

Psychoactive Substance Use and the Relationship to Creativity:  
A Systematic Literature Review

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Master Thesis

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There is no doubt that creativity is the most important human resource of all. Without creativity, there would be no progress, and we would be forever repeating the same patterns.

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De Bono (1992)

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## Introduction

Creativity is a topic that has been researched widely over time. It has been investigated in diverse directions, ranging from development, tourism, culture, or connectionism to innovation (Gurteen, 1998; Richards, 2011; Sawyer, 2003; Smith, 1995; Stein, 1953). However, a certain ambiguity has been associated with defining the concept of creativity. This ambiguity in conceptualizing creativity might stem from the vastly different fields of investigation, among others psychology, cognitive science, artificial intelligence, and philosophy (Colin, 2017; Hennessey & Amabile, 2009; Runco, 2004). This vagueness in defining creativity might also be the result of either its originality of concepts and norms or the subjectivity by which people judge creativity (Colin, 2017; Hennessey & Amabile, 2009; Runco, 2004).

So, how can creativity be defined? According to a more standardised definition provided by Colin (2017), creativity consists of two concepts: effectiveness, which includes the effective problem-solving of a specific issue, and originality, in essence, the ability to come up with novel and original ideas. This is closely related to the notion of creativity being linked to divergent and convergent thinking. In this case, creativity is understood as the distinction and interplay of divergent thinking and convergent thinking (Cropley, 2006; Runco & Acar, 2012). Divergent thinking is defined by Cropley (2020) as thinking that forms new, original, or unanticipated answers. In other words, the ability to investigate various directions of thought, finding as many novel and original solutions to a single problem as possible (Akbari Chermahini & Hommel, 2012; Baer, 1993; Lubart, 2016). Convergent thinking, however, is described as the opposite of divergent thinking. It entails the ability to hone a single idea, one specific solution that fits one individual task rather than many (Akbari Chermahini & Hommel, 2012; Lubart, 2016). Creative individuals blend these various disciplines of thinking (convergent thinking vs. divergent thinking), motivation (intrinsic vs. extrinsic), and feelings (fear of failure vs. thrill) to use creativity in their everyday life (Akbari Chermahini & Hommel, 2012; Cropley, 2020). Moreover, Zhang et al. (2020) define creativity as the ability to come up with novel ideas or products. This includes the expression of creativity through music, literature, visual arts, film, and many other aspects of art in general. Showing that creativity is built through a life-long experience of what one experiences subjectively as visually aesthetic (Morkina, 2019; Zhang et al., 2020). Accordingly, creativity has oftentimes been summarized as an artistic, novel, and original expression.

Keeping in mind the differences in defining creativity by different fields of research

and the ambiguity of the concept of creativity, this systematic literature will interpret creativity as a concept divided into divergent and convergent thinking, and focusing on the production of novel ideas.

Research into creativity examines various layers of the concept. A specific area of interest is the relationship between drugs and creativity. This has previously, been researched in many different areas of science (Berge, 1999; d'Angelo et al., 2017; Kerr, 1991; Krippiwr, 1977; Lapp et al., 1994; Wolf, 2005). Further investigation has revealed that a lot of studies investigating this relationship have found a bidirectional interplay of psychoactive drugs and creativity (Costa, 2022; Iszaj et al., 2018; Iszaj et al., 2017; Iszaj et al., 2018; Krippiwr, 1977; Krippner, 1985; Sessa, 2008).

These psychoactive drugs are defined as chemical substances that change different functionalities of the central nervous system. As a result, changes in mood, cognition, behaviour, and perception take place (Nichols, 2016; Rudgley, 2014). This review wants to focus on the use of psychoactive substances on a recreational basis. Recreational use, in this case, is described as the casual consumption of psychoactive drugs by the population (Anderson, 1998; Morgan et al., 2013; Rudgley, 2014). Psychoactive substances include a wide array of different drugs, such as psilocybin, lysergic acid diethylamide (LSD), cannabis, ayahuasca, and legal highs or new psychoactive substances (NPS) which are mostly synthetic versions of preexisting drugs (Frecska et al., 2012; Kowal et al., 2015; Mason et al., 2021; Mason et al., 2019; Prochazkova et al., 2018; Rudgley, 2014; Shafi et al., 2020). Additionally, research has revealed that in the year 2010 a population of 153 to 300 million people between the age of 15 to 64 engaged in the use of an illicit substance (UNODC, 2012). To further specify towards psychoactive substances, 270 million people (5.5% of the global population) between the ages of 16 and 64 have indulged in psychoactive substance use during the last year (WHO, 2023). This shows the high prevalence of psychoactive substances in comparison to general illicit substance use in the population. Hence, psychoactive substances were chosen as the focal drug in this literature review.

As above-mentioned, a lot of previous research has investigated the interplay of psychoactive drugs and creativity. These have taken the form of qualitative studies and also quantitative studies, revealing varying outcomes. Iszaj et al. (2017) proposed that available literature suggests a bi-directional association between creativity on psychoactive substance use and vice versa, although the interconnectivity is not clearly defined. This has further been supported by Wang (2020), suggesting that psychoactive substances have a relationship with creative behaviour and the enhancement of creativity. Moreover, it was shown that it gives

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opportunity to unique neurological processes that increase creative potential. Specifically, there is evidence that low to moderate dosages can increase higher cognitive functioning, like visual enhancement or access to the subconscious. Overall, findings show that substance use was more prevalent in populations with higher levels of creativity. Additionally, it was tested and found probable that the association between the two phenomena stems from a bi-directional relationship (Iszaj et al., 2017). On the other hand, different studies have revealed that the nature of the relationship might stem from artists using psychoactive substances as relaxants or stimulants for the creative process, rather than introducing drugs to increase creativity in itself (Iszaj et al., 2018). To conclude, the results of current research into the topic remain inconclusive and not exhaustive in investigating the enhancement of creativity through psychoactive substances.

Notably, the topic of creativity has recently experienced a resurgence of relevance in the academic community (Baggott, 2015). Papers investigating the influence of psychoactive substances on creativity have shown that, despite a large amount of research, the specific bond towards psychedelics is yet to be established (Smith, 2015). Therefore, this literature review wants to investigate the current standing of the aforementioned research, its relevance, and its most important focal points.

Reviewing this relationship and keeping in mind the difficulty of defining creativity, the following research question and sub-questions were formulated.

Research Question: How do psychoactive substance use, and creativity influence each other?

Sub-Question 1: What is the relationship between psychoactive substance use and divergent thinking?

Sub-Question 2: What is the relationship between psychoactive substance use and convergent thinking?

## Methods

To investigate and answer the proposed research questions, a systematic literature was carried out. This systematic literature followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PRISMA guidelines support and ensure clear, concise, and complete reporting for the methodology of a systematic literature review, while transparent and elaborate reporting aims to reduce the researcher’s bias (Asar et al., 2016).

### Search Strategy

To develop a specific and sufficient search string the Population or Problem, Interest, Context (PICO) method was used (Pollock & Berge, 2018). In line with the PICO, four basic search terms were identified. The problem “Psychoactive Substance Use”, the context “relationship” and the interest “creativity”. To build and design a search string that is specific yet comprehensive enough, various synonyms were introduced (see Appendix A). A preliminary search showed which of these synonyms would be included in the final search string or were included in the exclusion criteria.

After this iterative search, the final search strings for a variety of databases were created, as seen in Table 1. Furthermore, to include as much of the relevant data as possible, all fields of research were included in these literature searches.

Table 1

*The Search Strings per Database*

Data Base	Final Search String
ScienceDirect	(psychoactive AND psychotropic AND drugs OR hallucinogenic) AND creativity AND (relation OR connection OR correlation)
Web of Science	(psychoactive* OR hallucinogenic) AND creative*
PubMed	(psychoactive* OR hallucinogenic OR psychotropic) AND creative* AND (relation* OR corr* OR connect*)

## **Inclusion and Exclusion Criteria**

To select studies tailored to the research question, various inclusion criteria were defined to simplify the screening and selection process. Firstly, only studies published after the year 2010 were included in the final selection, to ensure the inclusion of relevant, up-to-date research conducted in the last decade. Secondly, the only records eligible to be used in this study were papers written in the English language. Third, the studies had to specifically look at the relationship between psychoactive substance use and creativity. Therefore, only studies were included that quantitatively investigated the relationship between a psychoactive drug (e.g., psilocybin, ayahuasca, LSD, cannabis) and a broad range of creativity (e.g., visual creativity, divergent thinking, convergent thinking, artistic creativity, scientific creativity). Fourth, only studies that investigated this relationship during active substance use (the administration of psychoactive drugs before or during measurement) were included in the final sample. Fifth and lastly, the studies chosen had to use a quantitative measure to assess the concepts of interest.

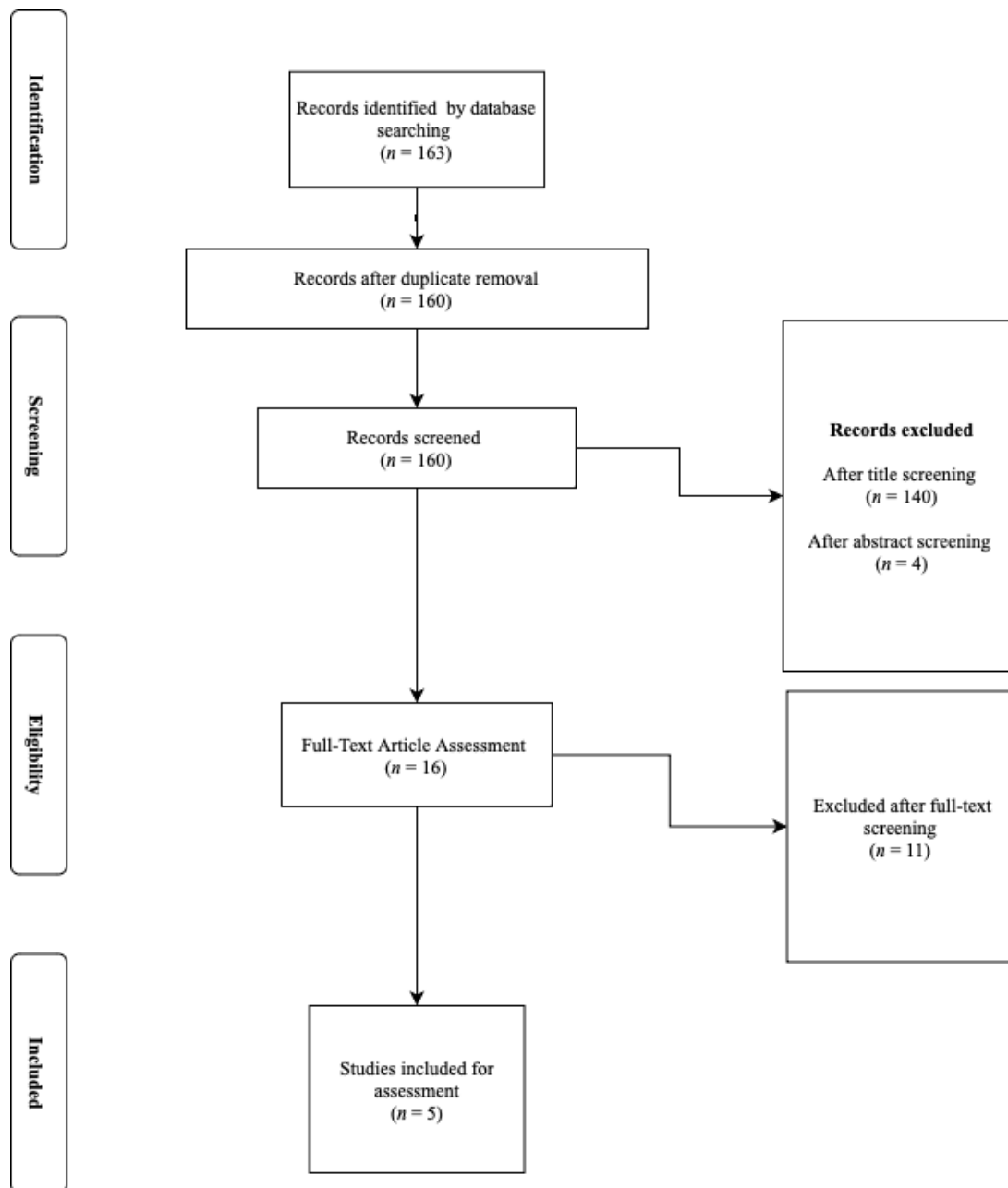
This led to the following exclusion criteria: Studies were excluded that did not investigate the effect of psychoactive substance use on the creative process. Additionally, studies were excluded if they did not measure active substance use. In other words, studies that investigated substance use that dates back to earlier years of life, or passive exposure to substances were excluded. More specifically, studies with a measure that did not actively administer a psychoactive drug during the research process were excluded from the final sample, for instance, studies including self-reported drug consumption. Furthermore, studies that used a qualitative measure or reviews were excluded from the final sample. Lastly, studies were excluded that looked at parental substance use or genetic relationships, like genetic predisposition, rather than a subject's own substance use.

## **Procedure**

A search for relevant literature was conducted on the 25th of October 2022. It was conducted through various online databases, namely, Science Direct, Web of Science, and PubMed. The conducted search yielded a total of 163 results: Science Direct (N=80), Web of Science (N=42), and PubMed (N=41). After the exclusion of duplicates, a final total of 160 search results were included through the search of the three databases, as seen in Figure 1.



Figure 1 *Systematic Search Process*



Utilising the PICO statement and following its procedure, the first step was to title-screen the 160 search results. After an initial title screening, 140 of the papers were excluded based on the inclusion and exclusion criteria earlier specified. Most of the papers were excluded for investigating a non-relevant relationship when looking at the tailored criteria, for example, rather investigating the relationship between psychoactive substance use and

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satisfaction of life. After an abstract screening of the relevant literature, four more papers were excluded based on the criteria. The remaining 16 papers were used for conducting a detailed full-text screening to determine relevant literature. After the full-text screening of possibly relevant literature, 11 of the articles were excluded, for instance, literature reviews, those using only a qualitative measure, self-reported measures on drug consumption, or investigating creativity and substance use through genetic predisposition. Ultimately, this resulted in a final sample of five papers.

To ensure the reliability of the conducted search, a second independent researcher was tasked to conduct a screening, based on the specified inclusion and exclusion criteria, and the tailored search strings. This was implemented to determine the inter-rater reliability of the literature search. The inter-rater reliability was determined, utilizing a descriptive crosstab analysis. This was conducted to measure Cohen’s Kappa, a well-researched measure of reliability (McHugh, 2012). A Cohen’s Kappa of 0.72 ( $p < 0.001$ ) indicated a substantial agreement between the two researchers (McHugh, 2012), see Tables 2 and 3).

Table 2

*Crosstabulation of Ratings of Researcher 1 \* Researcher 2*

Count		Researcher 2		
		No	Yes	Total
Researcher 1	No	156	2	158
	Yes	1	4	5
Total		157	6	163

Table 3

*Calculation of Cohen’s Kappa*

	Value	Asymptotic Standard Error	Approximate T	Approximate Significance
Measurement of Agreement	Kappa <b>0.718</b>	0.156	9.205	<b>&lt;0.001</b>
N of Valid Cases	163			

- a. Not assuming the null hypothesis
- b. Using the asymptotic standard error assuming the null hypothesis

### **Data Extraction**

After the in-depth search process, various data was chosen for extraction and analysis. This included a general outline of the paper's content, namely, the author and publication year, the aim of the study, the theme of the study, and the general measure used. Furthermore, a more detailed data extraction was conducted focusing on the population, the specific measure used, the dosage of drugs admitted in the studies, the type of test battery used to assess creativity, as well as the final findings of the studies.

### **Data Analysis**

To analyse the extracted data, two analysis types were used to address the research question on the relationship between psychoactive substance use and creativity. Firstly, a matrix synthesis was employed to overall assess the content of the sampled papers and secondly, an in-depth narrative analysis was utilized as a supportive measure. Furthermore, to investigate the two sub-questions a meta-analysis was conducted in SPSS to identify the effect of psychoactive substances on divergent and convergent thinking.

In the meta-analysis, only the papers [1], [3], and [4] were included (see Table 4). The meta-analysis consisted of the synthesis of quantifiable data from these papers. Namely, the divergent thinking scores of the alternate uses task (AUT), and the convergent thinking scores of the picture concept task (PCT) and remote association task (RAT). These papers were included as they included an individual measure of creativity in their research. More specifically, in the meta-analysis on divergent thinking of paper [1], the scores of the active treatment group in the seven-day follow-up measure were used. For study [3] the pre- and post-scores of the active treatment group were included. Lastly looking at study [4], the scores of the active treatment group that was administered lower amounts of THC (5.5mg) were included in the analysis. Finally, the aggregated data of these tasks was synthesised employing a random effects model to provide summarised data for the meta-analysis.

## Results

### Overview of the Included Studies

Overall, the studies (see Table 4) analysed the data of 252 participants ( $M= 50.4$ ). Thereby, a main area of interest was the study design used in the five studies. Two of the papers, [1] and [4], used a randomised, placebo-controlled, double-blind study design. The remaining papers [2], [3], and [5] used single-group measures to investigate the effect of psychoactive substance use on creativity, utilising a baseline measure, a measure during active treatment, and a follow-up (only study [2]) measurement. The studies included in this review (see Table 4), solely consisted of studies that were published from 2012 to 2021. Furthermore, the majority of the studies were conducted in the Netherlands [1], [2], [3], [4]. The only exception to this was study [5] which took place in Brazil. A large array of the ultimately included sample examined various other concepts next to creativity. Study [2] not only focused on creativity as a concept but further investigated topics such as empathy and subjective well-being during psilocybin exposure. Ultimately, these additional measures were excluded from the analysis in this paper. The sole additional measure included was taken from study [5], as the phosphoric drawing is closely related to creativity and showed good inter-rater reliability (Frecska et al., 2012). Nonetheless, the majority of the studies focused on investigating creativity through divergent thinking, and convergent thinking tasks [1], [2], [3], [4]. The only exception was study [5] which used a broader creativity measure. Furthermore, the dosage of psychoactive substances used in the studies was of interest. While one paper (study [2]) did not mention any dosage used in their research, the other papers have provided dosages. More specifically, [1] 0.17mg of psilocybin, [3]  $M= 0.37$ g of truffles, and [5]  $M= 538$ ml of Ayahuasca tea. As an exception, study [4] applied two different levels of dosages with either 5.5mg of THC administered or 22mg of THC administered through a vaporiser (Table 4).

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Table 4  
*Extracted Data on Aim, Theme, and Measure*

Author	Aim	Theme	Measure
[1] Mason et al. (2021)	Investigating creative cognition during and after active psilocybin usage	Psychoactive drug use (Psilocybin) and creativity	Quantitative measure on treatment groups (treatment condition 0.17 mg/kg psilocybin or placebo) and performance on creativity tasks
[2] Mason, Mischler, Uthaug, and Kuypers (2019)	Investigating the effect of psilocybin on empathy, creative thinking, and subjective well-being	Psychoactive drug use (Psilocybin) and creative thinking	Quantitative measures in a closed treatment group (treatment condition, psilocybin truffle tea [no dosage known]) and three creativity, empathy, and satisfaction assessments (baseline, during use, and seven days after)
[3] Prochazkova et al. (2018)	Investigating the effect of micro-dosing psychedelics on creativity	Psychoactive drug use (psychoactive truffles [~0.38g psychoactive substance]) and creativity	Quantitative measure done during a micro-dosing event. On-stage presentation and voluntary assessment of substance effect on creativity. Test batteries at baseline and during consumption.
[4] Kowal et al. (2015)	Investigating the effect of cannabis on creativity and divergent thinking	Psychoactive drug use (cannabis) and creativity and divergent thinking	Quantitative measure done in lab setting. Three groups were given sativa marijuana (placebo, 5.5mg of THC, 22mg of THC) randomly.
[5] Frecska, More, Vargha, and Luna (2012)	Investigating the effect of psychedelic ayahuasca on creativity	Psychoactive drug use (ayahuasca) and creativity	Quantitative measure done during ayahuasca ceremonies. Participants consumed at least 50ml of ayahuasca during each of the ceremonies. Baseline creativity test before the ceremonies and a test battery after completing the 2 weeks of ayahuasca ceremonies.

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Table 5  
*Extracted Data on Population, Study Design, Dosage, Tests, Measures, and Results*

Author	Population	Study Design	Dosage	Test Battery	Measures	Results
[1] Mason et al. (2021)	60 Participants	Randomized, placebo-controlled, double-blind, parallel-group design.	0.17mg psilocybin or placebo	PCT AUT	Placebo vs. Treatment Group	Increase in spontaneous creative insights  Decrease in task-based creativity
[2] Mason, Mischler, Uthaug, and Kuypers (2019)	55 Participants (23 females)	Psilocybin retreats	Unknown	PCT	Pre to Post	Seven days after usage novel ideas increased Single administration of psilocybin has a positive sub-acute effect on creative thinking
[3] Prochazkova et al. (2018)	38 Participants	Micro-Dosing event.	Dependent on body weight 0.22 g, 0.33 g, 0.44 g (~0.37g)	PCT AUT	Pre to Post	Convergent and divergent thinking improved after micro-dosing
[4] Kowal et al. (2015)	59 Participants (52 males & 7 females)	Randomized, placebo-controlled, double-blind between-groups measure Three conditions, placebo, low dosage and high dosage	Placebo, 5.5mg THC, 22mg THC	AUT RAT	Placebo vs. Treatment Group	High dosage of THC impairs divergent thinking  Lower Dosage did not affect creativity
[5] Frecska, More, Vargha, and Luna (2012)	40 Participants, 17 males & 23 females, Age 30.9 (SD = 7.7)	baseline measures and active measures of creativity during Ayahuasca ceremony	Min. 50ml per dosage Overall: 538ml (SD = 315)	TTCT	Pre to Post	Positive effect on originality (especially visual creativity) and phonemic activity Sig. increase in highly original task solving

## **Extracted Data**

### *Matrix Synthesis*

Summarising the data as presented in Table 5 and examining the results of the papers, it was shown that for most of the psychoactive substances actively administered, creativity has improved at one point in time, either when conducting a measurement during active treatment or a week after substance exposure. Study [1] has shown a significant increase in spontaneous creative insights and an increase in novel ideas in the treatment group as compared to the placebo group. [2] has shown a positive sub-acute on creative thinking. Sample paper [3] showed an improvement in convergent and divergent thinking. Furthermore, [5] has proven a positive effect on originality and phosphenic activity. Additionally, a significant increase in highly original task-solving was reported. As an exception to this, [4] has shown that a large volume of THC intake impairs divergent thinking while lower dosages of THC did not affect the creative thinking of participants.

Overall, the papers have suggested a positive effect of psychoactive substance use on creativity, more specifically, divergent thinking. As an exception to this, [4] has shown that THC does not affect creativity in low dosages, while a high dosage impaired the creative thinking process. Lastly, convergent thinking was largely unaffected or even impaired by the intake of psychoactive substances as shown by the results of the reviewed papers ([1], [4])

### *Narrative Analysis*

In this part of the analysis, a closer look was taken at the varying results sections to get a better understanding of the findings. The first paper investigated is [1] Mason et al. (2021). Mason et al. (2021) have found in their study that in large parts the convergent thinking in participants was decreased during the psilocybin exposure in comparison to the control group. Furthermore, some parts of divergent thinking, namely, fluency, were decreased during the active state, but at the seven day follow up other components of divergent thinking, namely, novelty was increased. Lastly, individuals reported a higher subjective state on spontaneous thinking, suggesting an influence on their creative thinking process.

The second paper, [2] Mason et al. (2019), suggested in their findings that overall creativity in participants was increased during the exposure to psilocybin in both convergent and divergent thinking. On the other hand, it was also mentioned that seven days after

psilocybin ingestion there was no effect on divergent thinking

In the investigation of the third paper, [3] Prochazkova et al. (2018), have stated that an improvement in convergent thinking after a microdose of truffles (~0.38mg) occurred. This was additionally shown for most aspects of divergent thinking.

In study [4], Kowal et al. (2015) have shown a significant main effect of 5.5mg of THC on divergent thinking compared to the placebo group. However, the higher results of a low dosage of THC in comparison to the placebo group were very small and shown to be comparable to studies without pharmacological intervention, indicating that there was no difference in divergent thinking. These findings were, as above-mentioned, largely dependent on dosage whereas the experimental condition with the lower amount of THC was found to be significant but not relevant, and the experimental condition with higher amounts of THC was found to reduce creativity scores. Additionally, there was no effect recorded for the convergent thinking measurement, the RAT.

Lastly, the fifth study [5] by Frecska et al. (2012) showed no significant increase in creativity scores after a dosage of ~538ml of ayahuasca. This was shown for some creativity measures, namely, fluency, relative flexibility, and relative originality. However, the number of highly original solutions showed a significant increase). Additionally, phosphoric response was higher after drug administration compared to the baseline measure.



### **Definitions of Creativity**

In investigating the effects of psychoactive drugs on creativity, one must understand how the various studies define creativity to clearly understand what kind of observations can be drawn from the research.

Overall, the papers employed similar definitions of creativity: Creativity was understood as a dynamic, multifaceted concept. It focuses on the generation of novel ideas, solutions, and products as well as finding connections in problem-solving activities, rather than the creative process itself. As mentioned earlier, this is divided into two processes: First, divergent thinking, the notion to create multiple alternative solutions to one specific problem and, second, convergent thinking as the honing of one specific solution to a single problem and evaluating its effectiveness. In addition, the papers all identified similar measures to investigate creativity, with a total of four measures being used in the studies. The Alternate Uses Task (AUT) was utilised in three studies ([1], [3], and [4]), and the Picture Concept Task (PCT) in three others ([1], [2], and [3]). The Remote Association Task (RAT) was only admitted in one study ([4]). The Torrance Test of Creative Thinking (TTCT) was admitted as a complete measure of creativity only in [5]. An overview is provided in Table 5.

Table 6

*Definitions of Creativity*

Study	Def. of Creativity	Creative Measure
[1] Mason et al. (2021)	- dynamic process - problem-solving - divergent thinking - convergent thinking	1. Picture concept task (PCT) 2. Alternate uses task (AUT)
[2] Mason, Mischler, Uthaug, and Kuypers (2019)	- multicomponent construct → divergent thinking → convergent thinking	1. PCT
[3] Prochazkova et al. (2018)	- multi-layered phenomenon - generate ideas, solutions, products that are novel and appropriate - problem identification - divergent thinking - convergent thinking	1. PCT 2. AUT
[4] Kowal et al. (2015)	- divergent thinking - convergent thinking	1. AUT 2. Remote association task (RAT)
[5] Frecska, More, Vargha, and Luna (2012)	- generate ideas, solutions, products that are novel and appropriate - divergent thinking - convergent thinking	1. Torrance Tests of Creative Thinking (TTCT)

**Meta-Analysis**

*Meta-Analysis Divergent Thinking (Synthesis AUT scores)*

To answer the first sub-question relating to the effect of psychoactive substance use on divergent thinking, a meta-analysis was utilised to synthesise the results of the divergent thinking tasks from the sample papers. As mentioned in the methods, in this analysis, only papers [1], [3], and [4] were included since they featured an individual measure for divergent thinking, the AUT.

Table 7

*Divergent Thinking Meta-Analysis*

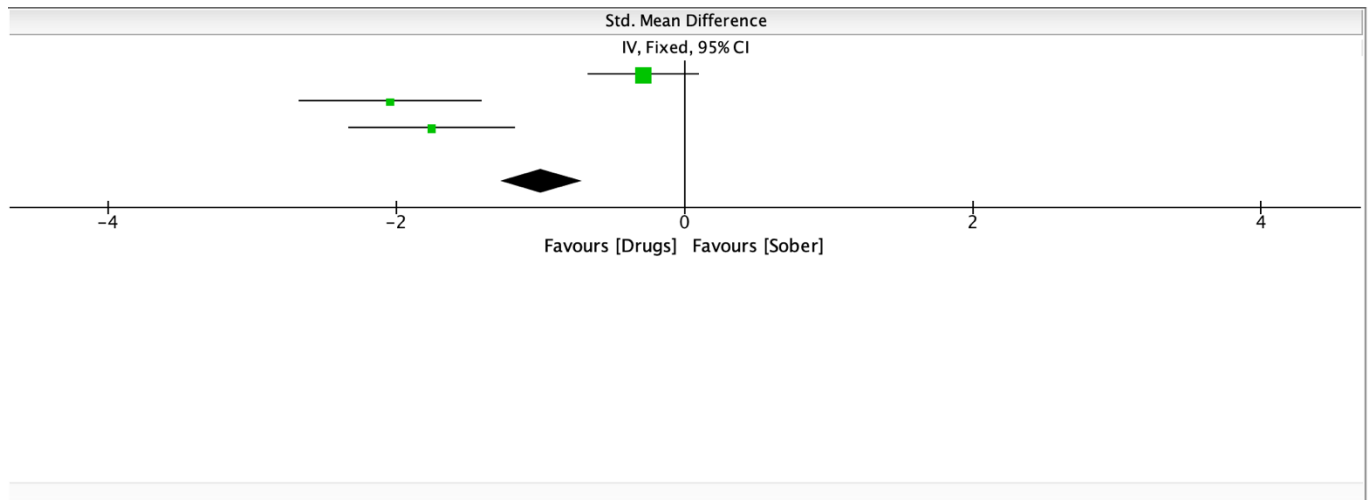
Study	No Treatment			Active Treatment			Data Weight	Std. Mean Diff	
	Mean Div. Thinking scores	SD	Total	Mean Div. Thinking Scores	SD	Total			
Kowal et al. 2014	18.78	6.4	54	20.73	7.1	54	55.6%	-0.29 [-0.67, 0.09]	
Mason et al. 2021	-2.1	0.69	30	-0.64	0.7	30	20.0%	-2.04 [-2.68, -1.41]	
Prochazkova et al. 2018	10.11	0.85	33	11.72	0.9	33	24.4%	-1.75 [-2.33, -1.18]	
Total (95% CI)			117				117	100%	<b>-1.00</b> [-1.28, -0.71]

*Note.* Heterogeneity:  $\chi^2=30.77$ ,  $df = 2$  ( $p < 0.00001$ );  $I^2 = 94\%$ , Test for overall effect:  $Z = 6.90$  ( $p < 0.00001$ )

After the meta-analysis of the AUT, the results of the papers have shown an overall positive effect ( $Z = 6.9$   $p < 0.00001$ ). The overall standardised mean difference of the papers found an effect size on mean divergent thinking scores of  $-1.00$   $[-1.28, -0.71]$  as seen in Table 7. In other words, a favour towards divergent thinking was shown while under the influence of drugs compared to no administration of drugs. However, the analysis was also shown to be largely heterogeneous ( $I^2 = 94\%$   $p < 0.00001$ ). This suggests a diversity between samples too large to make a final inference on scores. This is further illustrated by visualisation in a forest plot as seen in Figure 2.

Figure 2

*Forest Plot Divergent Thinking*



*Meta-Analysis Convergent Thinking (Synthesis PCT and RAT scores)*

Next, the second sub-question investigating whether psychoactive substance use affects convergent thinking was addressed in a further meta-analysis. This was done to summarise the data from the subsequent sample papers chosen for this review. In this analysis, only papers [1], [3], and [4] were included since they used an independent measure for convergent thinking, namely the RAT and the PCT.

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Table 8  
*Convergent Thinking Meta-Analysis*

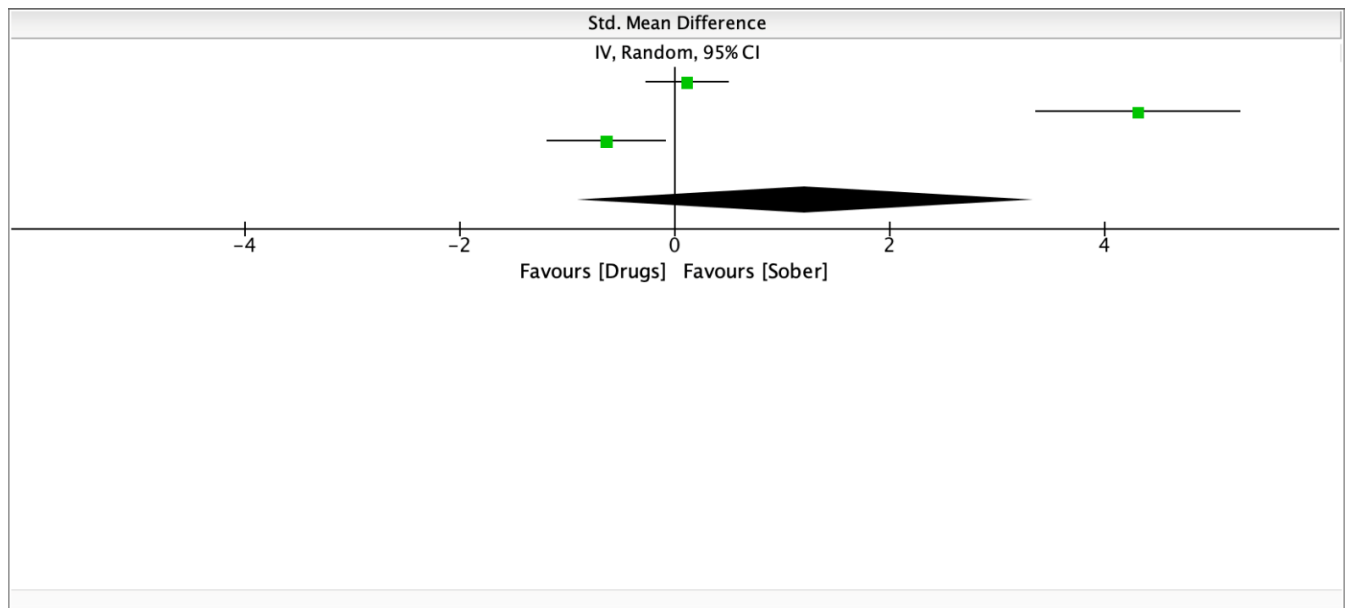
Study	No Treatment			Active Treatment			Data Weight	Std. Mean Diff	
	Mean Con. Thinking Scores	SD	Total	Mean Con. Thinking Scores	SD	Total			
Kowal et al. 2014	4.8	2.3	54	4.5	2.8	51	34.1%	0.12 [-0.26, 0.49]	
Mason et al. 2021	1.61	0.37	30	-1	0.76	30	32.2%	4.31 [3.37, -5.25]	
Prochazkova et al. 2018	6.56	1.601	27	7.59	1.6	27	33.7%	-0.63 [-1.18, -0.09]	
Total (95% CI)			111				111	100%	<b>1.22</b> [-0.90, 3.33]

*Note.* Heterogeneity:  $\tau^2 = 3.38$ ;  $\chi^2 = 81.29$ ,  $df = 2$ , ( $p < 0.00001$ );  $I^2 = 98\%$ , Test for overall effect:  $Z = 1.13$  ( $p < 0.26$ )

The analysis revealed an overall effect size of  $Z = 1.13$  ( $p < 0.26$ ) and a standardised mean difference of 1.22 [-0.90, 3.33]. This suggested a favour towards the capacity of convergent thinking when sober and not under the influence of psychoactive substances as compared to active drug administration. Furthermore, the meta-analysis of the studies has shown that the results were largely heterogeneous ( $I^2 = 98\%$   $p < 0.0001$ ). Again, this indicated a strong variance between the sample, making it difficult to judge the final significant effects. This is furthermore illustrated through a visualisation of the data in the plot seen in Figure 3.

Figure 3

*Forest Plot Convergent Thinking*



## Discussion

This systematic literature review was aimed at investigating the relationship between psychoactive substance use and creativity. Therefore, this study systematically reviewed previous findings to summarise the current status of research on this topic. Specifically, this review investigated the active administration of drugs and its relation towards the creativity of subjects (Frecska et al., 2012; Kowal et al., 2015; Mason et al., 2021; Mason et al., 2019; Prochazkova et al., 2018).

To further tailor this investigation of literature, the main research question was formulated, namely, “How do psychoactive substance use, and creativity influence each other?”. Furthermore, two sub-questions were added to more closely investigate two sub-categories of creativity, namely, divergent thinking and convergent thinking: “What is the relationship between psychoactive substance use and divergent thinking?” and “What is the relationship between psychoactive substance use and convergent thinking?”. In the following sections, these questions will be answered in detail.

### Main Research Question

A review was conducted to investigate the relationship between psychoactive substance use and creativity. The study was comprised of two analyses: a thematic narrative analysis and a meta-analysis. The studies included in the review used either a single-group design or a placebo-controlled, between-group design to examine the effects of various psychoactive substances, including psilocybin, cannabis, ayahuasca, and truffles, on creativity. In the sampled research the concept of creativity was consistently defined as a multi-component, dynamic process with the two sub-components divergent thinking and convergent thinking. The results from 252 participants revealed varying impacts of the different psychoactive substances on creativity. Psilocybin showed a mixed impact, with an increase in spontaneous creative insights but a decrease in task-based creativity and impaired convergent thinking (Mason et al., 2021; Mason et al., 2019). Truffles improved both divergent and convergent thinking, while cannabis had an impact on creativity depending on the dosage of THC (Kowal et al., 2015; Prochazkova et al., 2018). Ayahuasca showed positive effects on originality, especially in visual creativity and original task-solving (Frecska et al., 2012).

The present study researched the current standing of literature on the relationship between psychoactive substance use and creativity. The results of the reviewed literature

varied and showed that different substances seem to have different effects on creativity. Prochazkova et al. (2018) found a significant effect of truffles on creativity, as did Kowal et al. (2015) in their study on cannabis and Mason et al. (2019) in their study on psilocybin. However, Mason et al. (2021) reported no immediate effect of psilocybin on creative thinking, but a delayed positive effect was shown by a post-test a week after exposure. Frecska et al. (2012) did not find a significant effect on creative thinking, only on creative behaviour, which is in line with previous research indicating a difference in the impact of various illicit substances (Bijnsdorp, 2011; Izenwasser, 2005; Newcombe, 1999). One important finding was the delayed effect of psilocybin on creativity, as recorded by Mason et al. (2021). The authors explained this through the within-network functional connectivity of a neural mechanism involved in creative thinking, the default mode network. This highlights the potential importance of considering the time frame of substance use in relation to its impact on creativity. Additionally, the results suggest that the use of psychoactive substances may increase the creative sub-component of divergent thinking while having little effect on convergent thinking. The subjective creativity in individuals was heightened by the admission of drugs, as well as the notion of starting a creative process.

The findings of this review were in line with earlier research into the topic of psychoactive substance use and creativity, including a review by Costa (2022). However, a clear direction of this relationship has yet to be identified (Frecka et al., 2012; Iszaj et al., 2017; F. Iszaj et al., 2018; Kowal et al., 2015). The review confirmed the results of Costa (2022) that creativity might be facilitated by the use of psychoactive substances, as evidenced by the significant increase in novel ideas a week after exposure to psilocybin in Study [1]. The results also suggested that psychoactive substances may have a larger influence on divergent thinking, rather than convergent thinking, which was supported by the majority of the analyzed papers. However, Prochazkova et al. (2018) reported a significant increase in convergent thinking after exposure to a micro-dose of psychoactive truffles, which confirms previous findings that the consumption of a low dosage of a psychoactive drug can help facilitate creativity (Berge, 1999; Kerr, 1991; Prochazkova et al., 2018; Sessa, 2008).

Despite these findings, it should be noted that the high heterogeneity of the results makes it difficult to provide a clear understanding of the relationship between creativity and psychoactive substances. Further, more comprehensive and controlled studies are needed to confirm and clarify these findings. The limitations of the current studies, such as small sample sizes, self-reported measures of creativity, and lack of control groups, highlight the importance of conducting further research with larger and more diverse samples, using



objective measures of creativity, and comparing the effects of psychoactive substances to those of placebo or no substance use.

In conclusion, the results of this review suggest that the use of psychoactive substances may have an impact on creativity. However, the results remain inconclusive, and more research is needed to establish a detailed understanding of this relationship. The findings point to the importance of considering the type and dose of a substance, as well as the time frame of use, in relation to its impact on creativity.

### *Sub-Question 1*

To further investigate this discrepancy, the two major sub-components of creativity were analysed. The first sub-question “What is the relationship between psychoactive substance use and divergent thinking?” can be answered as follows.

The relationship between psychoactive substance use and divergent thinking is a complex issue that has been the subject of several studies. Results from previous research indicate a positive effect of psychoactive substance use on the sub-component of divergent thinking. For example, Kuypers et al. (2016) found that ayahuasca enhances creative divergent thinking by increasing psychological flexibility. On the other hand, Bourassa and Vaugois (2001) found no positive effect of marijuana use on divergent thinking in novice users and reported that it reduced divergent thinking in regular users. This highlights the importance of considering the specific substance, as well as the frequency and dose of use when examining the relationship between psychoactive substance use and divergent thinking. Kuypers (2018) hypothesized that exposure to psilocybin would lead to enhanced divergent thinking due to heightened empathy and openness. Meanwhile, Humphrey (2012) reported a positive effect of marijuana on divergent thinking, but only in a group that thought they had received the substance, suggesting that placebo effects may also play a role in the relationship between psychoactive substance use and divergent thinking.

A meta-analysis was conducted to examine the relationship between psychoactive substance use and divergent thinking in this review. The results revealed a positive effect of psychoactive substance use on the sub-component of divergent thinking, with the largest effect sizes being recorded for psilocybin and the microdose of truffles, which is in line with the above-noted research. This is further true for previous research on the effect of THC on divergent thinking, where regular usage was found to impair divergent thinking, which is in line with the findings of this review.

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However, the researched studies were found to be highly heterogeneous, making it difficult to draw significant inferences from the analysis results. Additionally, it is important to note that while these findings suggest a positive relationship between psychoactive substance use and divergent thinking, the relationship is complex and may be influenced by several factors, including substance type, dose, and individual differences. Further research is needed to better understand the relationship between psychoactive substance use and divergent thinking, as well as to identify the underlying mechanisms and the potential risks and benefits of substance use in this context.

### *Sub-Question 2*

The second sub-question “What is the relationship between psychoactive substance use and convergent thinking?”, will be answered in this section.

Psychoactive substance use and convergent thinking have been the subject of numerous studies in recent years. The analysis of these studies has consistently revealed a negative effect of substance exposure on convergent thinking, with favour towards a sober mind in terms of problem-solving and focus. Pope et al. (2001) found that marijuana use impairs convergent thinking by reducing the ability to focus and solve problems effectively. Wießner et al. (2022) also showed that psychoactive substances have a negative effect on convergent thinking. This conclusion was further supported by Hutten et al. (2019) who identified that the administration of psychoactive drugs impairs the convergent thinking process.

However, it is important to note that the results of these studies are not without limitations and inconsistencies. While this study confirms most of the previous findings, for example, that most psychoactive substances were found to have a negative impact on convergent thinking. Micro-dosing with low amounts of psychoactive substances, such as truffles, has been shown to have a positive effect on this cognitive function. Additionally, a lower dosage of THC (5.5mg) was found to have a lower effect on creativity, indicating that the effects of psychoactive substances on convergent thinking may depend on the drug and the dosage administered.

Despite these inconsistencies, the overall trend of the findings supports the conclusion that substance exposure harms convergent thinking. The high heterogeneity in the results, however, makes it difficult to make a final inference about the relationship between

psychoactive substances and convergent thinking. Further research is needed to clarify the effects of different substances and dosages on convergent thinking and creativity.

In conclusion, while the existing evidence suggests a negative relationship between psychoactive substance use and convergent thinking, the findings are not without limitations and inconsistencies. It is important to exercise caution when interpreting the results of these studies and to continue to conduct further research to gain a more comprehensive understanding of the relationship between psychoactive substances and convergent thinking.

### **Limitations and Recommendations**

During the process of this systematic literature review on psychoactive substance use and creativity, three main limitations have crystallised. These limitations are, in order of importance, the focus of the studies, the substance and dosage, and lastly the causal directionality of the relationship.

#### *The Quality of the Studies*

The quality of a quantitative study is a crucial aspect to consider in the research of the relationship between psychoactive substance use and creativity. This is because the validity and reliability of the study results can be affected by various factors, such as the sample size, the methods used, and the measures employed to assess creativity and substance use.

For example, a study with a small sample size may not accurately reflect the general population, leading to biased results (APA, 2012). Furthermore, a lack of control groups, inadequate randomization procedures, or biased participant selection can also impact the validity of the results, as seen in the single-group designs used in the sampled papers. These limitations can make it difficult to determine cause-and-effect relationships, as other factors besides substance use may also influence creativity (Kuypers, 2018). In addition to these limitations, the measures used to assess creativity and substance use are also critical to consider. Currently, there is no universally accepted definition or method for measuring either construct, making it difficult to compare results across studies (Kuypers, 2018). Furthermore, self-report measures, which are commonly used in studies of substance use, can be biased by the social stigma associated with substance use, leading to underreporting and inaccurate results (American Psychological Association, 2010).

Based on this limitation it is recommended that future research in this area take the following steps to improve the quality of the studies:

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1. Control for confounds: It is important to control for potential confounds, such as the individual's baseline level of creativity, the setting in which the substance was used, and other factors that may influence the results.
2. Use validated measures: Future research should use validated measures to assess both substance use and creativity, such as standardized self-report questionnaires or objective measures of performance.
3. Consider individual differences: Future studies should also consider individual differences, such as personality traits, motivation, and prior experience, which may influence the relationship between substance use and creativity.
4. Longitudinal designs: Longitudinal designs would allow researchers to observe the effects of substance use on creativity over time, providing a more nuanced understanding of the relationship.

### *Substance and Dosage*

The substance and dosage administered are important limitations in current research into psychoactive substance use and creativity, due to the variability in the effects of different psychoactive substances on the brain and behaviour (Krebs & Johansen, 2012). For example, different substances can have different mechanisms of action, resulting in different effects on cognition, mood, and behaviour. Additionally, the effects of a given substance can vary based on the dose, administration method, and individual characteristics of the person taking it (Bouso et al., 2012). As a particular problem in the estimation of dosage effects, many studies on psychoactive substance use and creativity have used self-reported measures, which can be limited by biases such as recall errors, social desirability, and experimenter expectations (Krebs & Johansen, 2012). In addition, many studies have not used controlled experimental designs, making it difficult to establish causality between substance use and creative outcomes (Bouso et al., 2012). Finally, the relationship between psychoactive substance use and creativity can be complex and can depend on the substance, dose, and individual characteristics of the person taking it. For instance, some studies have shown that low doses of psychedelics can enhance creativity, while higher doses can impair it (Carhart-Harris et al., 2012).

Based on this limitation, the following recommendations are made for future research in this field:

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1. **Use of Controlled Experimental Designs:** Future studies should aim to use controlled experimental designs to establish causality between substance use and creative outcomes. This will allow for a more accurate evaluation of the effects of different substances and doses on creativity.
2. **Dose-Response Relationships:** Research should aim to explore dose-response relationships between psychoactive substances and creative outcomes. This will provide a better understanding of the optimal dose range for enhancing creativity and minimizing adverse effects.
3. **Use of Objective Measures:** Future studies should aim to use objective measures, such as neuroimaging techniques or behavioural assessments, to evaluate the effects of psychoactive substances on creativity. This will help to reduce the potential biases associated with self-reported measures.
4. **Consideration of Individual Characteristics:** Future research should aim to take into account individual differences in personality, cognitive ability, and other factors that can influence the effects of psychoactive substances on creativity.
5. **Multidisciplinary Approach:** To fully understand the complex relationship between psychoactive substances and creativity, future research should take a multidisciplinary approach, incorporating insights from fields such as psychology, neuroscience, pharmacology, and ethnobotany.

### *Risk of Bias*

The risk of bias is an important limitation of current research into psychoactive substance use and creativity because it can affect the validity and reliability of the findings. Risk of Bias refers to the possibility of systematic error in the design, conduct, analysis or interpretation of a study that can result in incorrect or misleading conclusions (Higgins & Green, 2011). In the field of psychoactive substance use and creativity, studies are often limited by their design and methods, including self-reported measures, small sample sizes, and lack of control groups. These limitations can introduce biases in the results and impact the validity of the conclusions drawn about the relationship between substance use and creativity.

For example, a study that relies on self-reported measures of substance use may not accurately reflect the actual use of psychoactive substances, leading to an overestimation or underestimation of their effects on creativity. Similarly, studies that have small sample sizes

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may not be representative of the general population, which can limit the generalizability of the results (Borenstein et al., 2009).

In conclusion, the Risk of Bias is a crucial consideration in the interpretation of current research into psychoactive substance use and creativity, and it highlights the need for rigorous and well-designed studies to better understand the relationship between the two.

It is recommended that future research should focus on the following areas:

1. **Methodology:** Future studies should adopt rigorous and well-designed methods to minimize the risk of bias. This can be achieved by using objective measures of substance use, increasing the sample size, and including control groups in the study design.
2. **Representativeness:** Future studies should aim to be representative of the general population by recruiting participants from diverse backgrounds and considering the effects of substance use on creativity in different populations.
3. **Long-term effects:** Short-term effects of psychoactive substance use on creativity have been widely studied, but future research should focus on the long-term effects of substance use on creativity.
4. **Substance type:** Future studies should also consider the specific types of psychoactive substances that are used, as different substances may have different effects on creativity.

### *Causal Directionality Recommendation*

It is recommended that future research directions in the field of psychoactive substances and creativity should consider bidirectional causality, as existing studies have only investigated the effects of psychoactive substances on creativity, rather than the effects of creativity on substance use. Therefore, a review of research on the causal bidirectionality of creativity and substance use is necessary to investigate whether creativity influences psychoactive substance use or if psychoactive substance use influences creative thinking. Researchers should take this bidirectionality into account when investigating the relationship between psychoactive substance use and creativity, as the causal relationship might be reversed from the common assumption. (Iszaj et al., 2017; F. Iszaj et al., 2018; Berge, 1999; Krippner, 1985).

### **Implications and Conclusion**

The relationship between psychoactive substance use and creativity is complex and multi-faceted and has been the subject of much research and debate. While some research has

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suggested that the use of certain psychoactive substances may enhance creativity, other research has claimed the opposite, as it could impair creativity. On the one hand, studies have found that the use of psychoactive substances such as marijuana, ayahuasca, and psilocybin can increase divergent thinking, the ability to generate multiple solutions to a problem, and overall creativity. This is often attributed to the drugs' ability to alter one's perception and state of mind, leading to increased openness, flexibility, and imagination. On the other hand, other studies have suggested that the use of psychoactive substances can impair creativity by causing problems with memory, attention, and cognitive flexibility, which are all critical components of creative thinking.

The results of this analysis indicated a general effect of psychoactive substance use on creativity, as confirmed by the observed impact on both overall creativity and its first sub-component of divergent thinking. However, it should be noted that the evidence is not consistent, as some studies showed a lack of effect of psychoactive substances on the convergent thinking process, the second important sub-component of creativity. Furthermore, the impact of drugs on creativity might be influenced by factors such as the dosage, with higher dosages potentially impairing the creative process or the effect only becoming noticeable after several weeks of drug administration.

It is important to note the limitations of the current research on this topic. The small sample of five studies and the high heterogeneity of results among them raise concerns about the validity and generalizability of the findings. Specifically, heterogeneity refers to the differences between the studies in terms of their designs, methods, populations, and outcomes, which impacts the comparability and interpretability of the results. In this case, the heterogeneity of results in the systematic review highlights the difficulties in making definitive conclusions about the relationship between psychoactive substances and creativity.

To conclude, this systematic review has emphasized the need for more in-depth research into the effects of different psychoactive substances and varying dosages on creativity. Moreover, the bi-directional nature of the relationship between psychoactive drugs and creativity should receive more attention in future research. Given the limitations of the current research, caution should be exercised when interpreting the findings and making inferences about the relationship between psychoactive substances and creativity.

Despite the limitations of the current research, it is encouraging to see that the effects of psychoactive substance use on creativity have received attention and have been subject to rigorous examination. Further research in this area has the potential to greatly enhance our understanding of this complex and multi-faceted relationship. By exploring the impact of

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different substances and dosages on creativity, we may be able to gain new insights into the nature of creativity and its relationship with the human mind. Additionally, a deeper understanding of this relationship and its potential may lead to new and innovative approaches to enhancing creativity in various fields and industries. Therefore, it is important to continue research in this area and to remain open-minded about the potential positive impact that psychoactive substance use may have on creativity



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Appendix A

<b>PICo</b>	<b>Basic Search Terms</b>	<b>Identified Search Terms</b>
<i>Problem</i>	Psychoactive Substance Use	“hallucinogenic” “conscious-expanding” “psychotropic” “tryptamines” “trip”
<i>Interest</i>	Creativity	“imaginativeness” “imagination” “inspiration” “originality” “inventiveness”
<i>Context</i>	Relationship	“link” “relation” “association” “correlation” “interconnection”