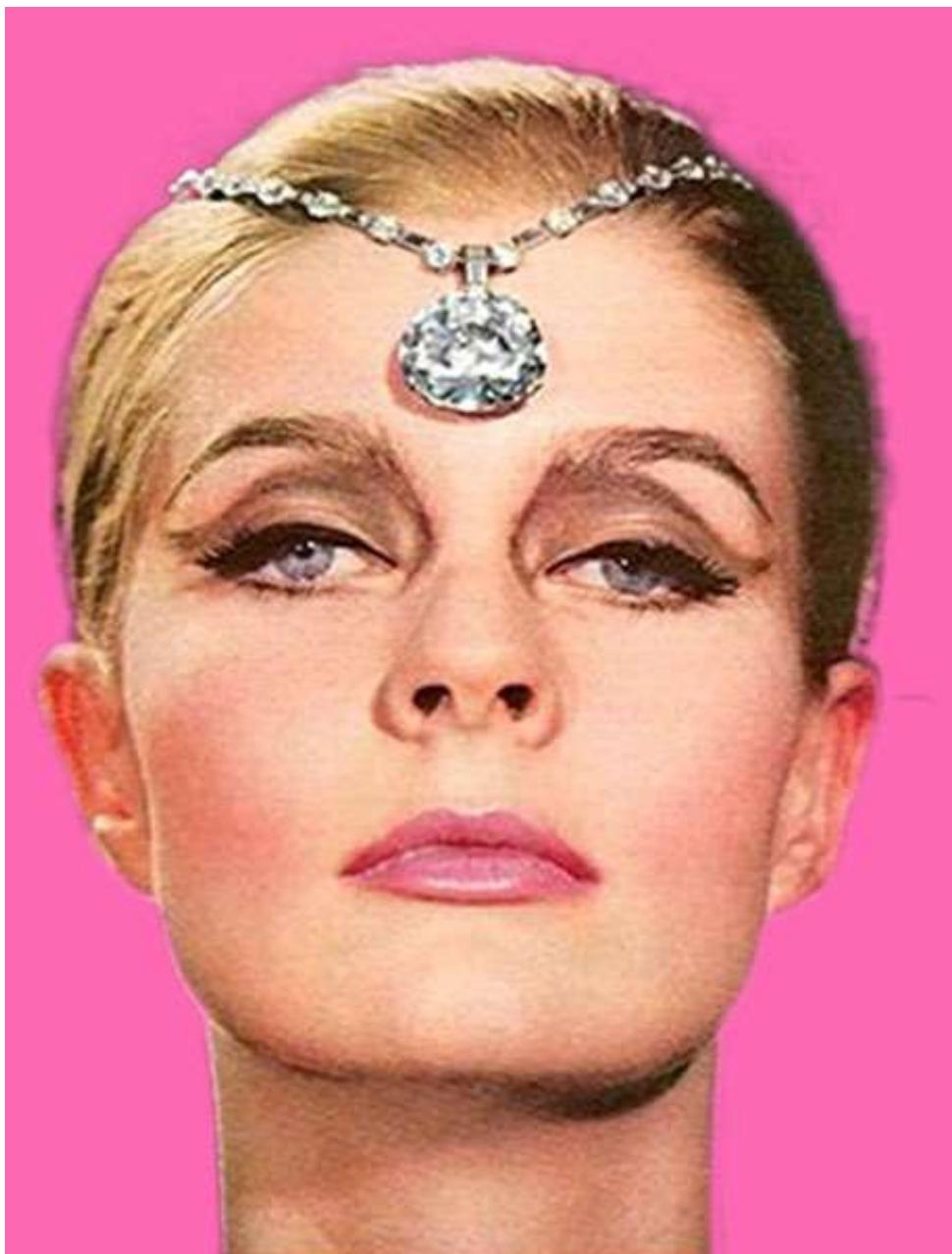


LYSERGIC ACID DIETHYLAMIDE (LSD)



*Cool woman with a groovy diamond, 60s Model wearing the "Idol's Eye" diamond,
1963, "Matter", Life Science Library.*

"Now my own suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose. I suspect that there are more things in heaven and Earth than are dreamed of, or can be dreamed of, in any philosophy".

Possible Worlds. J.B.S Haldane, 1927.

*Picture yourself in a boat on a river,
With tangerine trees and marmalade skies
Somebody calls you, you answer quite slowly,
A girl with kaleidoscope eyes.*

*Cellophane flowers of yellow and green,
Towering over your head.
Look for the girl with the sun in her eyes,
And she's gone.*

*Lucy in the sky with diamonds.
Lucy in the sky with diamonds.
Lucy in the sky with diamonds.*

*Follow her down to a bridge by a fountain
Where rocking horse people eat marshmallow pies,
Everyone smiles as you drift past the flowers,
That grow so incredibly high.*

*Newspaper taxis appear on the shore,
Waiting to take you away.
Climb in the back with your head in the clouds,
And you're gone.*

*Lucy in the sky with diamonds,
Lucy in the sky with diamonds,
Lucy in the sky with diamonds,*

*Picture yourself on a train in a station,
With plasticine porters with looking glass ties,
Suddenly someone is there at the turnstile,
The girl with the kaleidoscope eyes.*

*Lucy in the sky with diamonds
Lucy in the sky with diamonds
Lucy in the sky with diamonds*

Lucy in the Sky with Diamonds, The Beatles 1967

The largest faceted diamond on Earth is the 546 carat Golden Jubilee, recovered from the Premier mine in South Africa. Worth millions of dollars it is a breathtaking sight for those few that have been lucky enough to have seen it with their own eyes.

On the cosmic scale however this Earthly gem would not even rate as much as the tiniest most insignificant grain of sand on the beach. There are stranger things in the Universe than we can possibly begin to imagine. In the vast firmament of the Southern night sky, in the constellation of the Centaur, invisible to the naked eye and fifty light years from the Earth, lurks an unimaginable wonder.

In 2004 astronomers at the Harvard-Smithsonian Center for astrophysics were studying a celestial object known simply as BPM 37093. This object is a variable white dwarf star. A white dwarf star is what small stars, those up to about the size of the Sun, turn into when their nuclear fuel is spent and they begin to die and collapse into themselves, a small dark remnant of their once glorious luminosity.

A half-forgotten bizarre theory emerged in the world of the astronomers of the early 1960s that under certain conditions a collapsed star might generate the element carbon at its central core, and that under immense pressures that would exist within the core, this carbon could suddenly begin to crystallize. The Harvard-Smithsonian astronomers in 2004 were studying the variable pulsations of BPM 37093, in order to try to understand its interior structure. Astronomer Travis Metcalfe, leader of the investigating team, later described one of the most astonishing conclusions of modern astronomy:

"By measuring these pulsations we were able to study the hidden interior of the white dwarf, just like the seismograph measurements of earthquakes allow geologists to study

the interior of the Earth...We figured that the carbon interior of this white dwarf has solidified to form the galaxy's largest diamond!"

BPM 37093 is actually a 4,000 kilometer diameter diamond, enveloped in a hot hydrogen-helium atmosphere. In term of carats, BPM 37093 has 10 billion trillion trillion of them! So when a woman is offered "a star or the Moon", by potential suitors, she would do well to remember that "diamonds are a girl's best friend", and she could have no better friend in the cosmos than BPM 37093!

By implication many other white dwarf stars must also have diamond cores. It is thought that when our own Sun is in its terminal life it too will become a white dwarf. A giant diamond will reside in the center of our Solar system. A white dwarf is stable once formed and will continue to cool almost indefinitely; eventually it will become a black dwarf. A black dwarf is a hypothetical stellar remnant created when a white dwarf becomes sufficiently cool to no longer emit significant heat or light. Since the time required for a white dwarf to reach this state is calculated to be longer than the current age of the universe of 13.7 billion years, no black dwarfs are expected to exist in the universe as yet. Therefore diamonds are indeed very nearly forever! We can only feel the wonder of children as they gaze into the night sky and recite the age old nursery rhyme: "twinkle, twinkle, little star, how I wonder what you are, up above the world so high, like a diamond in the sky,". The star-gazing children of past ages were more correct than we could have possibly imagined, white dwarf stars are indeed "diamonds in the sky."

From my own childhood in the 1960s I recall the famous Beatles' song "Lucy in the Sky with Diamonds". The astronomers of my own generation who discovered the "diamond in the sky" no longer refer to this wonder merely as BPM 37093, today it is affectionately known as "Lucy".

Age sometimes sanitizes the past however. Anyone who remembers the Sixties knows the widely whispered rumors that the song had far more to do with the kaleidoscopic effects of the initials of the title (LSD) than it did with John Lennon's claim that the song was merely describing a surreal dreamscape inspired by a picture drawn by his son Julian.

Those who ingest this drug, are truly in for a "magical mystery tour". Perceptions of great universal truths may await them, such as planet sized diamonds hidden in the firmament of the sky!

LYSERGIC ACID DIETHYLAMIDE (LSD)

Introduction

Lysergic Acid Diethylamide (LSD) is one of the most potent psychoactive drugs known, being many orders of magnitude (3000-5000 times) more potent than mescaline or psilocybin.

It is primarily an **hallucinogenic** agent.

The classic hallucinogens include **LSD, psilocybin, and mescaline**.

Phencyclidine (PCP) and ketamine are more correctly dissociative anesthetics rather than hallucinogens

History

LSD was first synthesized in 1938 by the Swiss biochemist Albert Hofmann.

The powerful hallucinogenic properties of LSD were not appreciated until 1943 when Hofmann himself inadvertently ingested a large dose.

It became extremely popular during the 1960s and early 1970s as a “recreational” drug. The experience of taking LSD became known as a taking a “trip”.

In the 1960s it was trailed as a medicinal agent for many conditions including, alcoholism, autism, sexual disorders, personality disorders or pain control in the terminally ill. No therapeutic benefits were found, the observed toxicity however was alarming!

It was banned by the US government in 1967.

Though its recreational use declined dramatically after the mid-seventies, its use has begun to increase again in recent years.

Chemistry

LSD can be synthesized from diethylamine and lysergic acid, a naturally occurring plant ergot alkaloid produced by the Rye grain fungus, *Claviceps purpurea*.

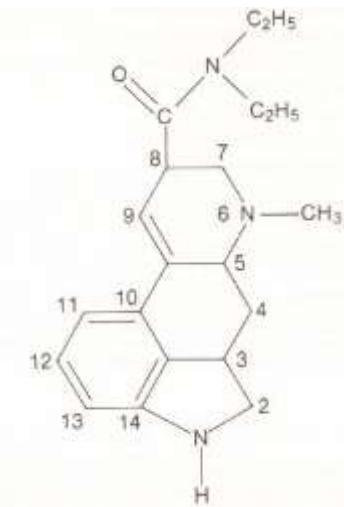
It is an odorless and colorless substance with a slightly bitter taste.

It is water soluble.

Illicit use

LSD is sold on the street in many forms including tablets, capsules, powder, and occasionally in liquid form.

It is often added to sugar cubes, gelatin or **absorbent blotting paper** where it is divided into small decorated squares, with each square representing one dose.



Chemical structure of LSD



LSD impregnated blotting paper squares, (USA Drug Enforcement Administration, photo library)

Street names are legion - but most commonly “**acid**” is used.

It should be noted however that using a slang term to try and identify a drug of abuse is potentially dangerous since there are many regional variations and the terms continually change over time.

Pathophysiology

The psychotropic effects of LSD are attributed to its strong agonist effects at central serotonergic receptors. 5-HT₂ receptors stimulation correlates well with hallucinogenic potency

LSD is one of the most potent hallucinogens known, and psychoactive effects can be observed after ingestion of just 20 to 25 ug.³

Serotonin syndrome can be induced.

Pharmacokinetics

LSD is an extremely potent drug.

Clinically significant dosages are measured in micrograms. As little as 20-30 micrograms will cause clinical effects. Typically ingested doses range from 100 -1000 micrograms.

Absorption

- LSD is usually ingested orally.
It is absorbed rapidly from the GIT
- It is *not* absorbed through the skin.

Distribution

- The volume of distribution is 0.27 L/kg
- It is over 80 % protein bound.
- It may cross the placenta and may affect the fetus.
- It can be excreted in breast milk

Metabolism and excretion:

- LSD is metabolized in the liver.
- The elimination half-life of LSD is approximately 2.5 hours; however clinical effects are more prolonged.

- It is excreted primarily in the urine as 2-oxy-lysergic acid diethylamide, which is pharmacologically inactive.
- Minor amounts of LSD are excreted unchanged in the urine

Risk Assessment

The state of mind the person is in when they ingest (will influence whether a good or bad “trip” will occur)

The concurrent use of other agents, (other serotonergic agents will increase the risk of serotonin syndrome)

The estimated average lethal dose in naive humans ranges from 0.2 to 1 mg/kg. Although doses of up to 1 mg/kg have been taken without significant toxicity.³

Clinical Features

Time course of clinical effects

Effects begin within 30 - 60 minutes after oral ingestion.

Peak effects occur at 2 - 4 hours.

Effects may last approximately up to approximately 12 hours, but occasionally hallucinations can last up to **48 hours** and psychotic states for **3 - 4 days**.²

Clinical effects

The psychoactive effects of LSD are powerful and legion and include:

1. Hallucinations or illusions:

The term *illusion* refers to a specific form of sensory distortion. Unlike a hallucination which is a distortion in *the absence of a stimulus*, an illusion describes a *misinterpretation of a true sensation*.

Illusions are more commonly experienced, but frank hallucinations are also common.

These can be:

- Visual (most commonly):
 - ♥ These are typically extremely vivid and bizarre, or “psychedelic”, often described as a kaleidoscopic array of intense moving colours.

- ♥ Others experience what can only be described as unclassifiable Salvador Dalian type visions.

Less commonly:

- Auditory
 - Tactile
2. Perception disorders:
- **Bizarre distortions of movement through space or time.**

In particular:

- ♥ A feeling of the slowing down or cessation of time.
- ♥ Micropsia/macropsia:
 - ♥♥ The sensation that the user is very small or very large in relation to their surrounding environment.

- **Synesthesia:**
 - ♥ This is a bizarre, but well described phenomenon of “transposition of sensory modes”
Visual stimuli may be perceived as sounds, or sounds may be perceived as visual stimuli, for example!
Sounds including music may be reached out to and touched!
- **Bizarre distortions in perspective:**
 - ♥ Flat surfaces may appear to assume depth, fixed objects may appear to undulate.

3. Emotional changes:
- These can be very intense
 - They can also be very labile, (ranging from great euphoria to anxiety, terror or profound depression)
4. Dissociation:
- ♥ Depersonalization

♥ Derealization

5. Alteration of higher cortical functioning:

- Some describe existential experiences such as feelings of “oneness with the universe” or “great understanding or insights”.

6. Autonomic effects of LSD include:

Sympathetic hyper-stimulation may be seen.

Serotonergic type reactions can be severe and include:

- Tachycardia
- Hypertension
- Sweating
- Mydriasis
- Tremor
- Hyperthermia, (which may rarely lead to rhabdomyolysis).
- Seizures

7. Psychological effects can include:

- Extreme panic reactions, especially with feeling of loss of control.
- Frank psychosis:
 - ♥ This may lead to patient self-harm and/or harm to others.

Effects tend to be *minimal* on:

- Memory
- Immediate orientation

Determinants of the nature of the experience of LSD ingestion

Reactions to hallucinogenic drugs are idiosyncratic and unpredictable.

Users often have some awareness that what they are seeing, hearing, or smelling is distorted or not real.

The type of “trip” experienced will often be modulated by the prior mood and expectation, personality of the drug taker or the setting in which it is taken.

A “bad trip” can be caused by fear, anxiety, or anger at the time the drug is taken.

Worse experiences are more commonly seen in those who have ingested the drug unknowingly or knowingly but for the first time.

Addiction and tolerance

Physical addiction does not occur, though psychological addiction is possible.

Some tolerance may occur with repeated use.

Longer term effects

Longer term complications may include:

1. Prolonged psychotic reactions.
2. Severe depression
3. Exacerbation of a preexisting psychiatric illness.
4. Hallucinogen Persisting Perception Disorder (HPPD)

Or in lay terms, “**Flashbacks**”

This occurs when patients who are not intoxicated experience recurrent symptoms (or flashbacks) that occurred initially during their use of LSD.

Patients can have both **perceptual and visual** disturbances during these brief episodes.

HPPD may last several months, not usually longer than one year, however, some patients have reported these experiences up to 2 even 5 years after ingestion of the drug!

While more common after frequent use, they may result from a single exposure and most commonly within 18 months.³

Investigations

Routine drug screens do not detect LSD

Because of the complexity of detecting LSD, testing for it is not clinically useful and is most often done in forensics cases.

Investigations are directed towards the exclusion of alternative diagnoses or secondary complications

Management

Of those that present to an Emergency department the issue will be primarily one of an acute behavioural crisis or of frank psychosis.

Deaths associated with the use of LSD are usually secondary to acute behavioural disturbances rather than to any direct toxic effect of the drug itself.

The extreme agitation of a bad trip has been known to lead to suicide or to accidental death as users have tried to flee from their hallucinations.

1. Decontamination:

- Activated charcoal is of little clinical value by the time a patient presents to the ED, as LSD is rapidly absorbed.
- Attempts at administering it may also cause the patient to become more frightened and agitated.
- In any case patients are unlikely to be compliant.

2. Repeated verbal reassurance:

- This is very important in those who are orientated or aware enough of their real environment.

3. Restraint:

- Physical restraint, as for any extremely agitated and psychotic patient may be required.

4. Emergency sedation:

- **Benzodiazepines** titrated to clinical effect
- **Antipsychotics** titrated to clinical effect:

Options include:³

- ♥ Droperidol
- ♥ Olanzapine
- ♥ Haloperidol

5. There is no specific antidote for intoxication
6. There is no recommended method for enhancing.
7. Secondary complications:
 - Rarely secondary complications such as rhabdomyolysis or dehydration may require treatment.
 - More serious complications are treated supportively as indicated.

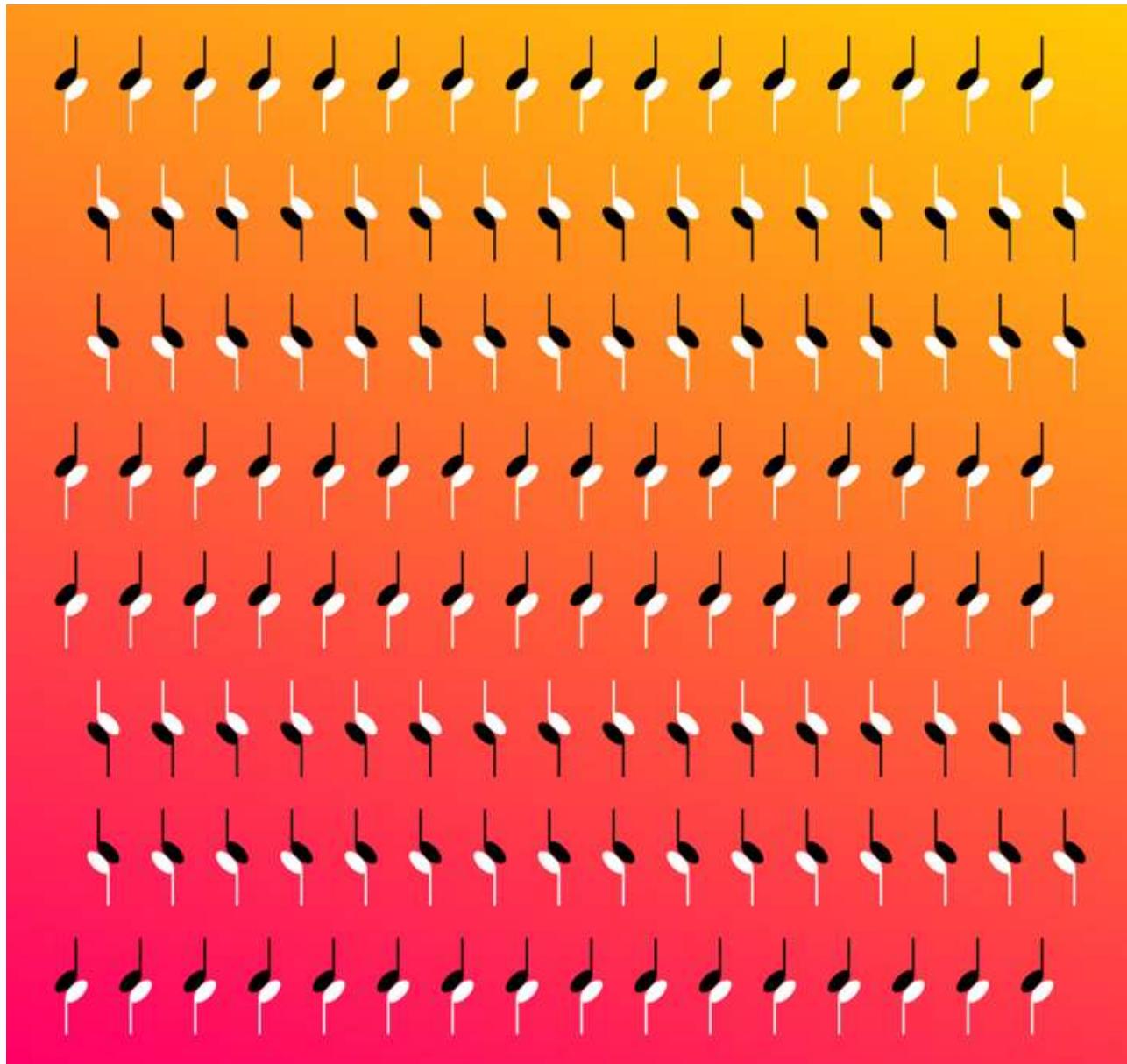
Disposition:

There should be close observation in a quiet, calm and darkened environment.

Distractions such as soft music may be helpful.

Most symptoms will have completely resolved by 12 hours.

Hallucinogenic persisting perception disorder or “flashbacks” may occur following recovery from acute intoxication. Patients should be warned of this possibility on discharge and instructed to return if somatic, perceptual or psychic effects occur.



“Notes”, Akiyoshi Kitaoka

One of the most bizarre, but well described phenomena of LSD hallucination is synesthesia or the “transposition of sensory modes”. Subjects claim for example to be able to “hear colors”, “taste sound”, “touch aromas” or to “see music”!

References

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Dr J. Hayes
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