marijuana and the teen brain

MARY ET BOYLE, PH. D.

DEPARTMENT OF COGNITIVE SCIENCE

UCSD
in this talk

- what is marijuana?
- the brain on marijuana
- is the teen brain special?
- current research
what is marijuana?

cannabis sativa plant

leaves, stems flowers

delta-9-tetrahydrocannabinol
\[= \Delta^9\text{-THC}\]

main psychoactive ingredient
Δ⁹-THC is the main psychoactive ingredient

Δ⁹-THC activates cannabinoid 1 (CB1) receptor in the brain.

CB1 is expressed at high levels in many brain areas.

Two endogenous brain lipids have been identified as CB1 ligands.
endocannabinoids – ligands for CB₁

N-arachidonylethanolamine

anandamide (AEA)

{ arachidonate-derived neuroactive lipids }

2-arachidonoylglycerol

2-AG
what areas of the brain process marijuana?

- hypothalamus
- basal ganglia
- ventral striatum
- amygdala
- brainstem
- cortex
- hippocampus
- cerebellum
hormones
appetite
circadian rhythms
sexual behavior

hypothalamus
basal ganglia
ventral striatum
amygdala
brainstem
cortex
hippocampus
cerebellum
motor controlled planning
initiation of actions
termination of actions
habit pathway

cortex
hippocampus
cerebellum
brainstem
amygdala
ventral striatum
basal ganglia
hypothalamus
prediction

reward

addiction?
vomiting reflex

pain sensation

sympathetic nervous system reactions

hypothalamus
basal ganglia
ventral striatum
amygdala

brainstem
cortex
hippocampus
cerebellum
hypothalamus
cortex
basal ganglia
ventral striatum
amygdala
brainstem
hippocampus
cerebellum

higher cognitive functions
sensation perception
judgment and pleasure
memory formation

learning: facts

sequences

places
The hypothalamus, basal ganglia, ventral striatum, amygdala, cortex, hippocampus, cerebellum, brainstem, motor control, coordination, motor learning, and doubles risk of car accident - DUI are all parts of the brain that are involved in various functions.

- Hypothalamus: involved in temperature regulation, sleep, hunger, and thirst.
- Basal ganglia: involved in movement coordination and motor learning.
- Ventral striatum: involved in reward and motivation.
- Amygdala: involved in emotional processing, including fear and anxiety.
- Cortex: responsible for higher brain functions such as sensation and perception.
- Hippocampus: involved in memory consolidation.
- Cerebellum: involved in motor control and coordination.
- Brainstem: involved in basic life functions such as breathing and heart rate.
- Motor control: involves the coordination of muscle movement.
- Coordination: involves the ability to perform movements accurately and efficiently.
- Motor learning: involves the ability to learn and adapt to new movements.
- Doubles risk of car accident - DUI: alcohol use can double the risk of car accidents due to its effects on motor control and coordination.
Three Types of Implicit Learning

- Habituation
- Sensitization
- Classical Conditioning
Most simple form of learning

Initial response to stimuli:
very defensive -

Repeated exposure to stimuli:
Response is muted - Eventually ignored.

Purpose:
Animal needs to learn which stimuli to safely ignore

Eliminates inappropriate or exaggerated defense responses

Important for:
Organizing perception
Sensitization – mirror image of habituation

After a noxious stimulus

the sensitized animal respond more strongly to all stimuli.

Purpose:
Instead of ignoring a stimulus – it is a form of learned fear. Survival.

It teaches the animal to attend and respond more vigorously to almost any stimulus

Konrad Lorenz: “An earthworm that has just avoided being eaten by a blackbird ... is indeed well advised to respond with a considerably lowered threshold to similar stimuli because it is almost certain that the bird will still be nearby for the next few seconds.”
Aversive Classical Conditioning

A neutral stimulus must always precede the aversive stimulus – that way the animal will come to predict it.

Pavlov: shock a dog’s paw. The shock caused the animal to raise and withdraw its leg – a fear response.

Pavlov found that after several trials in which he paired the shock with a bell – first sounding the bell then the shock – the dog would withdraw his paw whenever the bell sounded.

Classical conditioning an association is formed between a pair of stimuli that occur in rapid sequence.

Teaches the animal to associate an unpleasant stimulus with a stimulus that ordinarily elicits no response.
Habituation
Sensitization
Classical conditioning

Synaptic strength is not fixed – it can be altered in different ways by different patterns of activity.