

Red-Light Multimodal Ganzfeld Elicits Equivalent Complex Imagery to Moderate-Dose Psilocybin: A Cross Study Comparison

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Background & Research Question

Altered States of Consciousness (ASCs)

- Multidimensional shifts in waking subjective experience (Ludwig, 1966; Fort et al., 2025).

ASC Classification

- Induction-domain classification schemes distinguish **pharmacological vs. non-pharmacological** induction methods (Vaitl et al., 2005; Fort et al., 2025).

Core Question

- Pharmacological ASCs are often assumed as **more intense**, yet both types may share a **common phenomenological structure** (Dittrich, 1998; Fort et al., 2025).
- *How comparable are the experiences generally elicited by a pharmacological vs. non-pharmacological induction method?*

Results

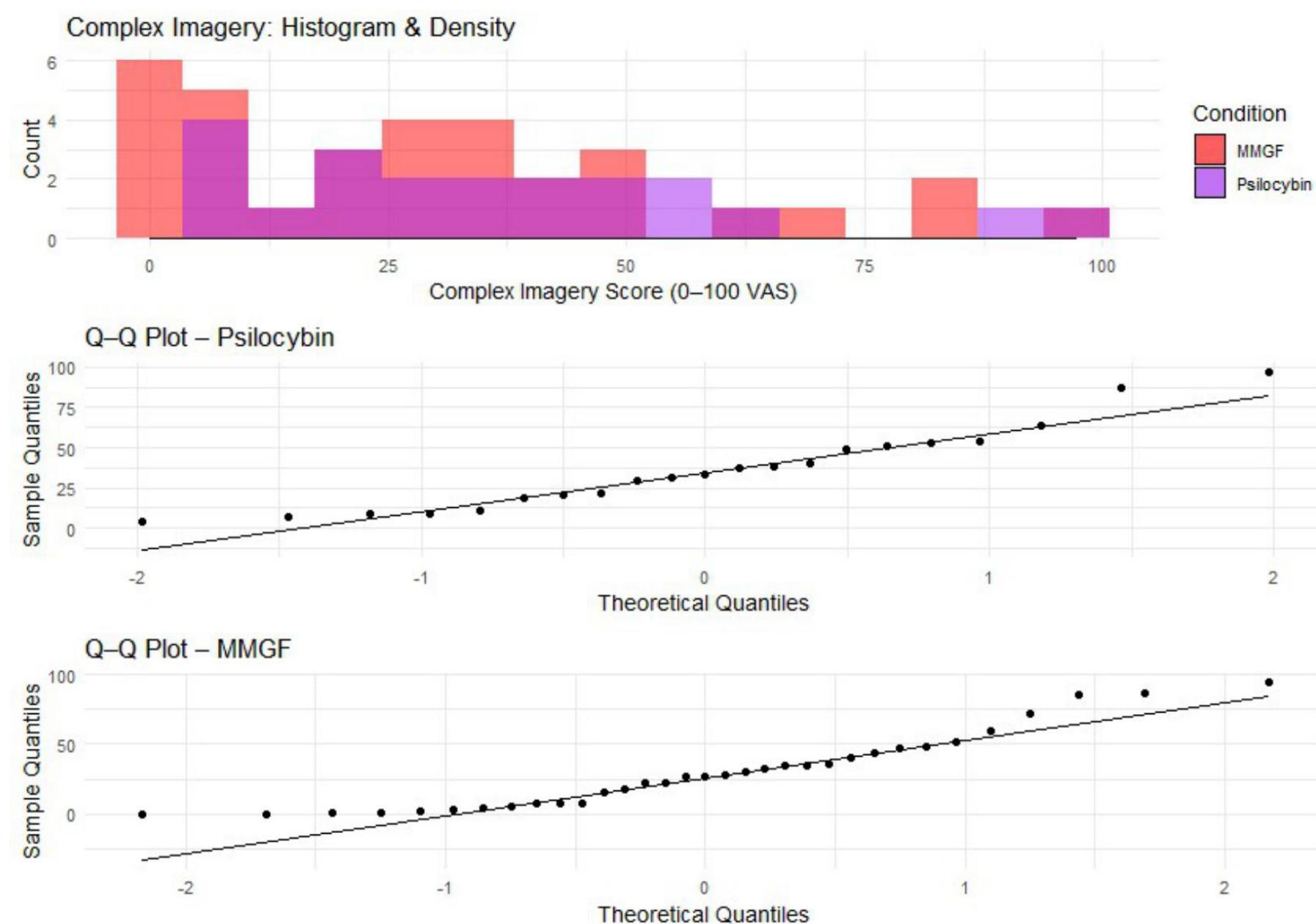


Figure 1. Normality Assessment.

Shapiro-Wilk tests indicated that **Psilocybin scores did not significantly deviate from normality** ($W = 0.93, p = .13$), while **MMGF scores showed a significant deviation from normality** ($W = 0.90, p = .006$). This violation of normality assumptions supports the use of **nonparametric methods**.

Variable	Statistic (W)	p FDR	Cliff's Delta (δ)
General Altered State Score (G-ASC)	137	.001***	-0.605
Oceanic Boundlessness	111	<.001***	-0.68
Dread of Ego Dissolution	279	.307	-0.195
Visionary Restructuralization	108.5	<.001***	-0.687
Auditory Alterations	293.5	.427	-0.153
Vigilance Reduction	390.5	.440	0.127
Experience of Unity	177.5	.005**	-0.488
Spiritual Experience	197.5	.014*	-0.43
Blissful State	138.5	.001***	-0.6
Insightfulness	153	.001***	-0.558
Disembodiment	296.5	.430	-0.144
Impaired Control and Cognition	301.5	.440	-0.13
Anxiety	248.5	.129	-0.283
Complex Imagery	277.5	.307	-0.199
Elementary Imagery	167	.003**	-0.518
Audio-Visual Synesthesia	70	<.001***	-0.798
Changed Meaning of Percepts	78	<.001***	-0.775

Table 1. Mann-Whitney U NHST Results.

Moderate-dose **psilocybin** induced **significantly more intense experiences** overall (G-ASC) particularly in **Oceanic Boundlessness** and **Visionary Restructuralization** dimensions. Several factors (e.g., **Experience of Unity**, **Spiritual Experience**, **Blissful State**, and **Elementary Imagery**) also showed **significantly higher scores** under psilocybin. Differences could **not be found** (supplemented with **small effect sizes**) in some dimensions (e.g., **Dread of Ego Dissolution**) and factors (e.g., **Complex Imagery**).

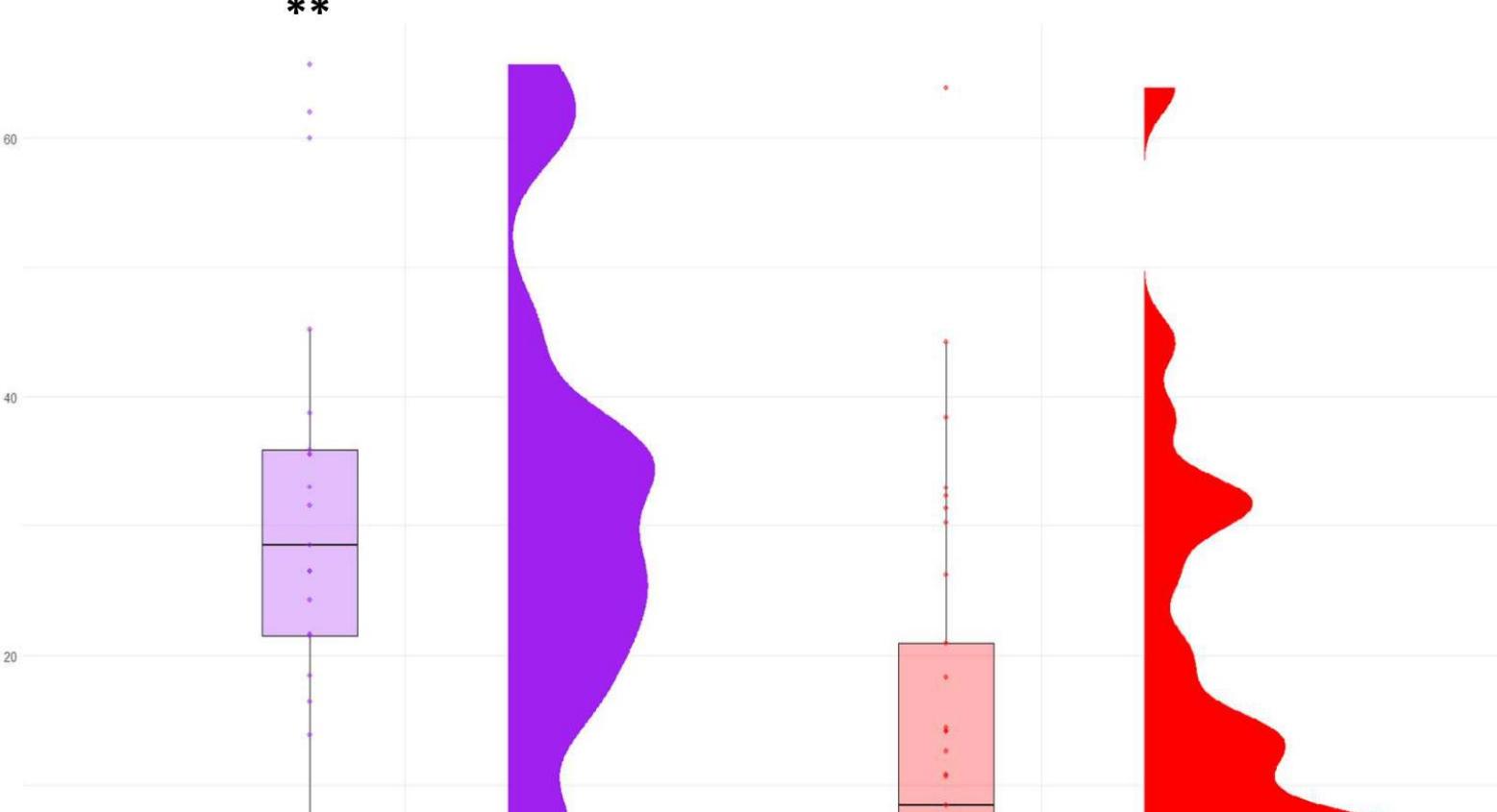


Figure 2. G-ASC Raincloud Plots. Psilocybin (purple) compared to MMGF (red). ** = $p < 0.01$.

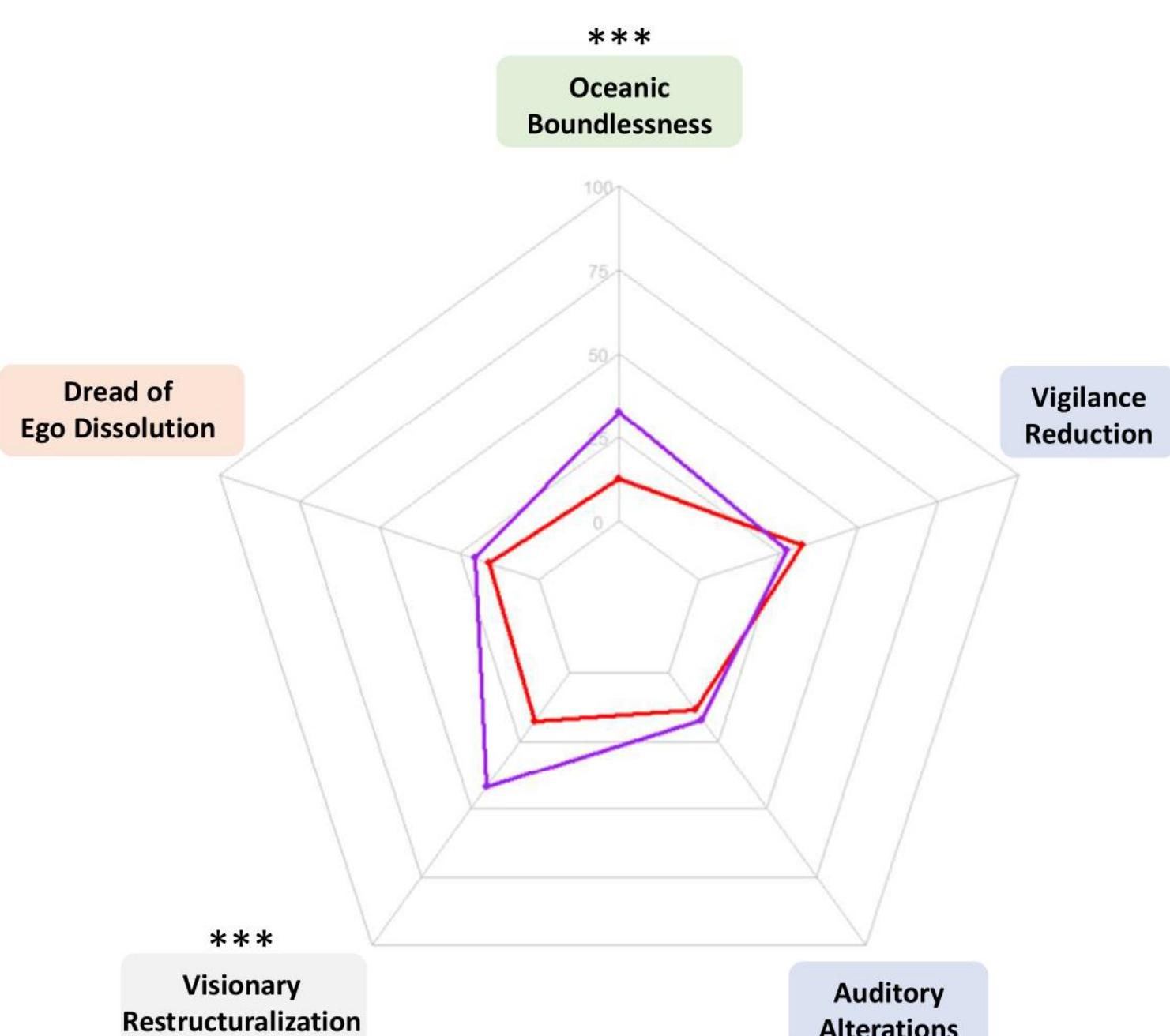


Figure 3. Radar Plot using Dimension Score means. Psilocybin (purple) compared to MMGF (red). * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

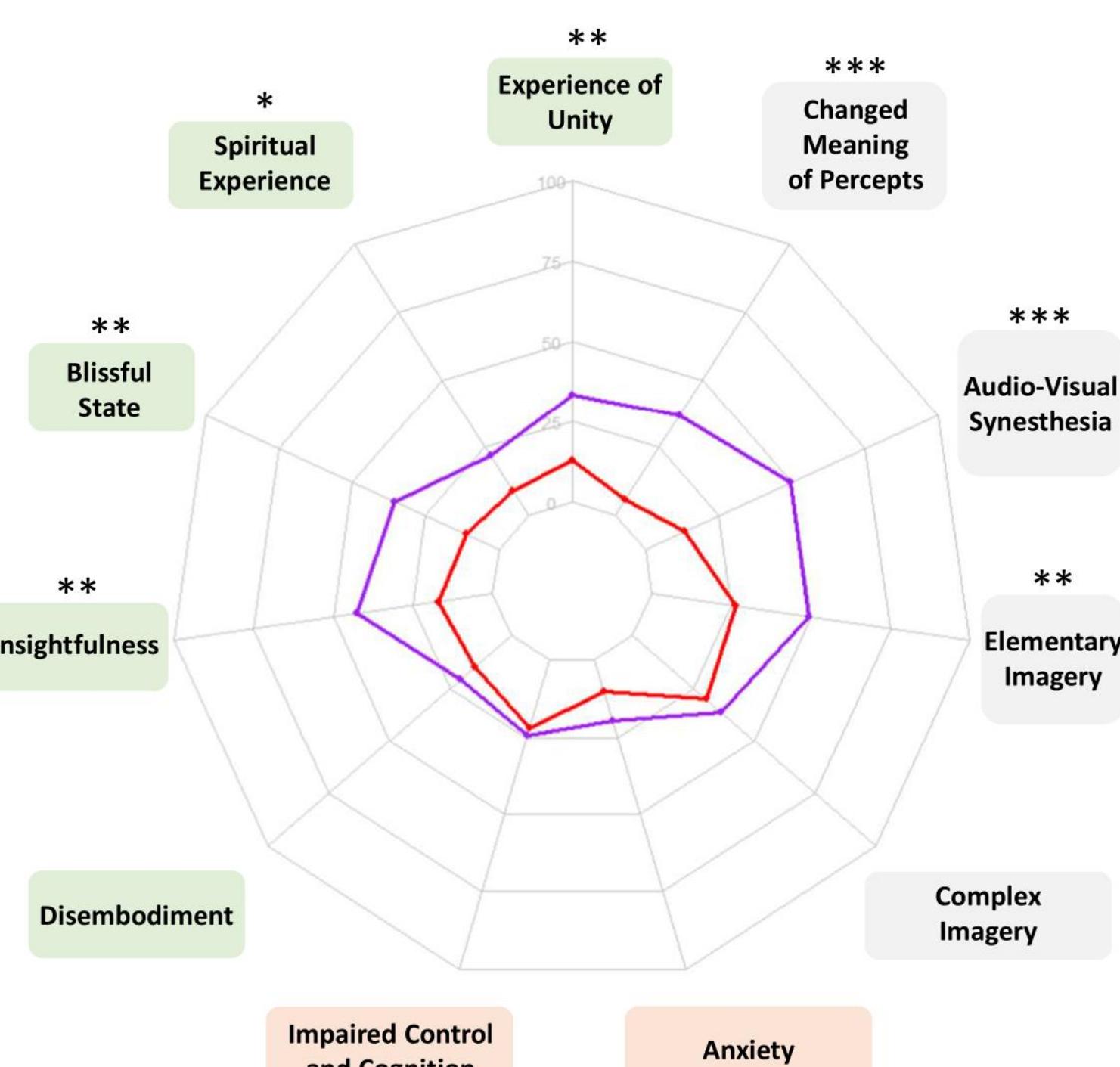


Figure 4. Radar Plot using Factor Score means. Psilocybin (purple) compared to MMGF (red). *** = $p < 0.001$

Conclusion

- Moderate-dose **psilocybin** induces a more intense ASC than **red-light/white noise MMGF**.
- Of interest, are the **non-significant p-values** and **small effect sizes** associated with the factors of **Impaired Control and Cognition**, **Disembodiment**, **Anxiety**, and **Complex Imagery**.
- Nonparametric equivalence testing (Meier, 2010) suggests **phenomenological equivalence** between them in **Complex Imagery**.
- MMGF offers a viable method to investigate the neural correlates of hallucinatory phenomena, suggesting the importance of factors such as **Complex Imagery** (Schmidt, 2020).
- Complex Imagery** is of interest as it may have **therapeutic potential**, possibly confronting unconscious material (Singer, 1971).
 - MMGF could hold **clinical value** as both a **standalone induction** or in **combination with serotonergic psychedelics** (e.g., psilocybin).
- The **cross-domain compatibility** of these states support developing **hybrid-induction ASCs** to engineer clinically relevant dimensions of experience.
- Future studies are needed** to directly compare MMGF and psilocybin **under matched conditions** to confirm the present findings.

Datasets

Psilocybin (n = 21)

- 0.17 mg/kg Psilocybin (UMaastricht MRI; Mason et al., 2020; Mortahab & Fort et al., 2024).
- 5D-ASC completed **360 min post-dose**
- Double-blind protocol**

MMGF (n = 33)

- Red Light/White Noise Multi-Modal Ganzfeld reclined in bed (Uliège)
- 5D-ASC + free association interview **after 25 min induction** (order randomized)
- Deception-based blinding**

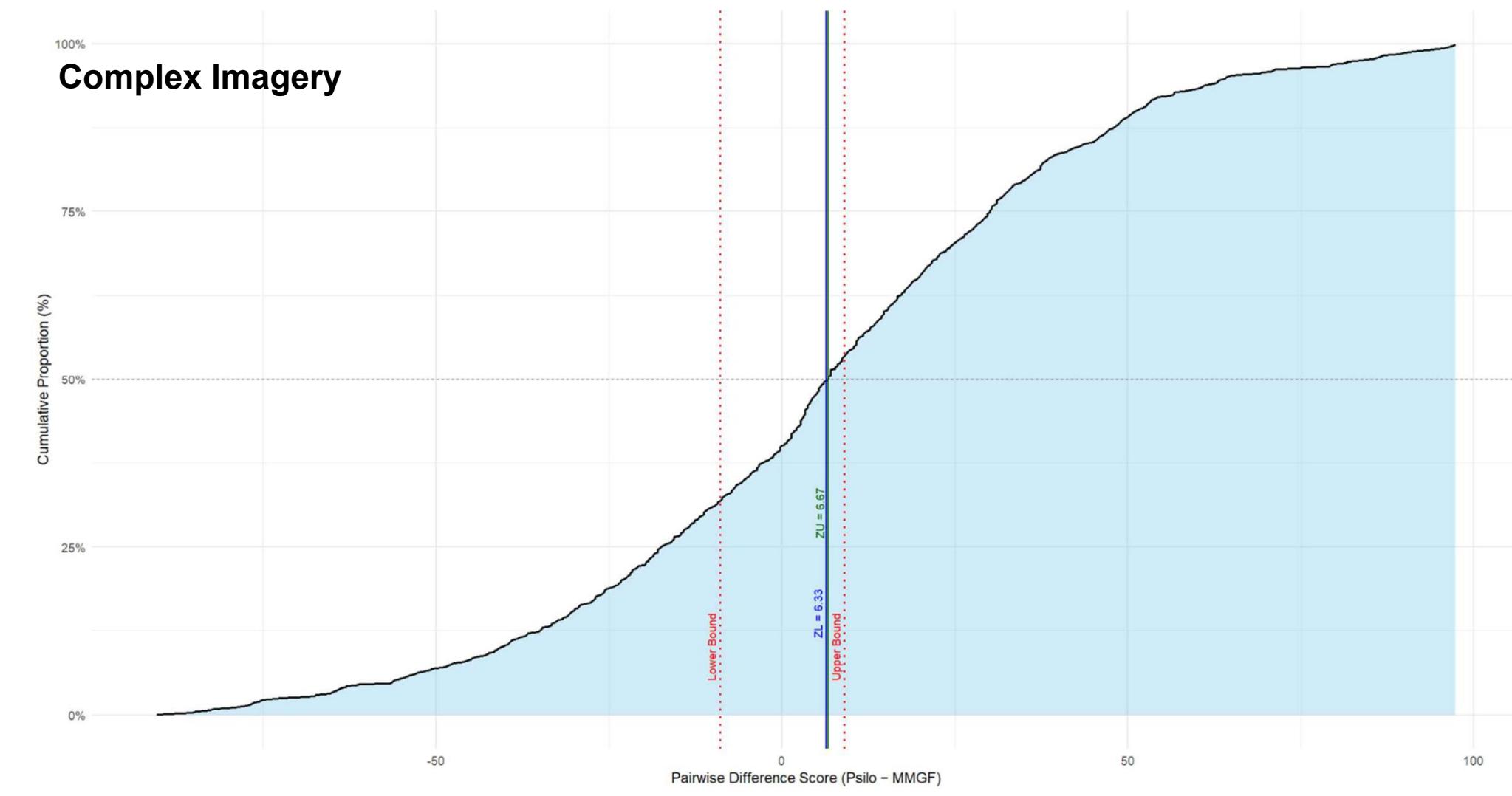


Figure 5. Non-Parametric Equivalence Test (Meier, 2010) on Complex Imagery.

1. Pairwise Differences

- 21×33 MMGF = 693 differences (Psilo – MMGF, 0-100 VAS ON 5D-ASC).

2. Empirical Cumulative Distribution Frequency

- X-axis = difference score; Y-axis equals cumulative % of comparisons.
- 50% line gives the **plausible median range** ($ZL = 6.33$, $ZU = 6.67$).

3. Equivalence bounds (SESOI raw score)

- A single step on the **Hallucination Rating Scale (HRS, 0-4; Strassman, 2005)** spans ≈ 25 VAS points (5D-ASC).
- $\pm 9 = < 1/4$ HRS category → too small to be **phenomenologically noticed**.

- **Conservative domain-based margin**. Reasoned to be **minimal point shift**.

4. Decision

- Entire median range lies within ± 9 = **phenomenological equivalence**.
- Supports NHST metrics (Mann-Whitney $p = .207$, Cliff's $\delta = -0.20$).

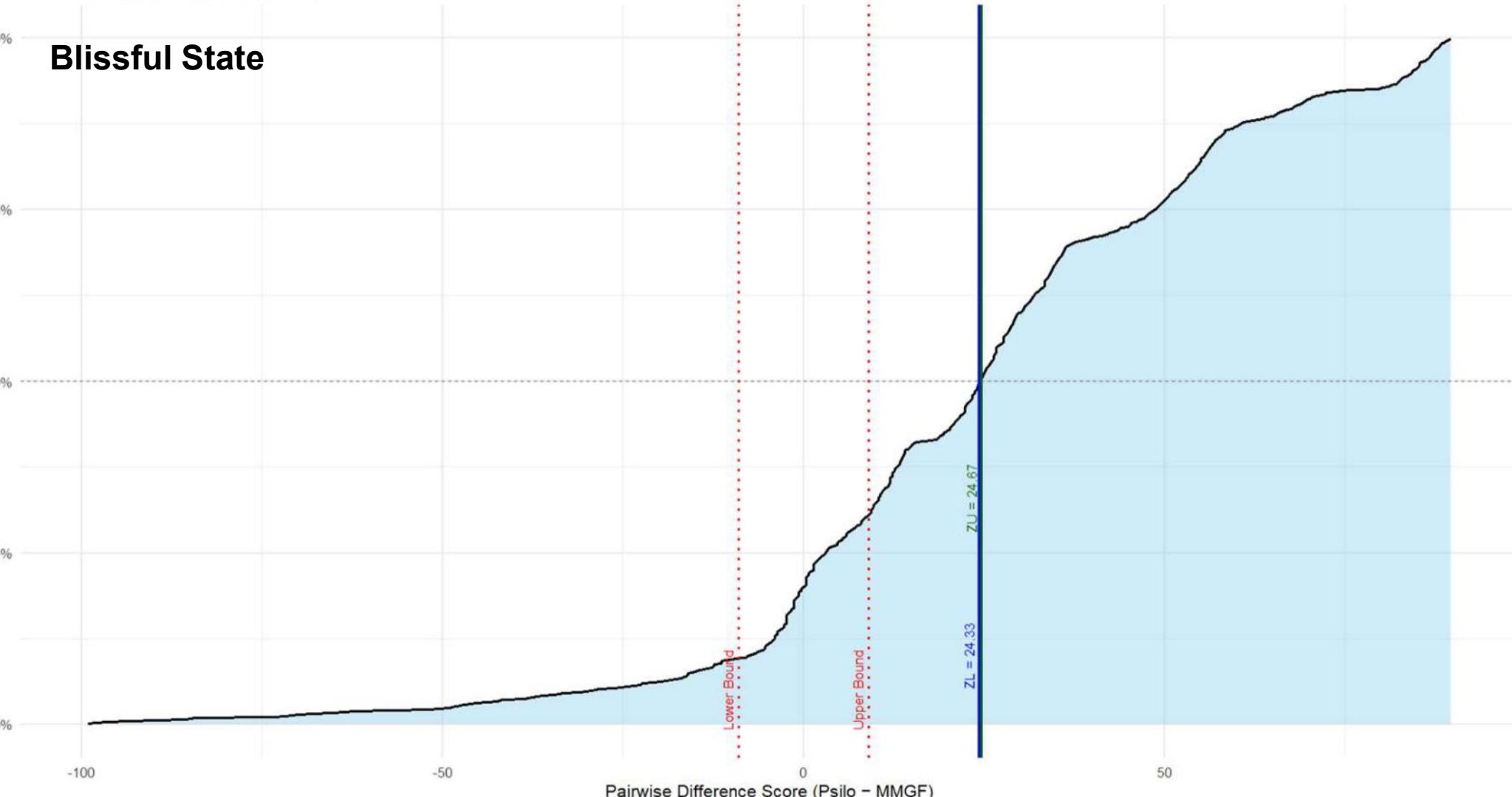


Figure 6. Non-Parametric Equivalence Test (Meier, 2010) on Blissful State.

1. Proof of Concept

- Test on factor where we do not expect equivalence.
- **Plausible median range** ($ZL = 24.33$, $ZU = 24.67$).

2. Equivalence bounds (SESOI raw score)

- ± 9 maintained

3. Decision

- Entire median range lies outside ± 9 = **no phenomenological equivalence**.
- Supports NHST metrics (Mann-Whitney $p = .001$, Cliff's $\delta = -0.6$).

References

- Dittrich, A. (1998). The Standardized Psychometric Assessment of Altered States of Consciousness (ASCs) in Humans. *Pharmacopsychiatry*, 31(S 2), Article S 2. <https://doi.org/10.1055/s-2007-979351>
- Fort, L. D., Costines, C., Wittmann, M., Demertzis, A., & Schmidt, T. T. (2025). Classification schemes of altered states of consciousness. *Neuroscience & Biobehavioral Reviews*, 175, 106178. <https://doi.org/10.1016/j.neurobrrev.2025.106178>
- Ludwig, A. M. (1966). Altered States of Consciousness. *Archives of General Psychiatry*, 15(3), Article 3. <https://doi.org/10.1001/archpsyc.1966.01730150001001>
- Mason, N. L., Kuyper, K. P. C., Müller, F., Reckweg, J., Tse, D. H. Y., Toennes, S. W., Hutton, N. R. P. W., Jansen, J. F. A., Stiers, P., Feilding, A., & Ramaekers, J. G. (2020). Me, myself, bye: Regional alterations in glutamate and the experience of ego dissolution with psilocybin. *Neuropsychopharmacology*, 45(12), Article 12. <https://doi.org/10.1138/s41386-020-0718-8>
- Meier, U. (2010). Nonparametric equivalence testing with respect to the median difference. *Pharmaceutical Statistics*, 9(2), 142–150. <https://doi.org/10.1002/pst.38>
- Mortahab, S., Fort, L. D., Mason, N. L., Mallaroni, P., Ramaekers, J. G., & Demertzis, A. (2024). Dynamic Functional Hyperconnectivity after Psilocybin Intake is Primarily Associated with Oceanic Boundlessness. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*. <https://doi.org/10.1016/j.bpsc.2024.04.001>
- Schmidt, T. T., Jagannathan, N., Ljubjanac, M., Xavier, A., & Niehaus, T. (2020). The multimodal Ganzfeld-induced altered state of consciousness induces decreased thalamo-cortical coupling. *Scientific Reports*, 10(1), Article 1. <https://doi.org/10.1038/s41598-020-75019-3>
- Singer, J. L. (1971). The Vicissitudes of Imagery in Research and Clinical Use. *Contemporary Psychoanalysis*, 7(2), Article 2. <https://doi.org/10.1080/00107530.1971.10745198>
- Strassman, R. (2005). Hallucinogens. In *Mind-altering drugs: The science of subjective experience* (pp. 49–85). Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195165319.003.0003>
- Vaitl, D., Birbaumer, N., Grzelcik, J., Jamieson, G. A., Kotchoubey, B., Kübler, A., Lehmann, D., Miltner, W. H. R., Ott, U., Pütz, P., Sammer, G., Strauch, I., Strehl, U., Wacker, J., & Weiss, T. (2005). Psychobiology of Altered States of Consciousness. *Psychological Bulletin*, 131(1), Article 1. <https://doi.org/10.1037/0033-295X.131.1.98>