Would Psychedelics Alter the Fitness Landscape of Cooperation? An Experimental Framework for an Agent-Based Model

Aly Debevec-Kruse, Martin Takáč

Faculty of Mathematics, Physics and Informatics
Comenius University Bratislava
kruse4@uniba.sk, martin.takac@fmph.uniba.sk

Abstract

Personality psychology broadly recognises personality traits as strong predictors of behaviour. Empirical research has also demonstrated a clear relationship between personality traits and strategy selection in cooperative game play. Although personality traits remain relatively stable throughout an individual's lifetime, a limited number of interventions, such as cognitive behavioural therapy and mindfulness-based practices, have been shown to produce stable changes. However, more recently, the "psychedelic renaissance" has produced a growing pool of evidence linking psychedelic use to enduring shifts in personality. As regulatory frameworks surrounding psychedelics evolve, their use may become more widespread, raising questions about how large-scale personality changes could affect cooperative social dynamics. This paper aims to present a computational approach to studying cooperation. We review the literature on the effects of psychedelics on personality and the relationship between personality traits and cooperation, and based on these findings, we describe the conceptualisation of an agent-based simulation of multi-agent Prisoner's Dilemma interactions between agents with varying personality profiles. The proposed framework is intended as a starting point for future computational experiments aiming to investigate how varying levels of psychedelic use within a population may influence cooperative dynamics.

1 Introduction

Psychedelics are psychoactive substances that are well known for their unique pharmacological properties and capacity to alter the conscious experience (Kelmendi et al., 2022). Due to a rapid expansion of empirical research on their therapeutic potential, the last few decades have seen the emergence of a "psychedelic renaissance" (Hadar et al., 2023). Although promising, this renewed interest has placed increasing pressure on regulatory systems around the world to review restrictive legal frameworks. As a result, the global legal landscape surrounding psychedelics is undergoing a significant transformation, with various countries already moving toward decriminalisation and medicalisation (Monte et al., 2024). With these substances becoming more accessible, it becomes relevant to ask what their broader social impacts may be.

Within the area of Anthropology, the idea that psychedelics played an inherent role in the evolution of human cognition has taken shape. Emerging evidence that psychedelics can induce measurable and sometimes lasting changes in personality traits underlie this concept (Rodríguez Arce and Winkelman, 2021). Given the established influence of personality traits on behaviour, it would be expected that reintroduction of psychedelics into a population on a large scale would produce individual behavioural changes, with downstream effects on social dynamics (Fleeson and Gallagher, 2009). However, the specific nature of these changes remains unclear and empirically answering these questions presents a challenge given the regulatory constraints surrounding these substances. Agent-based models (ABM) offer a promising solution, as their capacity for formal abstraction of complex systems allows for the systematic exploration of hypothetical scenarios. In this context, they can be used to examine the emergent patterns of social cooperation that can arise under conditions of large-scale psychedelic exposure.

Despite growing interest in both the cognitive impacts of psychedelic use and the role of personality in cooperative behaviour, to the best of our knowledge, there is currently no integrative model that captures the interaction between these domains. Existing models only incorporate personality in cooperation and are either overly complex or insufficiently aligned with the underlying mechanisms of interest. Although empirical studies provide valuable insights into the relationship between personality traits and cooperation, this literature remains fragmented and does not offer a clear, unified framework that can be directly operationalised in a modelling context. Therefore, the aim of this paper is to bridge this gap by reviewing the literature on (1) the effects of psychedelics on personality traits and (2) the relationship between personality and cooperative behaviour. Based on the reviewed literature, the paper seeks to develop a conceptual framework for personality-driven cooperative decision-making, designed for use in agent-based modelling. By doing so,

it aims to provide an initial step towards understanding how individual psychological changes may scale to influence broader social dynamics in contexts of increasing psychedelic use.

2 Related Work

Personality traits are understood as enduring patterns of thoughts, emotions, and behaviours that reflect consistent tendencies to respond in particular ways in different environments (Shum et al., 2025). A substantial body of research demonstrates that these traits can be measured with a high degree of reliability and stability throughout life and that they possess strong predictive validity in a wide range of life outcomes, including affect, life satisfaction, relationship stability, career success, and even longevity (Ozer and Benet-Martínez, 2006). More importantly, these personality measures, typically derived from questionnaire-based assessments, have been shown to correspond meaningfully with real-world behaviour (Fleeson and Gallagher, 2009). Within this domain, the Big Five personality traits (McCrae and John, 1992) have emerged as one of the most widely used and empirically supported frameworks for personality assessment. Its broad applicability and cross-cultural generalisability make it particularly valuable for modelling purposes, as it captures the core structure underlying both lay and expert descriptions of personality. The model comprises five key dimensions, which together provide a robust and quantifiable representation of individual differences.

Trait	**Core Characteristics**
Extraversion	Sociability and positive emotionality
Agreeableness	Compassion and interpersonal trust
Conscientiousness	Productivity and goal-directed behaviour
Neuroticism	Emotional instability and susceptibility to negative affect
Openness	Curiosity, creativity, and receptiveness to novel experience

Tab. 1: The Big Five personality traits and their core characteristics adapted from McCrae and John (1992).

2.1 Psychedelics and Personality Traits

Inquiry into the role of psychedelics within personality psychology as a potential mechanism of behavioural change has become more prevalent. Empirical work has linked psychedelic use to enhanced prosocial behaviour, with personality traits representing one key domain. Several prospective studies have examined changes in personality after long-term use of psychedelics. The most consistent findings indicate a decrease in Neuroticism and an increase in Openness, with almost half of the reviewed studies supporting these changes in traits (Weiss et al., 2021, 2023; Godfrey et al., 2025). On the other hand, evidence of an increase in Extraversion and Agreeableness, while present, appears less consistent and replicable (Erritzoe et al., 2018; Weiss et al., 2023), and Conscientiousness shows little systematic change overall (Barrett et al., 2020; Weiss et al., 2023). Although these effects are often described as long-term, there is no consistent definition across studies; therefore, follow-up periods vary, ranging from weeks or months to multiple years, and may contribute to inconsistencies in findings. MacLean et al. (2011), for example, reported sustained changes in trait Openness one year after administration, while Godfrey et al. (2025) more recently supported the observed patterns of decreased Neuroticism and increased Agreeableness, but only measured personality changes one month post- administration. In addition to these considerations, the variation in compounds, including psilocybin, LSD, ayahuasca, and clinical and natural settings, may help explain the differences in observed outcomes. Psychedelic use can therefore be deemed most reliably associated with reduced Neuroticism and increased Openness, with more variable effects across other traits and study contexts.

In addition to this exploration of psychedelic-induced personality change, personality traits have also been found to influence both the likelihood of psychedelic use and the subjective quality of the experience itself. For example, greater Openness has been associated with more positive and meaningful experiences, and greater Neuroticism is associated with a more challenging trip (Kajonius et al., 2025). Similarly, patterns of use differ between personality profiles, with psychedelic users tending to be more open and extraverted and less neurotic than non-users, while interest in use among non-users is associated with greater Openness (Weiss et al., 2023). These more recent findings point to a more complex and dynamic interaction in which personality both shapes and is shaped by psychedelic use.

2.2 Personality Traits and Cooperation

As a substantial body of literature demonstrates the role of personality in shaping cooperative behaviour, cooperation represents a particularly important dynamic to investigate. Broadly defined as individuals or groups working together to achieve shared goals or mutual benefit (Parks et al., 2013), cooperation is often studied using controlled experimental paradigms employed in the form of social dilemma games (Mantas et al., 2022). The Prisoner's Dilemma is one of such social games, capturing the tension between individual self-interest and collective results in a minimal setting. It requires two individuals to independently decide whether

to cooperate or defect, with defection yielding the highest individual payoff when the other player cooperates (see Table 2). When iterated, decisions are no longer driven solely by immediate payoffs but also by expectations of future behaviour and accumulated outcomes, allowing cooperation to emerge over time. In this setting, strategies represent recurring patterns of behaviour throughout rounds, with Tit-for-Tat being one of the most prominent, initiating with cooperation and then mirroring the opponent's previous move (Mantas et al., 2022).

Tab. 2: Prisoner's Dilemma: Standard Payoff Matrix. (Holodny, 2016)

	B silent (coop.)	**B betrays A** (def.)
A silent (coop.)	Both: 1 year	A: 3 years, B free
A betrays B (def.)	A free, B: 3 years	Both: 2 years

Although these models are grounded in assumptions of rational decision-making, individuals often behave irrationally in social dilemmas (Fischbacher et al., 2000). These systematic deviations from predicted behaviour can be partially explained by individual differences such as personality traits (Ruch et al., 2017). Within cooperative game settings, this translates into observable differences in strategy selection, with personality traits contributing to variation in cooperative dispositions.

Among the Big Five, Agreeableness emerges as the most consistent predictor of cooperation, with higher levels associated with an increased likelihood of cooperative and prosocial behaviour across a range of experimental settings (Rustichini et al., 2019; Volk et al., 2011; Kagel and McGee, 2014). This has been associated with a preference for fairness and a reluctance to exploit others for personal gain (Zhao and Smillie, 2015). Openness has also been positively associated with cooperation as well as reciprocity, and may reflect greater strategic adaptability, where individuals are more willing to explore long-term cooperative strategies rather than prioritising immediate payoffs (Al-Ubaydli et al., 2016; Lönnqvist et al., 2011). In contrast, Conscientiousness is generally associated with lower levels of cooperation, which could reflect a more cautious, rule-oriented approach, in which individuals closely follow the structure of the game and favour defection as a means of avoiding exploitation (Rustichini et al., 2019; Al-Ubaydli et al., 2016; Lönnqvist et al., 2011). Extraversion shows a limited and context-dependent relationship with cooperation, with some evidence linking it to increased cooperative behaviour, particularly under incentivised conditions (Hirsh and Peterson, 2009). This may be explained by the rewarding nature of social interaction, although this interpretation remains less widely supported. Neuroticism has been associated with lower baseline cooperation and greater behavioural variability, which is believed to reflect increased sensitivity to risk and uncertainty, leading individuals to cooperate defensively to avoid retaliation or defect due to fear of exploitation (Al-Ubaydli et al., 2016; Lönnqvist et al., 2011; Hirsh and Peterson, 2009).

2.3 Agent-Based Models of Personality in Cooperation

Although existing work has explored the integration of personality traits into ABMs of cooperation, approaches remain varied in how personality is operationalised. Indraprastha (2011) incorporates personality as continuous traits, using Extraversion and Agreeableness to modulate attraction, repulsion, and group formation. Szilagyi (2003) defines personality in terms of behavioural update rules within multi-agent Prisoner's Dilemma settings. In this model, agents differ in how they adjust to cooperation by responding to past rewards (accountant), conforming to majority behaviour (conformist), or imitating the most successful neighbour (greedy). The most closely related and recent work, Li et al. (2026), uses the Big Five framework within a spatial Prisoner's Dilemma, integrating both personality traits and emotional dynamics. The model is comparatively complex, with a primary focus on modelling dynamic emotional states, with personality traits subsequently integrated, largely to determine strategy adaptation and selection.

3 The Agent-Based Model

Although the model proposed by Li et al. (2026) includes several relevant elements, its complexity makes it unsuitable as a baseline, as it limits the ability to isolate individual effects. As a primary aim of this project is to examine how changes in personality traits influence cooperation, a simpler and more modular baseline is preferable. Therefore, we propose an ABM that isolates the role of personality traits in shaping cooperative behaviour. The design follows a bottom-up approach, beginning with a simple probabilistic agent and incrementally introducing complexity. Personality is operationalised using the Big Five (OCEAN), with each trait influencing the probability of cooperation through weighted parameters informed by empirical literature. For example, Agreeableness, being consistently associated with increased cooperation in iterated Prisoner's Dilemma settings, would be assigned a positive weight, whereas Conscientiousness, linked to more cautious and less cooperative behaviour, would be assigned a negative weight. This structure would allow individual mechanisms to be introduced and tested independently,

ensuring that their effects remain separable and interpretable.

As behaviour is not stable across different social dilemma games, but is relatively stable across variations of the same game, the model focuses solely on the Prisoner's Dilemma (Haesevoets et al., 2018). This choice is further motivated by the availability of an extensive empirical literature, from which behavioural mechanisms can be extracted, as discussed above. The model would also adopt an iterated rather than one-shot structure, as repeated interactions allow behavioural patterns such as reciprocity and reputation to emerge (Pothos et al., 2011). The empirical relationships used to parametrise the model would be primarily derived from incentivised experimental settings. This is relevant, as personality effects can differ between hypothetical and incentivised tasks: for example, Agreeableness has been shown to predict lower cooperation in hypothetical settings but higher cooperation in incentivised ones (Hilbig et al., 2014). As ABMs are inherently payoff-driven, the use of incentivised findings provides a more appropriate empirical basis for parameterisation.

The model outputs would extend beyond simple cooperation rates and would additionally capture how different personality profiles influence cooperation over time, allowing both individual tendencies and population dynamics to be examined. Finally, to simulate the effects of psychedelic-induced personality change, the model would include a manipulation phase in which personality traits are adjusted for a proportion of the population. By varying the magnitude and distribution of these changes, the model would allow systematic exploration of how shifts in personality structure may influence cooperative dynamics.

4 Conclusion

We reviewed the literature on the effects of psychedelics on personality and the relationship between personality traits and cooperation, and proposed a simple framework for modelling personality-driven behaviour in an agent-based Prisoner's Dilemma. The aim was to isolate the role of personality traits using a modular and interpretable design grounded in empirical findings.

The proposed model provides a baseline that can be extended with additional complexity, such as a spatial structure or evolutionary dynamics. It also allows for the simulation of psychedelic-induced personality change by shifting trait distributions within a population. Based on the literature, such changes would be expected to increase traits associated with prosocial behaviour, which may lead to higher and more stable levels of cooperation.

At the same time, behaviour is shaped by both individual traits and environmental factors, meaning that the model remains a reduction. Nonetheless, it provides a structured way to explore how changes in personality at the population level could influence cooperative dynamics.

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