studies on psychedelics aim to minimise the negative experiences with careful screening and designing optimal environments for the drug intake. Therefore, the more extreme negative experiences might be more prevalent in the naturalistic setting where people don't pay so much attention to these factors. However, there might be long-term positive outcomes on well-being, even if the experience itself would have contained feelings of anxiety and fear (Griffiths et al., 2006).

4.5 Results in theoretical context

The current results – high similarity in the general content of the narrative reports, but differences in the emotionality – are quite aligned with the two predictive coding theories about psychedelics (Carhart-Harris & Friston, 2019) and meditation (Laukkonen & Slagter, 2021). 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 (Carhart-Harris & Friston, 2019) suggests that the relaxation of top-down constraints in brain processing allows for more varied and intense emotional experiences. On the other hand, Laukkonen & Slagter (2021) 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.

The current results are also in contradiction with some theoretical notions about transformative experiences with psychedelics and meditation. According to (Millière et al., 2018), both psychedelics and meditation can disrupt the brain processes related to self-consciousness, potentially leading to experiences of self-loss or ego dissolution. The changes in self-consciousness in psychedelic and meditative states are also emphasized in the afore-mentioned predictive coding models about these states (Carhart-Harris & Friston, 2019; Laukkonen & Slagter, 2021). Therefore, it's interesting to notice that according to the present NLP analyses, these changes in self-consciousness are not emphasized at all in the reports.

However, the current results do not provide strong evidence for rejecting these theories, because the NLP analyses might be limited in their capability of recognising such experiences. Experiences of self-loss could be described using diverse vocabulary and metaphors that may not be captured by the present NLP analyses. Additionally, the sample size of this study is relatively small, and there were several limitations in the study design, which means that these results may not generalise to the wider population.

4.6 Limitations

This study has several limitations that impact the interpretation of its findings. Firstly, the use of a convenience sample from survey data introduces a potential self-selection bias, as it may disproportionately represent individuals with a pre-existing interest in psychedelics, including those willing to use these substances illegally. This bias could skew the data toward more favourable or extreme views on the effects of psychedelics. Additionally, the majority of participants in the meditation group were experienced practitioners (Table 1), which might not reflect the experiences of novice meditators or the general population.

The nature of the collected dataset and the study design pose many challenges for drawing strong conclusions from the analyses. The psychedelic and meditation groups were quite different in terms of their size and demographic factors (see Tables 1-2). The dataset was collected retrospectively with the independent samples design. This means that many potential confounding factors couldn't be controlled for and recall bias might be common among the participants. They might not accurately remember their experiences at the time of reporting or interpret the experiences in the light of their current knowledge and beliefs, further distorting their reports. Moreover, the small sample size, especially in the meditation group, may amplify the impact of outliers and reduce the statistical robustness of the findings.

In addition to the matching problems, lack of standardisation within the groups poses challenges for interpreting the data. Psychedelic group included experiences induced with wide variety of substances and also 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 (Breeksema et al., 2020; Chirico et al., 2022; Vollenweider & Kometer, 2010), it would be optimal to have data where the groups were more homogeneous. This would reduce confounding factors and strengthen the reliability of comparisons between groups. One potentially valid approach for the future would be to only include experiences from classical

psychedelics (serotonin 5-HT2A agonists) in the psychedelic group. This class contains different substances with unique mechanisms of action as well, but at least the resulting experiences have been proven to be so similar that even experienced users cannot tell the difference between them (Wolbach et al., 1962).

However, despite these challenges, the systematic survey used in this study provide a significant improvement over less structured data sources like Erowid trip reports which have been previously used for gathering information about psychedelic experiences (Tagliazucchi, 2021; Qiu & Minda, 2021). Gathering data directly from internet forums has many disadvantages, such as lack of demographic data, unreliable answers or even the use of bots. Compared to this approach, the current survey ensures that all participants are responding to the same prompts, reducing variability in the answers. Bot answers were not explicitly controlled in this study, but they are deemed highly unlikely due to lack of incentives – study participants did not receive any rewards for completing the survey and it would still require considerable effort to answer the survey with bots.

To summarise, this study faced several limitations, including self-selection bias, demographic differences between groups, retrospective data collection, and lack of standardization within groups. These factors challenge the interpretation of the results and limit generalizability. Future studies could benefit from larger, more homogeneous samples and more controlled designs to better analyse these complex experiences.

5 Conclusions

This study utilised Natural Language Processing (NLP) for comparing personally meaningful experiences facilitated by psychedelics or meditation. There was substantial overlap in the most common words used by participants and no statistical differences could be found between the word distributions nor in the MEQ scores across the groups. Both experiences expressed highly positive sentiments on average. However, psychedelic experiences were more emotionally charged, showing higher positive and negative sentiments, while meditation reports were more neutral. Additionally, psychedelic experiences were more socially oriented, often mentioning social contexts and relationships, unlike the more solitary and introspective meditation experiences.

The study noted challenges in the applicability of these NLP methods in this context. The LDA topic models did not produce distinct themes that would increase our understanding of the reports. In addition, many results from the NLP analysis turned out to be rather descriptive and it was difficult to make firm conclusions based on them. It can be argued that analysing narrative reports with NLP methods such as sentiment analysis can be useful in this context as well, but they should be combined with other analysis methods, such as structured psychometrically valid questionnaires about different aspects of the experiences.

There were limitations in the study design which limit the ability to draw definitive conclusions from the data, but this study provides nevertheless a good starting point for future research on this topic. Future studies should aim for larger, matched samples while minimizing within-group differences by standardizing substances and meditation techniques. NLP methods could be used for complementary analysis alongside structured questionnaires, combining quantitative and qualitative data for a more comprehensive understanding of these complex experiences.

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Appendices

Appendix 1. GitHub repository with all the code used in the present analyses

GitHub repository containing the Jupyter Notebook used for the present analyses can be found from: https://github.com/konstakm/psychedelics_vs_meditation_nlp.

Appendix 2. Statement on the use of generative AI

Large language models GPT4 and Claude 3.5 Sonnet were used in the process of writing this paper. More specifically, they were used for writing and reviewing code, summarising articles and providing suggestions. The model outputs were always reviewed by the author.