

Mini Review on Psychedelic Drugs: Illumination on the Hidden Aspects of Mind

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ABSTRACT

Psychedelics constitute a class of psychoactive drugs with unique effects on consciousness. Psychedelic means mind/soul "revealing" and refers to the ability of these drugs to illuminate normally hidden aspects of mind or psyche. Many psychedelic agents occur in nature; others are synthetically produced. Naturally occurring psychedelic drugs have been inhaled, ingested, worshiped, and reviled since prehistory. The phenomenology of the hallucinogenic experience is extremely complex, sensory, emotional, cognitive, and spiritual, levels. Most psychedelic drugs structurally resemble with neurotransmitters: acetylcholine, two catecholamines (nor epinephrine and dopamine), and serotonin. These structural similarities lead to three classes for categorizing psychedelic drugs: anticholinergic, catecholamine-like, and serotonin-like. And also a fourth class of psychedelic drugs can be included, the psychedelic anesthetics. This mini review focuses on pharmacological and medicinal aspects of this class.

Keywords: Psychedelic drugs, Pharmacological features of psychedelic drugs, SAR of psychedelic drugs.

INTRODUCTION

"Rational consciousness...is but one special type of consciousness, whilst all about it, parted from it by the filmiest of screens; there lie potential forms of consciousness entirely different."-William James. Psychedelics constitute a class of psychoactive drugs with unique effects on consciousness. Psychedelic means mind/soul "revealing" and refers to the ability of these drugs to illuminate normally hidden aspects of mind or psyche. Many psychedelic agents occur in nature; others are synthetically

produced. Naturally occurring psychedelic drugs have been inhaled, ingested, worshiped, and reviled since prehistory. Native American shamans consumed psychedelic plants such as the peyote cactus (contains mescaline), psilocybe "magic" mushrooms (contains psilocybin), or the brew called ayahuasca (contains DMT and harmaline) in order to communicate with God or the spirit realm. By supplying that stimulus, psychedelic drugs provide an instrument for experimental investigation of

what have come to be called altered states of consciousness (ASC). And shall examine what they have to teach us about brain physiology, schizophrenia, dreams, birth and death, artistic and scientific creation, and the roots of religious belief (Photograph).

Historical Background

These drugs can induce hallucinations, separating people who use them from reality. Because of the wide range of psychological effect they produce, the single term that might best be used to classify these agents has long been debated. The term hallucinogen is used because these agents can, in high enough doses, induce hallucinations. However, the term is somewhat inappropriate because illusory phenomena and perceptual distortions are more common than are true hallucinations. The term psychotomimetic has also been used because of the alleged ability of these drugs to mimic psychoses or induce psychotic states. However, most of these drugs do not produce the same behavioral patterns that are observed in people who experience psychotic episodes. Others have used a descriptive term, such as phantasticum or psychedelic to imply that these agents all have the ability to alter sensory perceptions. In this article the term psychedelic is used because it allows for more flexibility in grouping together a disparate array of effects into a quantifiable and recognizable syndrome¹. Abraham, Aldridge, and Gogia² define a psychedelic drug as “any agent that causes alterations in perception, cognition, and mood as its primary psychobiological actions in the presence of an otherwise clear sensorium.” This definition separates the pure psychedelic drugs from other substances that can cause altered states of thinking and perception, such as poisons that affect the mind and delirants that produce clouding of consciousness and amnesia.

The psychedelic experience is relatively new to industrial cultures, and has historically been at odds with centralized forms of government. Except for the accidental discovery of LSD in 1943, knowledge of psychedelic agents have come as legacies of ancient American religions, where these psychic effects are considered to be of a divine or holy in nature³⁻⁶.

Just over 110 years ago, the German pharmacologist Arthur Heffter began a systematic investigation into the isolated components of 'peyote' (*Lophophora williamsii*) by ingesting a series of these alkaloids himself. Subsequently, mescaline was identified as the active component of this North American cactus, which had been used since pre-Columbian times as a psychoactive sacrament. Peyote persists as the central sacrament of several native religions in Mexico and the U.S.

Following the discovery of LSD, psilocin and its phosphate ester (psilocybin) were both isolated from the fungi *Psilocybe mexicana* and synthesized in the late 1950s⁷. Again, the active components were only identified by human experimentation, after animal testing gave ambiguous results. To complete the study, synthetic psilocybin was returned to the village of Huatla de Jimenez in Oaxaca, Mexico, its place of botanical origin, and given to the Mazatec shaman María Sabina who confirmed the synthetic substance to be "the same God" she had previously known only through the mushroom⁸.

Throughout the 1950s psychedelics became an obvious and powerful influence on the growing field of molecular psychiatry, initially as models for psychosis and eventually as adjuncts to psychotherapy. At the same time, chemical warfare researchers explored these compounds for their potential as "truth serums" and adjuncts to "brain washing"^{6,9}. Through both military and medical channels, these substances then

began to surface in artistic and intellectual circles throughout the world. And in spite of proscription of some psychedelic drugs, popular experimentations have still continued.

CHARACTERISTIC FEATURES

The phenomenology of the hallucinogenic experience is extremely complex, operating, again, at physiological, sensory, emotional, cognitive, and we could say, spiritual, levels. Psychedelics induced alterations are so drastic from our normal states of consciousness, that, again, we may call the state induced by hallucinogens an Altered State Consciousness (ASC).

The physiological effects of hallucinogenic induced ASC are reasonably straight-forward: pupils dilate, heart rate increases, breathing patterns are altered, chills and tremors are experienced, spontaneous motor motions such as dance and gestures may result, and sleeping is significantly impaired. The controversy begins when we go beyond the obvious physiological symptoms of these drugs. At sensory, emotional and cognitive levels a wide variety of conflicting reports exist. Perhaps the easiest way to conceptualize the variety of views of the effects of psychedelic drugs is to realize that they lie along a spectrum.

At one extreme of this spectrum, the effects of psychedelics are viewed in a negative light and thought of as a neuropathology; sensory alterations; 'hallucinations', emotional changes are seen to be related to paranoia and the disjointed behavior of schizophrenics, and cognitive alterations are considered to be delusions. Thus, to some, all alterations caused by psychedelics are considered subnormal or pathological.

At the opposite extreme of the spectrum, psychedelic effects are viewed in a positive light and associated with super-

normal alterations in sensory, emotional and cognitive effects. The most positive accounts describes mystical revelations such as gaining direct knowledge of God or an all-encompassing cosmic unity. More commonly reported is a kaleidoscopic display of intensely colorful visions, ranging from continuously unfolding abstract designs to fully formed images of animals, plants, landscapes or more bizarre scenes. They also enhance creativity; enhance the operation of the mind and emotions, and produce effects highly therapeutic for the psychological growth of the individual¹⁰.

Psychedelic drugs are not addictive. Even enthusiastic proponents of psychedelics take them infrequently due to the intensity of the "trip." Animal research indicates that *Homo sapiens* are the only species that will voluntarily take a psychedelic drug again after having experienced the effects. Although laboratory animals such as rats or monkeys will readily self-administer most other drugs abused by humans, including cocaine, heroin, amphetamine, nicotine and alcohol, they find psychedelic drugs highly aversive (Yokel, 1987).

PHARMACOLOGICAL FEATURES

Mounting evidence continues to show strong correlations between receptor activity and behavior; however, the psychic effects are not contained within the chemistry of these or any other, psychoactive drugs. Instead, neurochemical interactions are thought to affect neuronal activity, and receptor sites for neuroactive compounds are one substrata of the neural circuitry which leads to mental activity. As with other drugs, the psychedelics may become ionized in receptor sites to form charge transfer complexes, thus modifying the local flow of electrons and, subsequently, the transmission of neuronal information^{31, 32}.

Typical Pharmacologic Effects Associated with Psychedelic Activity:

- Pupillary dilation at full dose/effect
- Cross tolerance between other members (rare exceptions)
- Tolerance not overcome by increasing dosage (rare exceptions)
- Not “addictive”, i.e., no withdrawal effects after discontinuing use
- Not associated with compulsive use
- Strong serotonergic activity, both “agonistic” and “antagonistic”
- Often a loss of appetite during the experience
- Heightened arousal; sleep is often impossible
- Toxic doses are essentially unknown, except with some phenethylamines³⁸.

Chemical similarities and interactions with other neurotransmitters may account for variations in effect between indolealkylamines, lysergamides, and phenethylamines. In very general terms, the phenethylamine psychedelics are said to be more energetic, sensual, empathogenic, or entactogenic, while tryptamine psychedelics are thought to be more hallucinogenic, disorienting, and somatically heavy. These descriptions are very broad, but this is the popular distinction made between the two major classes of psychedelics.

CHEMISTRY AND STRUCTURE ACTIVITY RELATIONSHIPS

Most psychedelic drugs structurally resemble one of four neurotransmitters: acetylcholine, two catecholamines (norepinephrine and dopamine), and serotonin. These structural similarities lead to three classes for categorizing psychedelic drugs: anticholinergic, catecholamine-like, and serotonin-like. And also a fourth class of psychedelic drugs can be included, the psychedelic anesthetics (eg. Phencyclidine-

PCP), which exert their psychedelic actions by affecting a specific subclass of glutamate receptors, the NMDA receptors.

However, with few exceptions, the chemistry of psychedelic compounds can be categorized as either indolealkylamines (i.e., as tryptamines or ergotamines) or phenethylamines¹¹. Stereochemical aspects are also important for psychoactivity, and have already been mentioned below^{12,13}.

A. Indole-alkyl-amines

Indole alkaloids are found in many plants, animals, and several microorganisms. They account for about one quarter of the known alkaloids. Many indoles that have known neuroactive properties carry an aliphatic ethylamine at position 3 on the indole ring (Figure 1). A large portion of psychedelic agents are tryptamines, where the ethylamine side-chain is alkylated and has a relatively wide range of molecular motion. Important substitution sites that determine psycho activity are on the indole ring, the side-chain carbons, and the aliphatic nitrogen. N, N-Dimethyltryptamines (DMTs) provide the most remarkable effects in this series (Figure.1), where only psilocin and psilocybin show oral activity. 5-HT receptor subtype differentiation among several N, N-dialkylated tryptamines has been reported¹⁴. A listing of psychedelic indolealkylamines, typical human dosages, and notable receptor binding sites are presented in Table 1.

N-Alkyl homologues of DMT, in which the N, N-dimethyl substituents are replaced with longer and more hydrophobic aliphatic moieties, include the diethyl-, dipropyl-, diisopropyl and diallyltryptamines. All of these derivatives are psychoactive in humans, and most are orally active. Qualitatively, homologation of the N, N-dialkyl substituents attenuates the intensity of the experience, and prolongs the course of action. Nonsymmetrical alkyl substitution of

the side-chain nitrogen (e.g., methyl isopropyl- or methyl ethyl-) also yields orally active compounds with threshold doses and qualitative actions similar to those of their N, N-dimethyl derivatives¹⁵.

In general, hydroxylation at the 4-position on the indole ring, as in the prototypical compound psilocin, enhances the potency of N, N-dialkyl homologues and non symmetric N-alkylated derivatives by approximately an order of magnitude, compared to the unsubstituted derivatives. Methoxylation at the 5-position on the indole ring similarly increases potency but also enhances the stimulatory ("amphetamine-like") effects while attenuating visual effects. Derivatives with 6-, 7-methoxy-, 5, 6-dimethoxy-, 5,6-methylenedioxy substituents also display greatly attenuated activity.

Methyl substitution on tryptamine's side-chain, at the α -carbon, also results in orally active psychotropic compounds. Racemic N1-n-propyl-5-methoxy- α -methyltryptamine, for example, has been reported to bind with high affinity and significant selectivity to 5-HT₂ receptors¹⁶. α -Methyl tryptamine, itself, and its 5-methoxy- and 4-hydroxy- congeners are orally active in humans at the 3 to 30mg level. α -substituted tryptamines are the only enantiomeric derivatives in this class that have been empirically investigated and, in general, the S-(+) enantiomers are more potent than the R-(-) enantiomers in human and other animal experiments. α -Methyltryptamine and α -ethyltryptamine are competitive inhibitors of monoamine oxidase (MAO), and this property may account for their oral activity, as well as their prolonged duration of action relative to other psychoactive tryptamines.

1. Psilocin and Psilocybin

These two di-methyltryptamines were first isolated from the mushroom *Psilocybe Mexicana*⁷ and named in 1958 by Swiss chemist Albert Hofmann. These alkaloids are

also present in at least 95 other species of mushroom which are found throughout the world. Both are orally active and epitomize the psychedelic effect for tryptamines. As a prodrug, psilocybin is quickly converted by the body to psilocin. Neither compound has known toxicities. As a natural product, often known as "magic" mushrooms, these two alkaloids may be the most widely used and readily available psychedelic agents. The subjective effects are relatively short compared to LSD or mescaline, though fairly long when compared with other dimethyltryptamines. Both have high affinity for 5-HT_{1A} and 5-HT₂ sites (Figure 1)¹⁴.

2. Di-Methyl Tryptamine

N, N-Dimethyltryptamine (DMT) is agonistic at 5-HT_{1A} and 5-HT_{1C} and antagonistic at 5-HT₂ sites, though may also show partial 5-HT₂ agonistic activity (Figure 1, Table. 1)^{14, 17}. It is not orally active, due to its rapid oxidation by type A monoamine oxidase (MAO-A). It was first identified as a component of cohoba, a psychotropic snuff prepared from the seeds of *Anadenanthera peregrina* (formerly *Piptadenia peregrina*) in 1955. Although it had been synthesized 24 years earlier, its psychoactivity was not reported until 1956¹⁸. DMT occurs in trace amounts in mammals, including humans, where it putatively functions as a trace amine neurotransmitter/neuromodulator, and can be injected, smoked, or insufflated¹⁹. It is originally derived from the essential amino acid tryptophan and ultimately produced by the enzyme INMT during normal metabolism³⁹. The most outstanding effect from this simple tryptamine is the explosion of visual imagery, primarily scintillating colored patterns, for only a few minutes after administration. This effect is almost absent in emotive content, perhaps due to the brevity and intensity of visual phenomenon.

3. MEO-DMT

5-Methoxy-DMT (5-MeO-DMT) was first synthesized in 1936, and in 1959 it was isolated as one of the psychoactive ingredients of *Anadenanthera peregrina* seeds used in preparing Yopo snuff. It is a full agonist at 5-HT_{1A}, 5-HT_{1C}, 5-HT_{1D}, and 5-HT₂ sites (Figure 1, Table. 1)^{14,20}. Like DMT, it is also found as a component of traditional psychoactive snuffs from the Americas, and the psychoactive effects are short. It is active orally, when taken with a MAOI, but according to numerous reports, the combination with MAOI is extremely unpleasant and has a strong body load. Additional mechanisms of action such as inhibition of MAOI may be involved also. According to the researcher Jonathan Ott, 5-MeO-DMT is active orally with doses over 30 mg without aid of an MAOI. Unlike DMT, however, its primary effect is almost entirely devoid of visual content, while an emotive phenomenon predominates. It has been described as a "near death" experience, though this is certainly psychological as no toxicological effects have been demonstrated. Besides being found in plants, 5-MeO-DMT is also produced in the skin of some toads, particularly *Bufo alverius* from the deserts of the American Southwest²¹. Contrary to popular belief, these toads are not licked, but "milked" for their venom from the parietal glands. The collected venom is dried and subsequently smoked for psychoactive effects.

4. LSD (Lysergic Acid Diethylamide)

LSD is a semisynthetic psychedelic drug of the ergoline family, well known for its psychological effects which can include altered thinking processes, closed and open eye visuals, synesthesia, an altered sense of time and spiritual experiences, as well as for its key role in 1960s counterculture. Ergot (*Claviceps purpurea*), a parasitic fungus that grows on rye and a few other grasses, has

been used since antiquity as an abortifacient. Ergotamines are now known to be powerful contractors of the uterus, a tissue rich in 5-HT receptors. The tetracyclic ergoline ring system is represented by LSD (Figure 1), and related derivatives are known more specifically as lysergamides.

Although first synthesized in 1938 as the 25th derivative in a series of lysergamides, LSD (Lysergic Acid Diethylamide), was not until 1943 that Albert Hofmann inadvertently absorbed enough d-LSD-25 to notice its psychoactive potential²². Subsequent investigations confirmed this activity. At the time it was the most potent neuroactive substance known, being active at less than 1µg/kg. LSD is a full 5-HT_{1A} agonist, partial/weak 5-HT₂ agonist/antagonist¹⁷, with additional affinity at 5-HT_{1D}²³, and also binds with high affinity to dopamine (DA) D₁ and D₂ receptor sites²⁴.

B. PHENETHYLAMINES

1. Mescaline

Mescaline (3, 4, 5-trimethoxyphenylethylamine) is an anomaly among psychedelic drugs in that the effective dosage is extremely high, perhaps due to interactions with MAO (Table. 2). It occurs naturally in the peyote cactus (*Lophophora williamsii*), the San Pedro cactus (*Echinopsis pachanoi*) and in the Peruvian torch (*Echinopsis peruviana*), and as well in a number of other members of the Cactaceae plant family. Even more potent phenethylamines seem to lack the unique "sparkle" of mescaline, in terms of psychoactivity; most are sympathomimetically more stimulating with some component of the full "mescaline" effect²⁵. It is surprising how little receptor binding data is available for mescaline.

Modifications to substituents on position 4 of the phenyl ring seem most tolerated in terms of maintaining potency with some psychoactivity. Modifications, and

especially lengthening, of substituents at position 2 are most disruptive, and position 5 is less sensitive to change than position 2 (Figure. 2, Table. 2). While the following compounds are not nearly a complete list of psychotropic phenethylamines, they are representative to some extent. Overall, methylation at the α -carbon on the ethylamine chain increases sympathomimetic potency at the expense of psychedelic activity, and the R(-) enantiomers are generally the more potent stereoisomers²⁶. Also, 2, 4, 5-substituted compounds are more potent than their analogous 3, 4, 5-derivatives²⁷. Increased lipophilicity of substituents at position 4 may facilitate passive diffusion into the CNS to interact with a hydrophobic region on the 5-HT receptor²⁸. Substitution at this position probably confers metabolic stability by blocking oxidation and hydroxylation²⁷. In general, these compounds show agonistic actions at serotonergic sites.

2. DOB

1-(2, 5-Dimethoxy-4-bromophenyl)-2-aminopropane (DOB) has essentially the same psychoactive profile as DOI²⁵. Both are phenyl isopropyl amines having a 2, 4, 5-substitution pattern, and both are very potent in humans at low dosages (Table. 2, Figure 2.). Also, the R(-) enantiomer of each compound binds with high affinity and selectivity to 5-HT₂ receptor subtypes²³. While some psychoactivity from this and related 2, 4, 5-substituted phenylalkylamines may be called “psychedelic”, the most prominent effect is sympathomimetic stimulation in conjunction with mescaline-like psychoactivity²⁵. At higher dosages, this stimulation tends to dominate more subtle overtones of psychoactivity that are certainly present and reflective of psychedelic activity.

3. 2C-B

2-(2, 5-Dimethoxy-4-bromophenyl)aminoethane (2C-B) was first synthesized by

Alexander Shulgin in 1974. In Shulgin's book *PiHKAL*, the dosage range is listed as 16–24 mg. It has a similar substitution pattern to DOB, though lacks a chiral center on the ethylamine side chain (Figure 2). This simplification is a distinct advantage over DOB as it eliminates the possibility of labeling a receptor with a racemic product. Both 2C-B and 2C-I have shorter durations of action and less sympathomimetic activity than either DOB or DOI²⁵. The subjective effects of 2C-B have been described as being more “tryptamine-like” than other phenethylamines.

4. MDMA

3,4-Methylenedioxy-ethamphetamine (MDMA) or commonly referred as Ecstasy, was first mentioned in a German patent assigned to E. Merck in 1914. In a review of declassified material from military studies, it is mentioned as having toxicological effects at high dosages²⁹. This was apparently the first publication of structure-activity relationships among psychoactive phenethylamines. While most psychoactive phenethylamines offer the R (-) stereoisomer as the most active form (e.g., MDA; DOB; DOM Figure. 2), the S (+) enantiomer is the more potent form of MDMA. The R (-) isomer of MDMA has been shown to be the more potent enantiomer in releasing 5-HT, thus linking psychoactivity for this compound with serotonergic function³⁰.

CONCLUSION

Vigorous research into psychedelic drugs, which began more than a half-century ago, effectively came to a halt in 1970 when Richard Nixon signed the Controlled Substances Act, outlawing the most common hallucinogens. But improvements in brain imaging, combined with a better understanding of neurochemistry, are helping psychedelics regain their status as promising therapeutic agents for curbing addiction,

anxiety, depression, OCD, and other ills. "These were considered drugs of abuse, and were not attractive for researchers," said David Nichols, a professor of pharmacology at Purdue University who synthesized psilocybin, MDMA, and other psychedelics for researchers when the drugs were difficult to obtain and co-founded the Heffter Institute, which supports psychedelic research. "Now I would say that in 10 years there might be a host of treatments that employ psilocybin or related substances for anxiety, depression, and addiction."

However, though in the future a breakthrough of psychedelic drugs in the treatment of affective disorders and other psychiatric diseases might occur, it won't be a sole solution of complete treatment from these disorders. Till date, one of the reasons to the inability to come up to a novel drug that could restore or relatively stabilize the normal functioning of the psychological mind is due to the highly integrated nature of the central nervous system and our incomplete understanding of its functioning. And as various specific molecules (chemical messengers, neurotransmitters, peptides...etc) bind to various sites, as molecular "transistors" to modify the flow of neuronal information, to work in an orchestral harmonious fashion for the proper functioning of the mental health, a specific antagonist/agonist for a certain mediator or neurotransmitter alone can't mimic the normal functioning of the nervous system. Just as fingers match specific keys on a piano to transmit music, psychedelic agents bind to discrete receptor sites and reveal psychic effects and also, other molecules give rise to specific behavioral pattern. That's why a new approach to treatment strategy of psychological disorders could possibly be seen as the combination of different centrally acting psychotropic drugs and others like Tricyclic Antidepressants, Psychedelic drugs, Neurokinins, IL-10 (Interleukin-10)...etc.

That each works in specific sites and regions of the brain, like specific key notes in a piano, that further gives rise to desired rhythm of mental functioning.

However, since the psychic effects of psychedelic drugs are almost entirely of the mind, meaningful information on the qualitative effects have not been readily obtained from animal studies, as with other drugs; i.e., the existence of "mindfulness" has not been sufficiently demonstrated in other animals and, more to the point, a common language does not exist between humans and any other animal to convey such information. In the absence of a useful experimental model, and considering the characteristic lack of toxicity with most psychedelic agents, further studies into the application of these drugs should proceed with experiments using healthy human volunteers.

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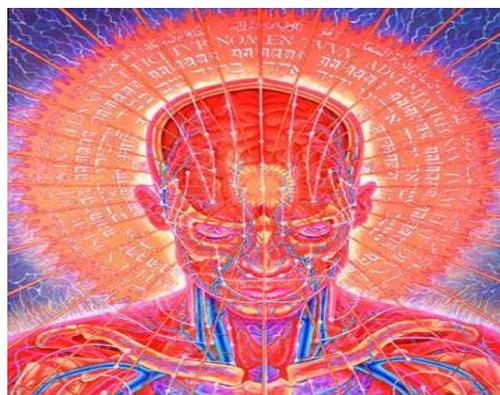
Table 1. A Listing of Psychedelic Indolealkylamines, Dosage, Route of Administration, Duration of Action and Notable Receptor Binding Sites

| Compound | Dose ($\mu\text{g}/\text{kg}$) | Route | Duration of action | Receptor sites |
|-----------|----------------------------------|--------|--------------------|---|
| LSD | 1.5 | p.o. | 8-12h | 5-HT _{1A} , C & D, 5-HT ₂ , DA ₁ & 2 |
| Psilocin | 300 | p.o. | 3-6h | 5-HT _{1A} , 5-HT ₂ |
| DMT | 400 | s/i.v. | 10-15m | 5-HT _{1A} & C, 5-HT ₂ |
| 5-MeO-DMT | 200 | s/i.v. | 10-20m | 5-HT _{1A} , C & D, 5-HT ₂ |
| 5-HO-DMT | 50 | s | 10-20m | 5-HT _{1A} , C & D, 5-HT ₂ |

Abbreviations: oral (p.o.), smoked/insufflated (s), injected (i.v.), hours (h), minutes (m), 5-HT =serotonin, DA = dopamine.

Table 2. A Listing of Phenethylamines (PEA) and Phenylisopropylamines (PIA), Their Substitution Patterns on the Aromatic Ring, Oral Dosage, Duration of Action in Hours and Notable Receptor Binding Sites

| Compound | Molecular class and substitution sites | Dosage ($\mu\text{g}/\text{kg}$) | Duration of action | Receptor |
|-----------|--|------------------------------------|--------------------|---|
| Mescaline | PEA 3,4,5 | 5,000 | 8-12 | 5-HT sites |
| MDMA | PIA 3,4 | 1,800 | 8-12 | 5-HT _{1A} , 5-HT uptake site |
| 2C-B | PEA 2,4,5 | 300 | 4-8 | 5-HT _{2A} and 5-HT _{2C} |
| 2C-I | PEA 2,4,5 | 300 | 4-8 | 5-HT _{2A} and 5-HT _{2C} |
| DOB | PIA 2,4,5 | 30 | 18-30 | 5-HT _{2A} and 5-HT _{2C} |
| DOI | PIA 2,4,5 | 30 | 18-30 | 5-HT _{2A} and 5-HT _{2C} |



Illumination of mind aspects.

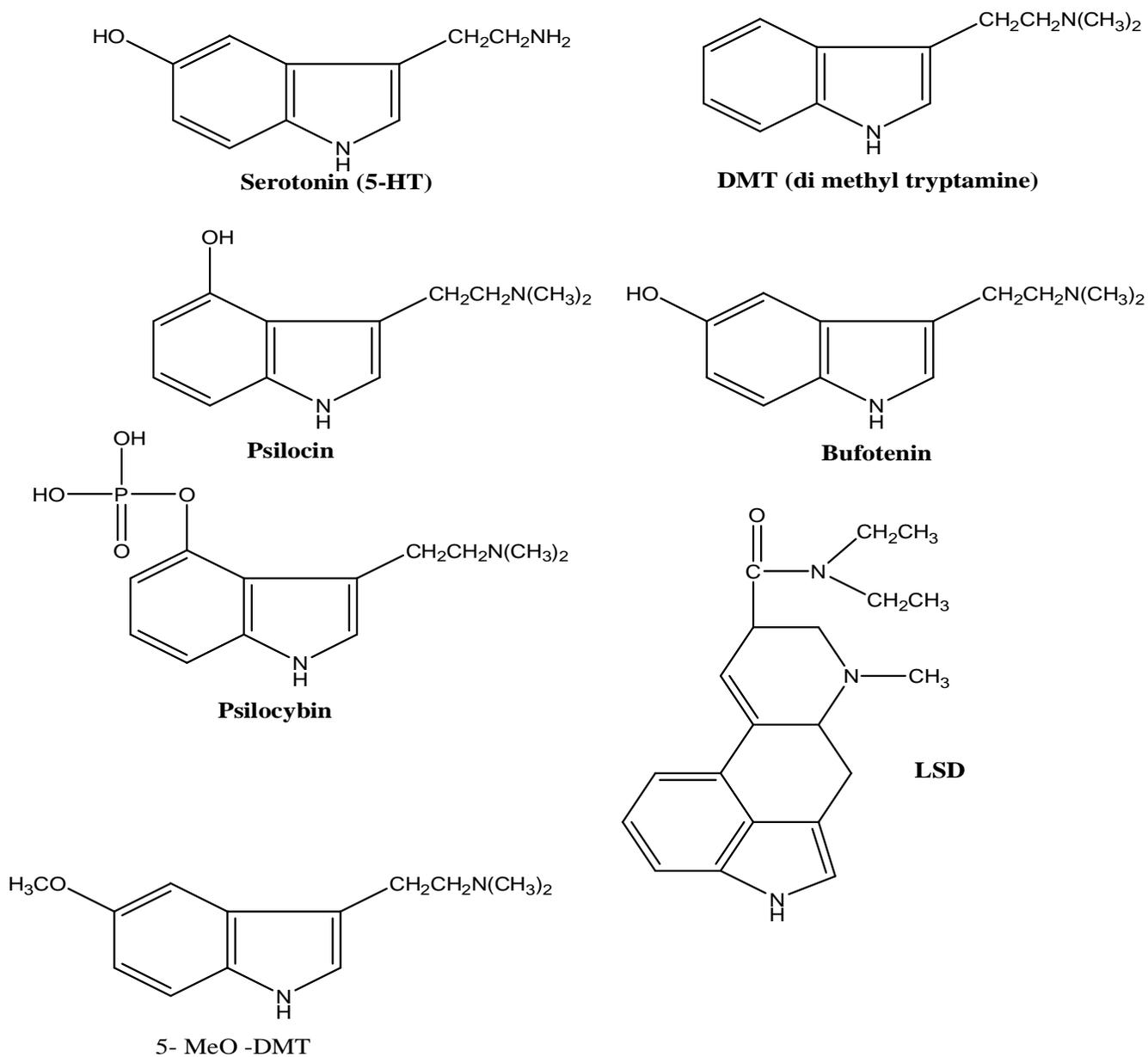


Figure.1. Structural formulas of serotonin (neurotransmitter) and six serotonin like psychedelic drugs. These six drugs structurally related to the serotonin and are thought to exert their psychedelic actions through alterations of serotonin's synapses in the brain. Although LSD is structurally much more complex than serotonin, the basic similarity of the two molecules is apparent.

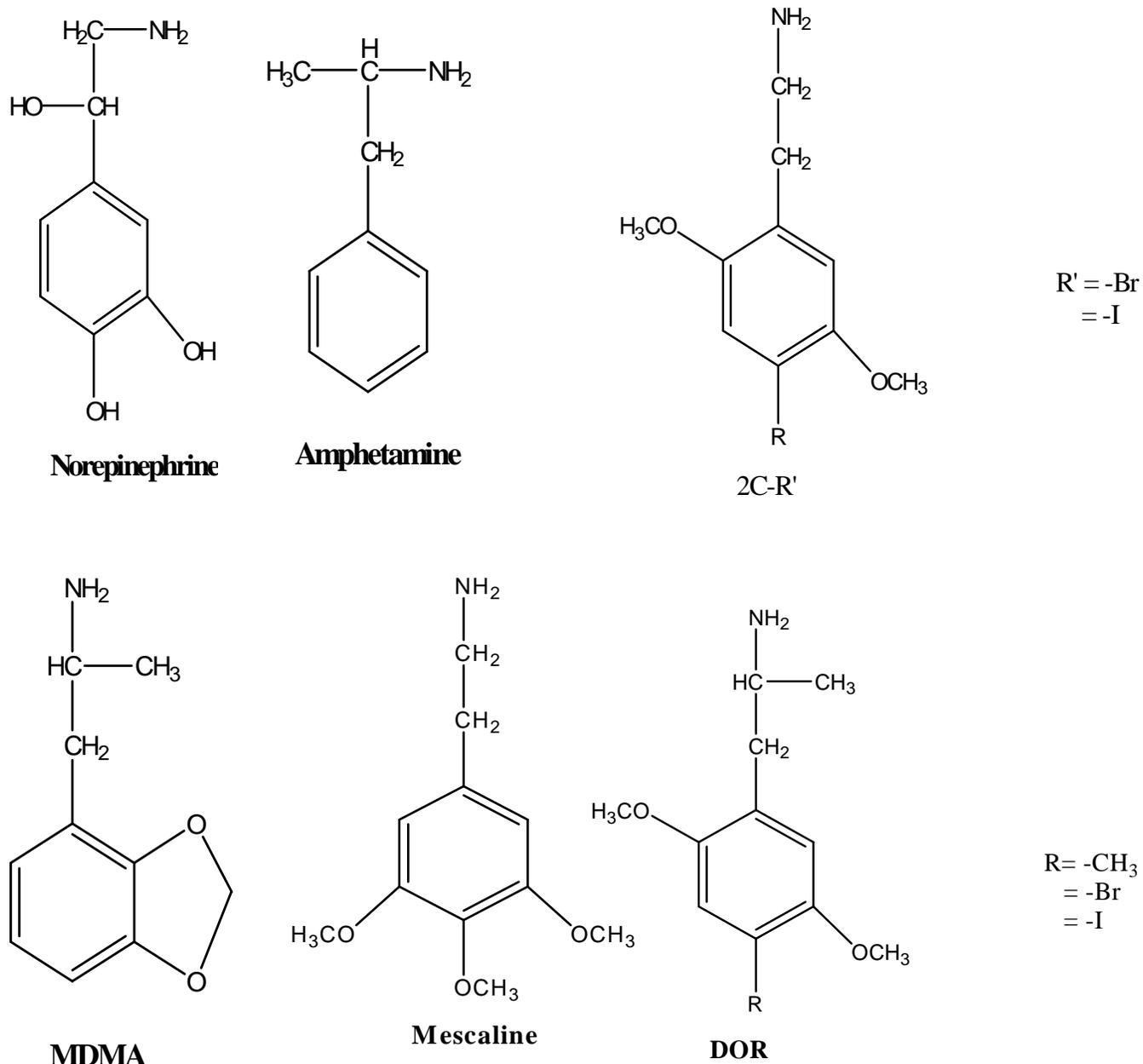


Figure.2. Structural formula of norepinephrine, amphetamine and four catecholamine like psychedelic drugs. These four drugs are structurally related to norepinephrine and are thought to exert their psychedelic actions by altering the transmission of nerve impulses at norepinephrine and serotonin synapses in the brain.