Marijuana: Driving Impairment

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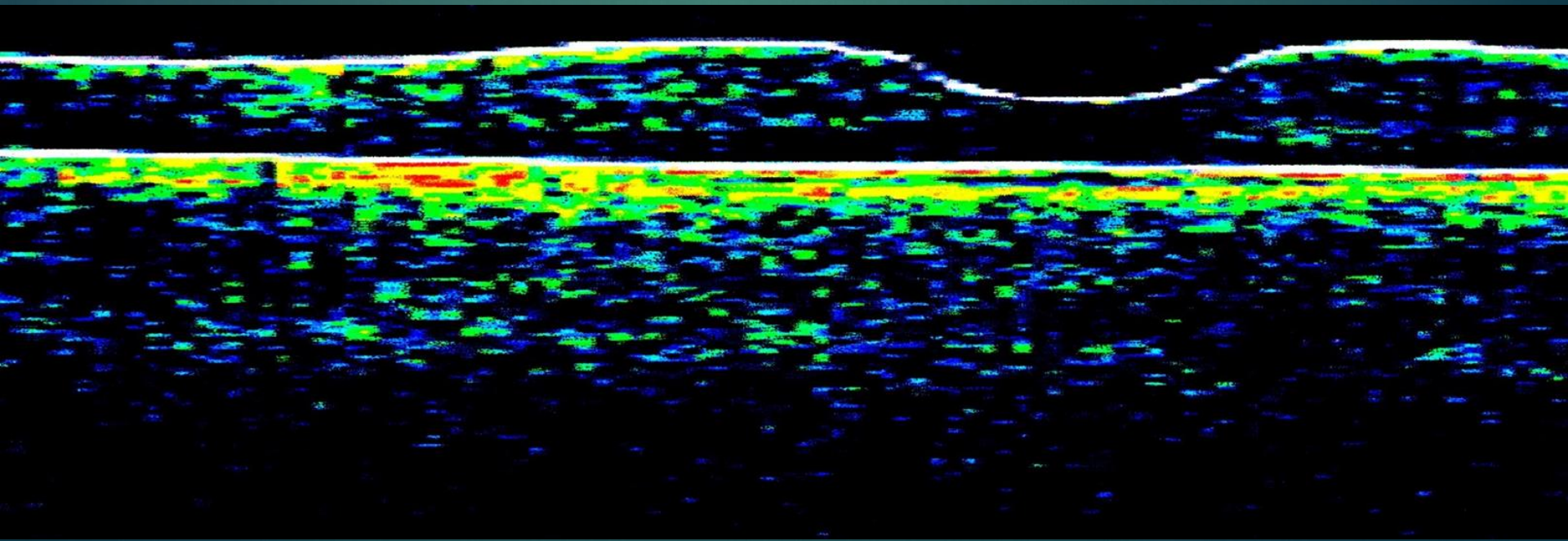


Disclosures

- Dr. Valenti is owner of IMMAD, LLC - a company specializing in technology, education and services for the responsible use of marijuana.
- Technology, IMMAD-Impairment Measurement Marijuana and Driving is specific to the assessment of fitness to drive with acute use of marijuana.

- All our research is self funded.
- And by NIH NIDA

  SBIR

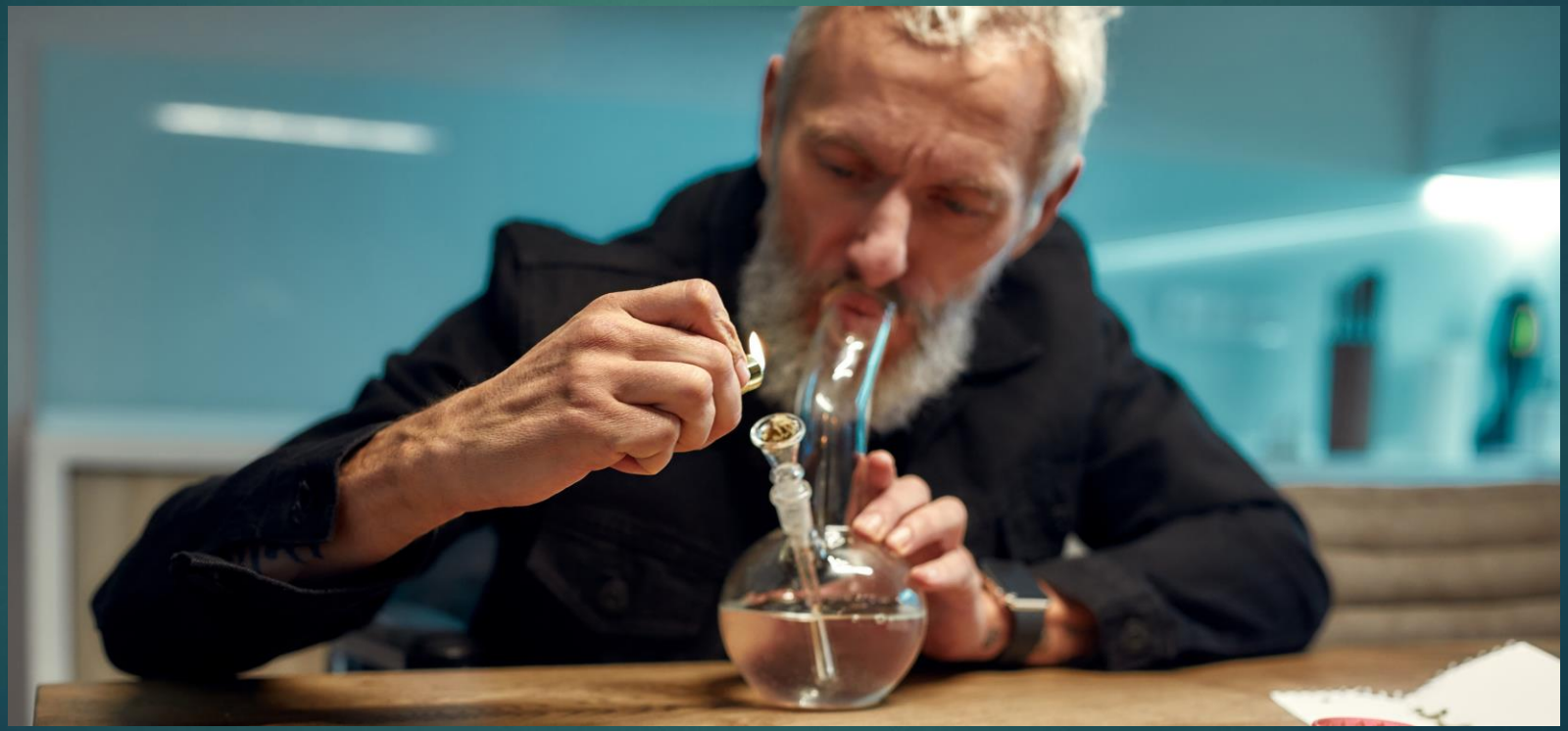
https://unsplash.com/@krakenimages

Marijuana in the US-Legal Adult Use Nineteen States

- Alaska, Arizona, California, Connecticut, Colorado, Guam, Illinois, Maine, Massachusetts, Michigan, Montana, Nevada, New Jersey, New Mexico, New York, Oregon, South Dakota, Vermont, Virginia, Washington and the District of Columbia allow for the legal use of recreational marijuana.

Over 55 Demographic

- The 55-and-older crowd is now the fastest-growing demographic of pot users in the country. Between 2013 and 2014, the number increased from 2.8 million to 4.3 million.



Marijuana Cultivation In US

- 1600s: cultivated in Jamestown for hemp
- 1850 there were 8000 cannabis plantations
- 1940s Hemp still used for sails and rope
- Farm Bill: Hemp now legal.

Medical Marijuana Not New

- 1850-1942: included in the US Pharmacopeia
- 1913: California law prohibits recreational use
- 1936: all 47 states prohibit recreational use
- 1937: Ban on medicinal use
- 1996: California Compassionate Use Act
- 2021: 36 states and four territories.
- 2021: Hemp federally legal.
- 2021: CBD from hemp legal.

Plants and Cannabinoids

- Delta-9-tetrahydrocannabinol (THC) Causes the High
- NOW Delta 8 synthesized from CBD hemp
- Cannabidiol (CBD) Modulates THC
- Cannabinol (CBN)
- Cannabigerol (CBG) Also from hemp What is being discussed around COVID.
- AND 11-tetrahydrocannabinol a by product primarily of edible and considered more pychoactivating than 9-THC

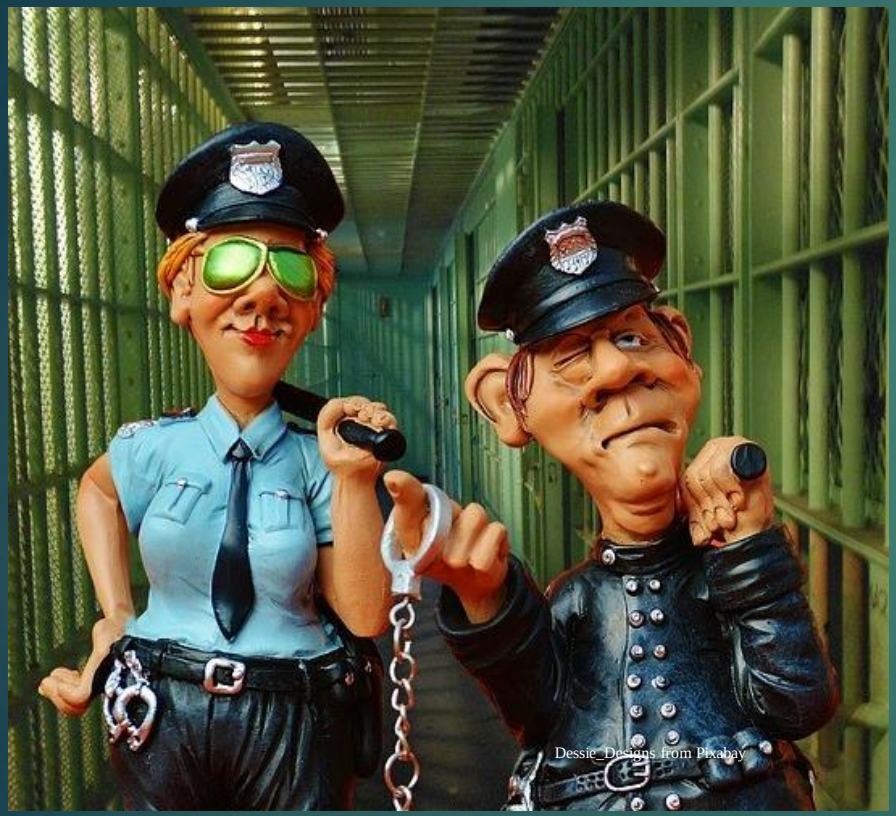
Marijuana Plant Has Evolved

- 1960's: 1-3% THC
- 1990's: up to 8-10%
- Now strains over 30% THC

Hemp or Marijuana

- Farm bill, allowing for growing of hemp.
- Problematic as can synthesize Delta 8 Psychoactive form of THC.
- No consistency in how states responding.
- Ruled legal in Texas, then reversed it.

Federal Prohibition On Research



- As Schedule 1, cannot do research.
- Up to 95% of research uses synthetic cannibinoids rather than marijuana (Nabilone, Dronabinol, Levanatrodol etc.) This is changing.

Federal Legal Studies on Marijuana

- If allowed to perform studies at all:

- Must use National Institutes of Health marijuana.
- Product is grown on a farm in Mississippi.
- Differs significantly from the legal adult use products.
- Potency much less; 3-8% compared to 20%.
- Availability of appreciable levels of CBD limited.
- Participants do not like it.
- Referred to as “ditch weed”.

NIDA Research Marijuana

- Low potency of 1.5% to 8.3%
- Little to no CBD
- Grown in Missippi
- Developed in 1960s
- Referred to as DITCH WEED

Drawback

- NIH product very, very, very low dose.
- A study looked at 13 mg and 17 mg dose in inhaled product.
- Found no impairment with the 13 mg, but did with the 17 mg dose.
- Tests of cognition and motor function.

Weinstein A et al A study investigating the acute dose-response effects of 13 mg and 17 mg Delta 9- tetrahydrocannabinol on cognitive-motor skills, subjective and autonomic measures in regular users of marijuana. J Psychopharmacol. 2008 Jun;22(4):441-51

Opportunistic Dosing

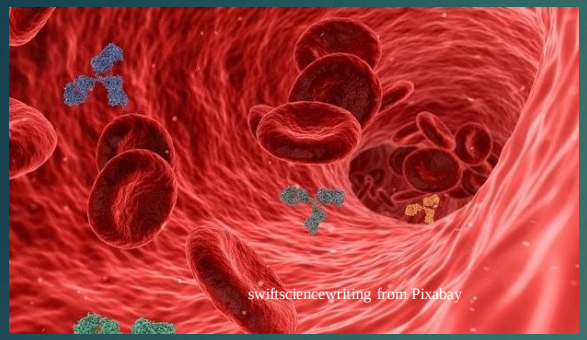
- Poor way to undertake research.
  - Consent and evaluate participants when they have reported not to have used any products or alcohol.
  - Discuss (not arrange) when and where the participant will be using their own product.
- Arrange immediate transportation to the test site and evaluate the participant. The study reported earlier did not have blood comparison. Arrange return transport.
  - IMMAD uses extensive questionnaire of use and draws blood at dosed visit and if able at undosed.

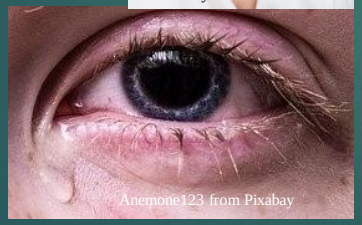
Metabolism of Marijuana

- Oral route – only 10-20% reaches systemic circulation unchanged – takes 30 – 60 minutes to achieve an effect.

- Via the lungs – onset of action within seconds – "high". Experience influences inhalation and onset.

Pharmacology of Cannabis

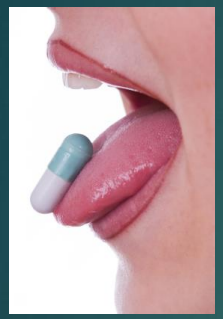




- 95-99% plasma protein bound
- rapid clearance from plasma
- Elimination over several days (adipose)
- Breast milk distribution
- Excretion: days to weeks, 20-35% found in urine
- 65-80% found in feces
- 5% as unchanged drug (when given by mouth)
- Identified in tears, as tears are lipid
- Poor binding to breath or saliva as water.
- Not detectable in breath with edibles.

Alternative Delivery

Pills



e-cigs

Pure Vape

Sprays
Liquid

Topical

Tincture

Dabbing
This is highly contrated up to 99%

More on Dabbing

- Leafly https://www.leafly.com/learn/consume/dabs
- Dabs are the concentrated form of the resin in flower marijuana.
- Think of the images of meth product from BREAKING BAD.
- Dabs are most commonly made by commercial extractors creating in bulk.
- However when hear of "BUTANE EXPLOSIONS", it is often an illegal operation for extraction.
- To extract, cannabis plant material and a solvent, such as butane, propane, etc., is placed in a contained, closed-loop system for several hours, creating a concentrate slurry, in which the solvent strips trichomes from the plant material.

How is Oil Extracted?

- Oils in Marijuana are extracted through Butane being forced through the "Bud" and this bonds with the oils and is extracted.
- Description from 420 magazine:

"Turn the butane gas can upside down and dispense the gas into the pipe via the single top hole. A whole 8-oz can takes about 10-12 seconds to evacuate.

Be brave, swift, and careful. A spark at this moment would spell disaster since you have basically created an incendiary explosive device that is leaking."

IMMAD

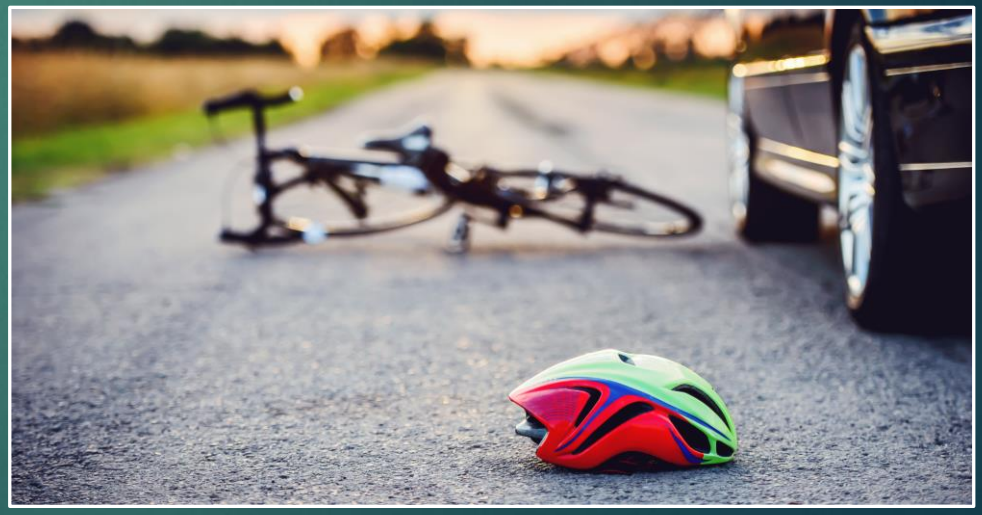
Aftermath Illegal Operation

Marijuana Driving Is Fatal

IMMAD

2X increase in fatal crashes in states with legal recreational marijuana.

6X more likely to kill pedestrians, other drivers, passengers or bicyclists.



Grondel 2016 Washington Marijuana Toxicology Report

First Dispensary Tribal Run 2015

Suquamish Tribe and Squaxin Island Tribe

Tribal Dispensaries 2021

Agate Dreams // Port Madison Indian Reservation

Agate Dreams is a retail cannabis shop operated by the Suquamish Evergreen Corporation, a wholly owned subsidiary of Port Madison Enterprises, an agency of the Suquamish Tribe.

- Cedar Greens // S'Klallam Territory – Sequim, Washington

This store is owned by the Jamestown S'Klallam tribe, a band of the S'klallam people who purchased 210-acres along the Strait of Juan de Fuca where they continue to preserve and enhance the Jamestown S'Klallam Nation's cultural identity.

- Commencement Bay Cannabis // Occupied Coast Salish & Puyallup Land – Fife & Tacoma, Washington

The Commencement Bay chain of stores is owned by the Puyallup Tribe.

- Elevation // Occupied Squaxin, Coast Salish land – Shelton, Washington

This store is owned by The Squaxin Island Tribe who have compiled this Native American etiquette for those who are visiting.

- High Point Cannabis // Occupied Suquamish, Coast Salish land – Kingston, Washington.

This cannabis dispensary is owned by the Port Gamble band of the S'Klallam tribe.

- Joint Rivers // Occupied Coast Salish, Muckleshoot land – Auburn, Washington

This store is operated by the Muckleshoot Tribe which is made up of Duwamish and Upper Puyallup people, the name Muckleshoot comes from the prairie on which the reservation was established, the tribe was then referred to by the name of the prairie rather than their historic tribal names.

- Remedy Tulalip // Tulalip territory – Tulalip, Washington

The government set up a reservation in Tulalip for the Snohomish, Snoqualmie, Skykomish, and other allied tribes and bands signatory to the Treaty of Point Elliot. Tulalip is one of the Coast Salish Tribes of Puget Sound and the tribe owns Remedy Tulalip.

- Salish Coast Cannabis // Occupied territories of the Samish, Coast Salish, Sauk Suiattle, Skagit, and Hul-qumi-num treaty group – Anacortes, Washington

This shop is owned and operated by the Swinomish Indian Tribal Community.

- Elwha Peaks // Occupied Coast Salish, S'Klallam land – Port Angeles, Washington

Elwha Peaks is wholly owned and operated by the Lower Elwha Klallam Tribe, all revenues from the store go to supporting the betterment of the tribe through infrastructure, education, and similar initiatives.

- Mountain Source Dispensary // Iipay Nation tribal lands – Santa Ysabel, California.

This shop is owned by the Iipay Nation tribal lands a band of the Kumeyaay Nation.

- Oak Creek Dispensary // Numu (Northern Paiute) territory – Independence, California

Oak Creek dispensary is owned by the Fort Independence tribe of Paiute Indians who are indigenous to the area. The tribe also owns Oak Creek Farm.

- Long Lodge Tribal Enterprises // Occupied Tongva (Gabrielino) land – Costa Mesa, California

The link above goes to the Long Lodge Twitter account which states that first the dispensary was shut down due to damage from police raids on illegal operations in the same business park as their regulated business. In the wake of this the brand moved to delivery, which has now been shut down by city regulators.

- Little Beach Harvest // Shinnecock nation territory – South Hampton, New York

This cannabis store is owned by the Shinnecock tribe in partnership with TILT and will be open soon.

- Nabodoka Dispensary // Numu (Norther Paiute territory) Lovelock, Nevada – Northern Paiute territory

The Lovelock Paiute nation owns Nabodoka dispensary. They view the human to cannabis relationship as one of mutualism where the plant ally provides for the people and the people put love in to the cannabis.

- NeWe Cannabis // Newe (Western Shoshone) land – Elko, Nevada

This shop is owned and operated by the Elko Band Colony of the Te-Moak Tribe of Western Shoshone Indians.

- NuWu // Newe (Western Shoshone) land – Las Vegas, Nevada

NuWu is a huge store with a modern design, smoking lounge, and drive thru window owned by the Las Vegas Paiute Tribe.

- Pesha' Numma // Yerington Paiute Tribe Colony – Yerington, Nevada

Pesha' Numma is owned and operated by the Yerington Paiute Tribe Colony, they have provided donations to local organization, Native American Domestic Violence, the Yerington Food Bank, and more.

- Tsaa Nesunkwa Dispensary // Shoshone tribal land – Ely, Nevada

The Ely Shoshone tribe runs Tsar Nesunkwa dispensary for the betterment of their people, money earned is put back into food drives, toy drives, and other fundraisers.

- Water Canyon Dispensary // Numu (Northern Paiute) territory – Winnemucca, Nevada

This store is owned by the Winnemucca Indian Colony.

- Green Chief Naturals // Mohawk land – Cornwall Island, Ontario
- Seven Leaf // Located on Akwesasne Mohawk land, known as Ontario.

The Canadian dispensary is run by Mohawk executive leadership.

Additional Approved

St. Regis Mohawk Tribe New York

Shinnecock Indian Nation New York

Crow Tribe Montana

Oglala Sioux Tribe South Dakota

Consumption Lounge/Tasting Room

NuWu Las Vegas, Nevada

Paiute Tribe

Vegas: Consumption Café

Unlike for Alcohol

NO breathalyzer to measure how much and what was used.

NO Standard Field Sobriety Test such as touch nose and walk and turn.

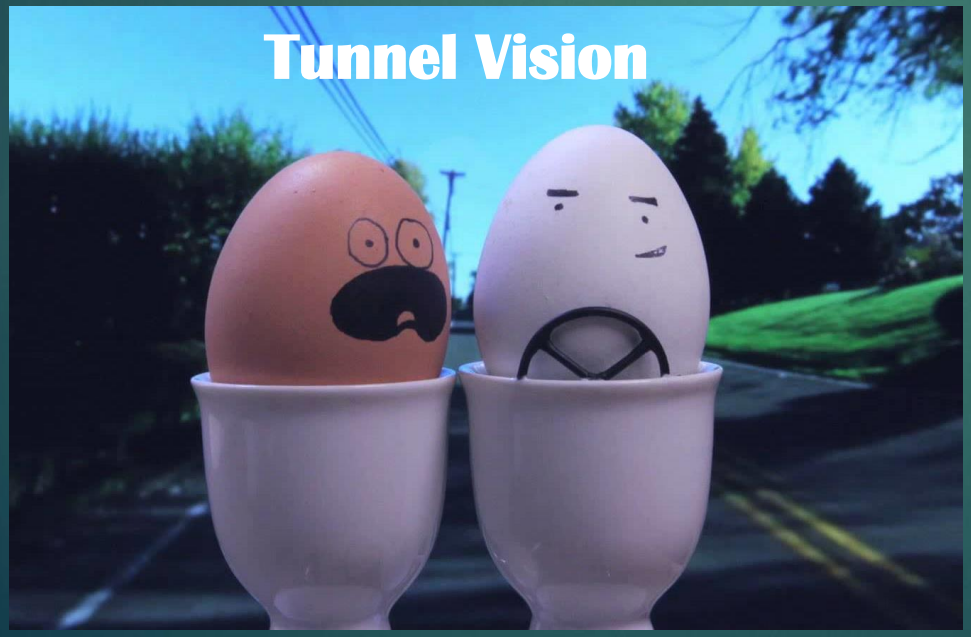
Often Hear Marijuana Tunnels Vision

- Users report tunneling of vision with some products.
- NHTSA reports tunneling of vision.
- Never has been a study on peripheral vision and cannabis.

Marijuana – Tunnel Vision

- Even education campaigns discuss tunnel vision.
- http://eggsonweed.ca/

  Have a video on "tunnel" vision



Single Study on Humans and Peripheral Vision

- Measured the 180 degree meridian only.
- With peripheral testing only, found no reductions related to alcohol.
- Found significant reductions related to marijuana.
- Used blinking lights at 6 degree intervals.

Moskowitz, H. Percept Mot Skills. 1972 Dec;35(3):875-82

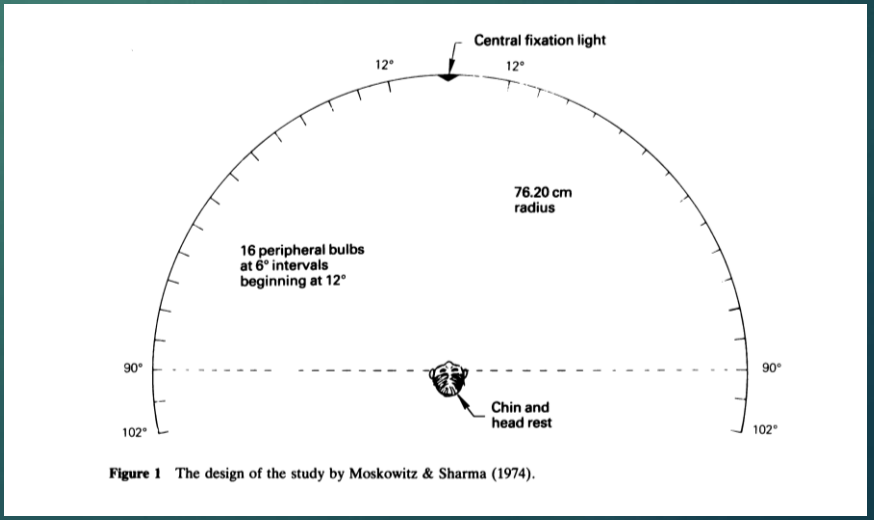


Figure 1 The design of the study by Moskowitz & Sharma (1974).

Single Study on Humans and Peripheral Vision

- Measured the 180 degree meridian only.
- With peripheral testing only, found no reductions related to alcohol.
- Found significant reductions related to marijuana.
- Used blinking lights at 6 degree intervals.
- Dark adapted.
- Test done in dark.

Moskowitz, H. Percept Mot Skills. 1972 Dec;35(3):875-82

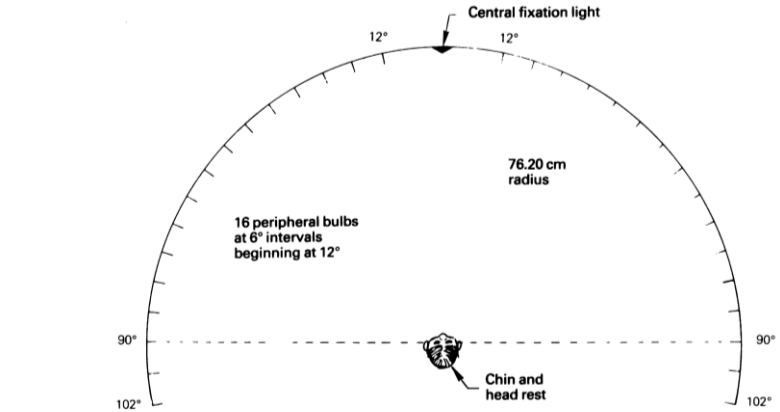


Figure 1 The design of the study by Moskowitz & Sharma (1974).

Defined Limits Undosed

Outside this positive +

Inside this negative -

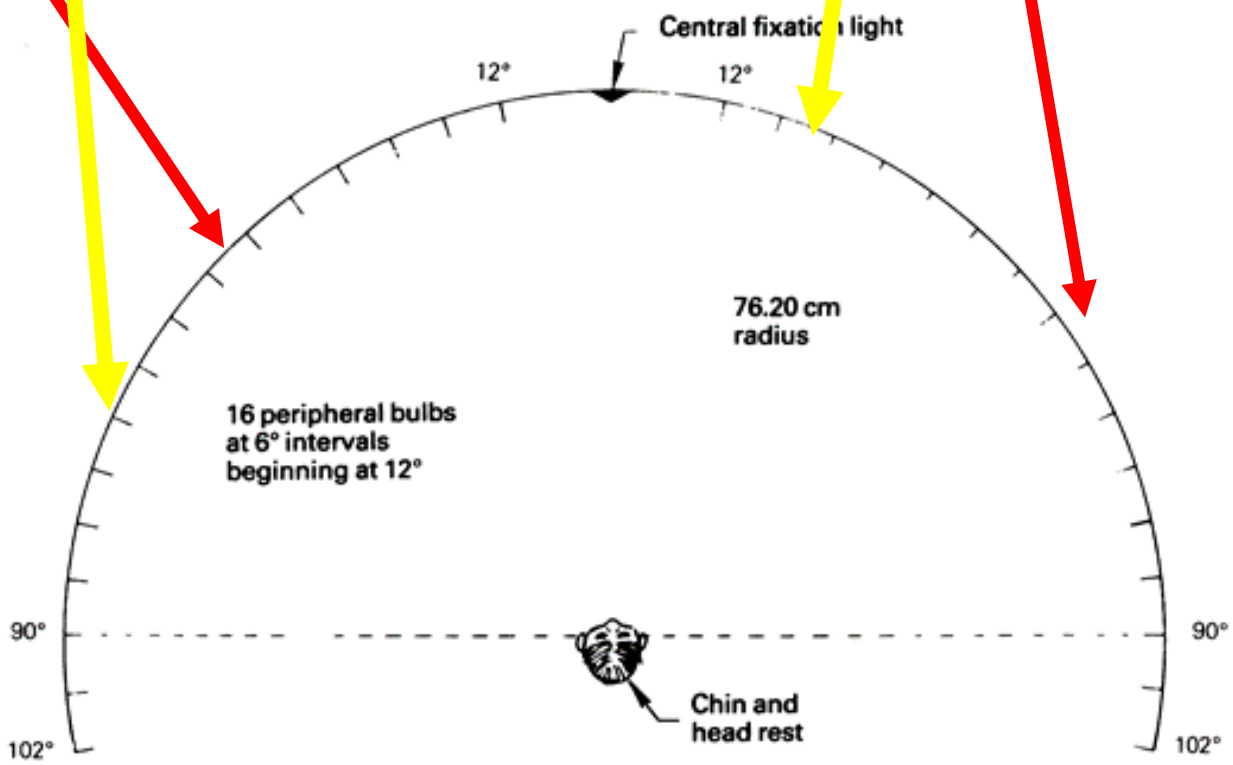
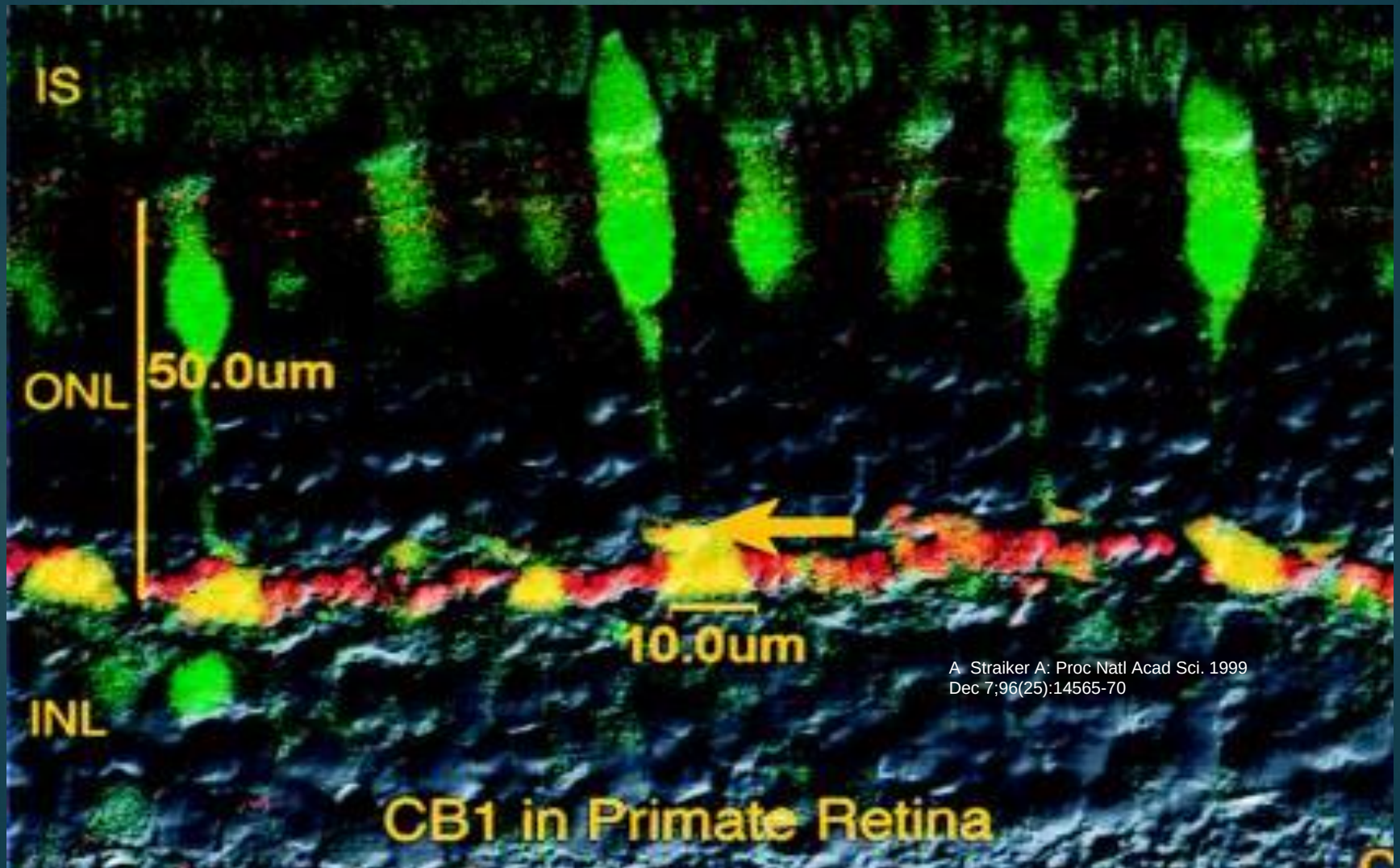


Figure 1 The design of the study by Moskowitz & Sharma (1974).

Visual Field Legal Driver's License

- Sixteen states have no required visual field testing.
- 34 states have a binocular horizontal visual field requirement,
- 15 stipulate 140 degrees.
- 19 states varies 105 degrees to 130 degrees.
- Maine requires 150 degrees.
- Only Kentucky has a vertical visual field requirement: 25 degrees above and below the fixation point.
- All of Canada requires intact vertical fields.

Cannabinoid Receptors Numerous In Human Retina



Cannabis Consumption Dysfunction In Glare Response

- The time to recover normal retinal function after a bright light exposure is significantly longer with the consumption of cannabis.

Adams A: Psychopharmacology, 56, 81-86, 1978

Am J Optom Physiol Opt. 1975 Nov;52(11):729-35
Invest Ophthalmol. 1975 Jan;14(1):52-5
Am J Optom Physiol Opt. 1976 Dec;53(12):764-7
Am J Ophthalmol. 1977 Mar;83(3):350-4
Psychopharmacology (Berl). 1978 Jan 31;56(1):81-6

Color Dysfunction With Cannabis Consumption

Dawson WW: Invest Ophthalmol Vis Sci. 1977 Aug;16(8):689-99.

Adams A: J Optom Physiol Opt. 1975 Nov;52(11):729-35.

Adams A: Perception and Psychophysics, 1976:20(2):119-124.

https://unsplash.com/@anniespratt

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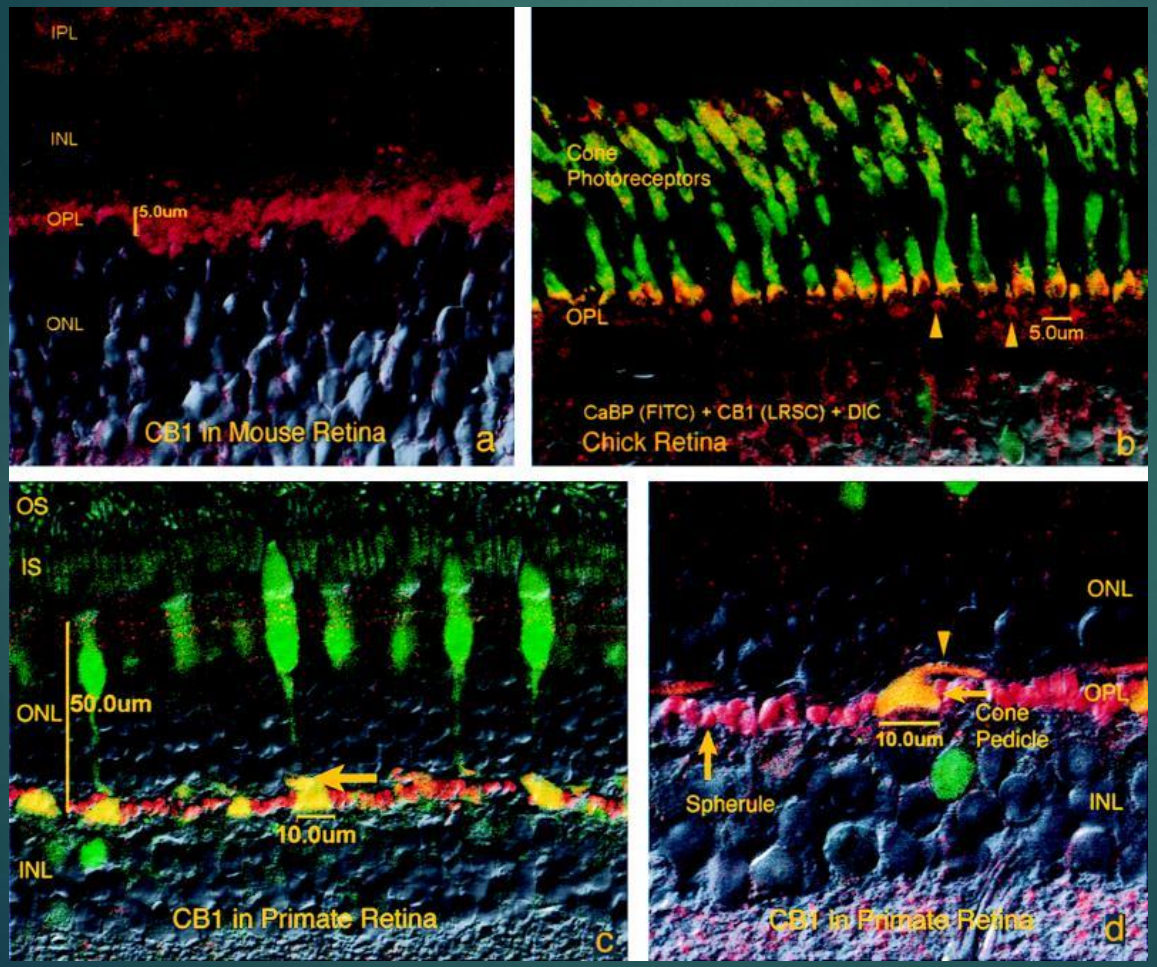
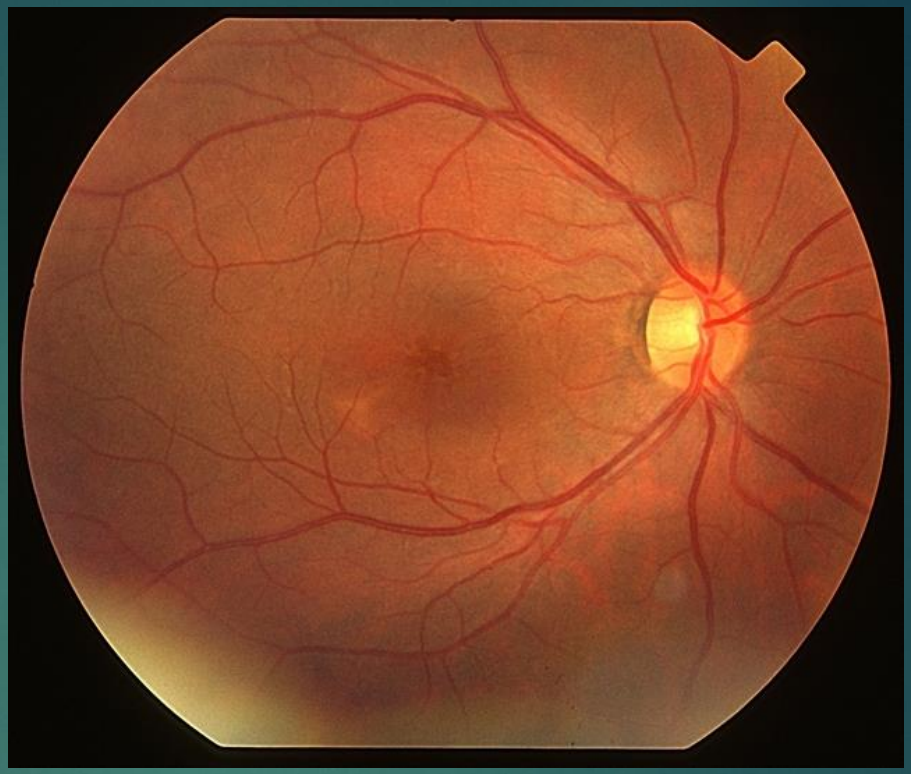


A Straiker A: Proc Natl Acad Sci. 1999 Dec 7;96(25):14565-70

Retina



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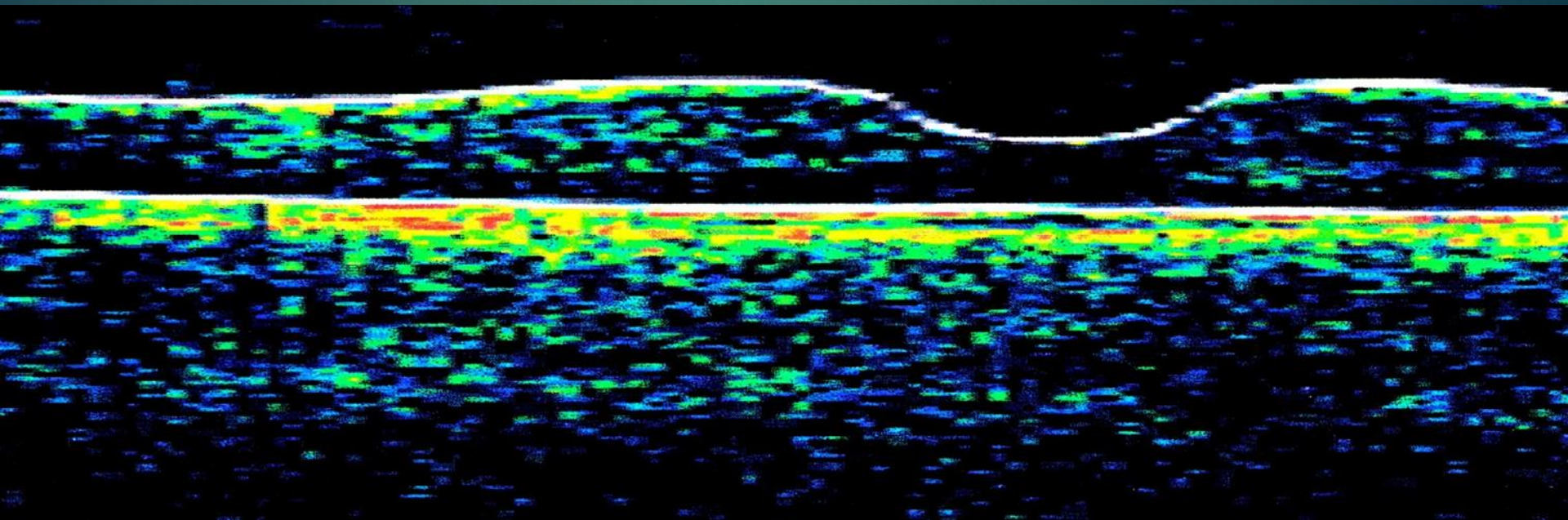
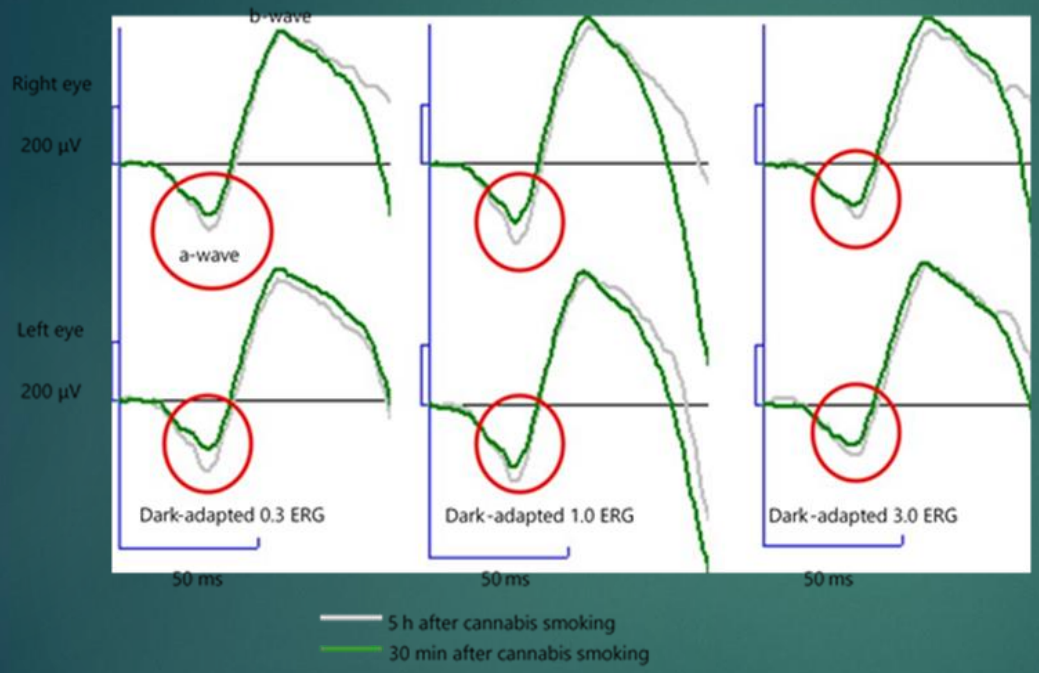


Marijuana Impairs Retinal Ganglion Cell (RGC) Function

Chronic, but abstinent use
Reported Fall 2016 in the
Journal of the American Medical Association

Schwitzer T: JAMA Ophthalmol. 2017 Jan 1; 135(1):54-60

Cannabis Acute Use Changes Retinal Response



Schwitzer T,. Eur Addict Res. 2016;22(6):287-291. Schwitzer 2016

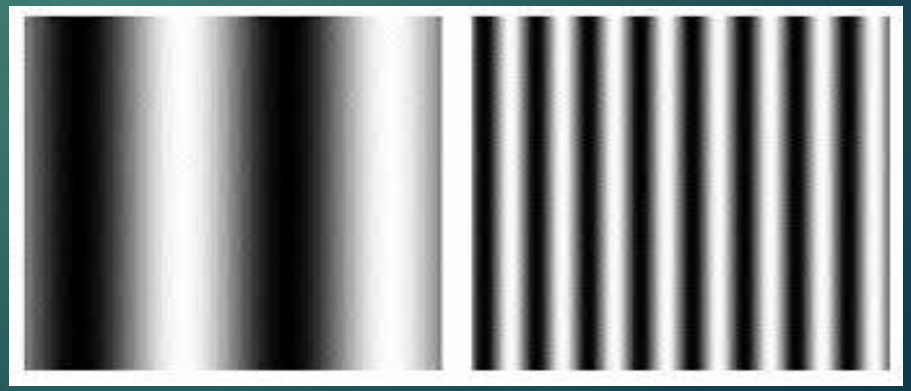
Amarasekera DC, et al, Clin Exp Ophthalmol. 2018 Jan;46(1):54-61.

Cannabis Early Onset Use Chronic Abstinent Users Contrast Function

- Early onset use defined as those having started use of marijuana/cannabis prior to age sixteen.
- Dysfunction in contrast sensitivity at low spatial frequencies in both static and dynamic 8 Hz.

Eur Neuropsychopharmacol. 2017 Dec;27(12):1289-1297

- Low Frequency Left
- High Frequency Right

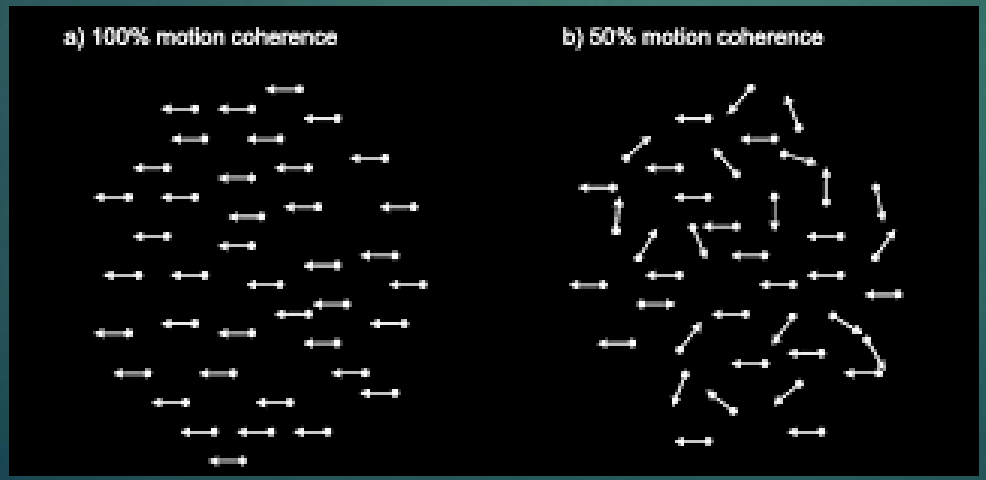


Reduced Motion Perception In Chronic Abstinent

- Stimulus contrast was under 16% for a moving target.
- Chronic users deficit even when abstinent.

Mikulskaya E1,2, Martin F1
Eur J Neurosci. 2018 Feb;47(3):269-276

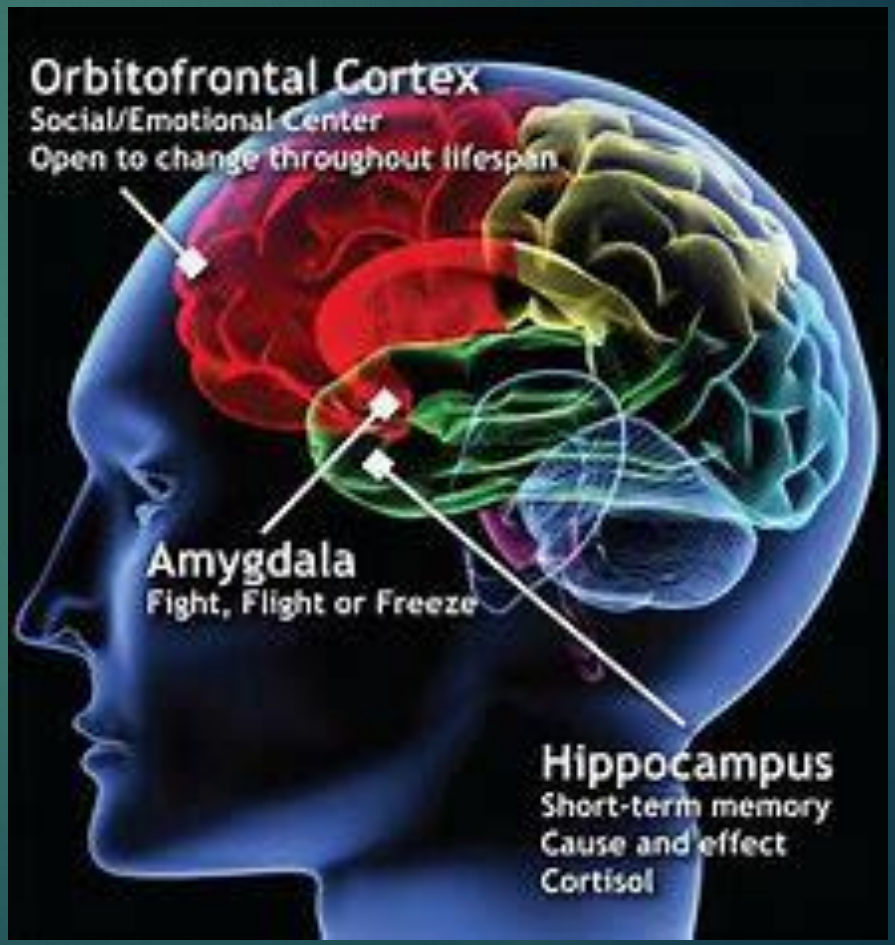
- Using ERG there was reduced response to coherent motion, incoherent motion, and static.



Skosnik PD[1], Krishnan GP
Neuropsychopharmacology. 2014 Dec;39(13):3087-99

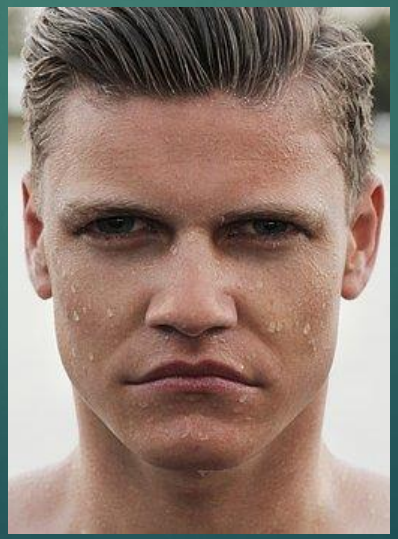
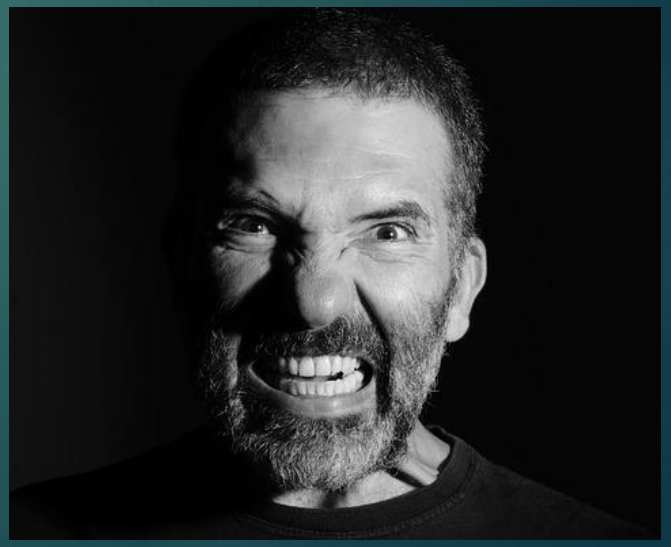
Early Initiation Use Reduced Brain Volume

- Several studies report that the brain volume of the orbito frontal cortex are reduced with early initiation and subsequent chronic use.



Newer Research
Lower Spatial Frequency

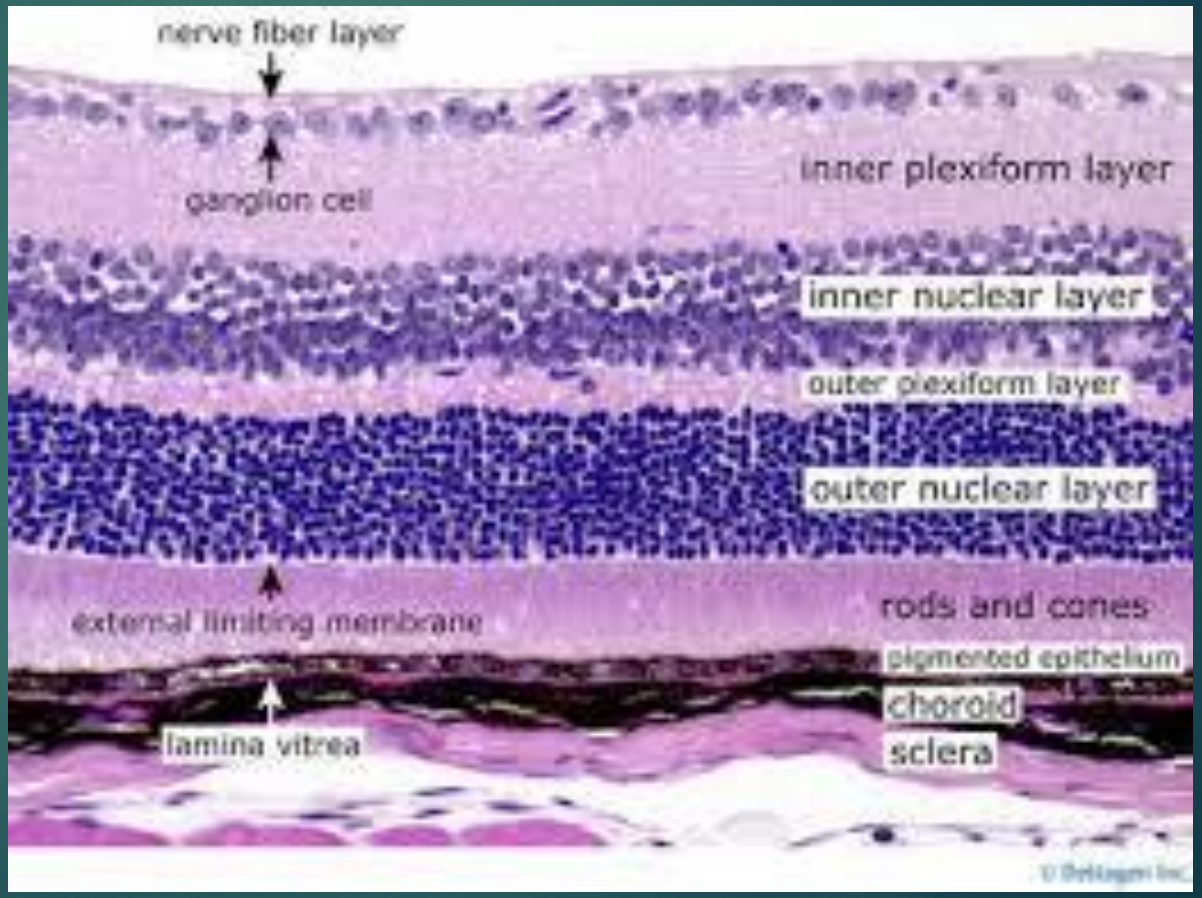
- Orbital frontal cortex processes information related to lower spatial frequencies.
- Lower spatial frequencies are involved in the perception of facial expressions. Churchwell JC, Lopez-Larson M, Yurgelun-Todd DA. Altered frontal cortical volume and decision making in adolescent cannabis users. Front Psychol. 2010 Dec 14;1:225.

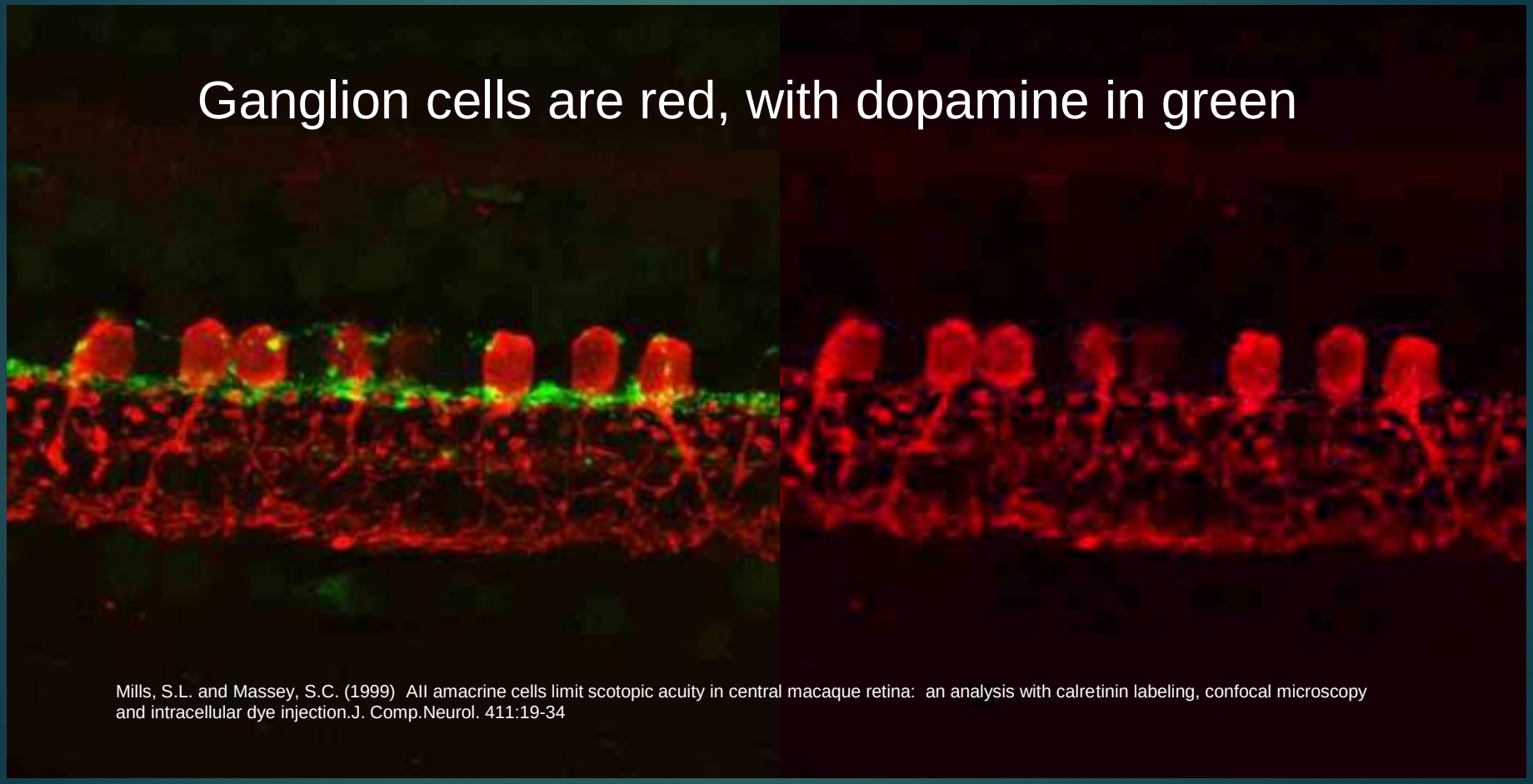
Prenatal Exposure to Marijuana: Thinner Retinas

- Mice exposed prenatally to marijuana have thinner retinas, with inner retina showing greatest reduction.

Investigative Ophthalmology & Visual Science June 2017, Vol.58, 271. doi:



Cannabis Inhibits Dopamine Production In Retina

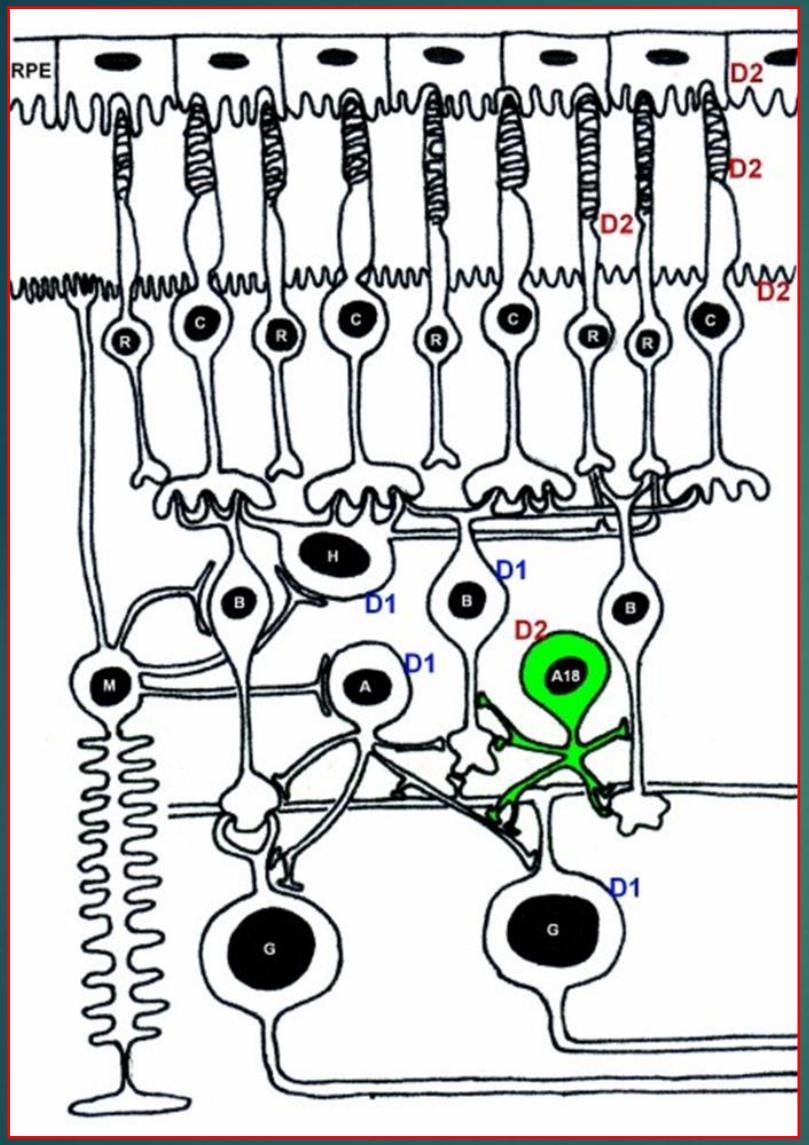


Mills, S.L. and Massey, S.C. (1999) AII amacrine cells limit scotopic acuity in central macaque retina: an analysis with calretinin labeling, confocal microscopy and intracellular dye injection.J. Comp.Neurol. 411:19-34

Cannabis Alters Dopamine Function

- Implications for retinal function is unknown
- Cannabinoid receptors in visual system are mixed function; some stimulate, some inhibit
- To little dopamine and to much both have implications

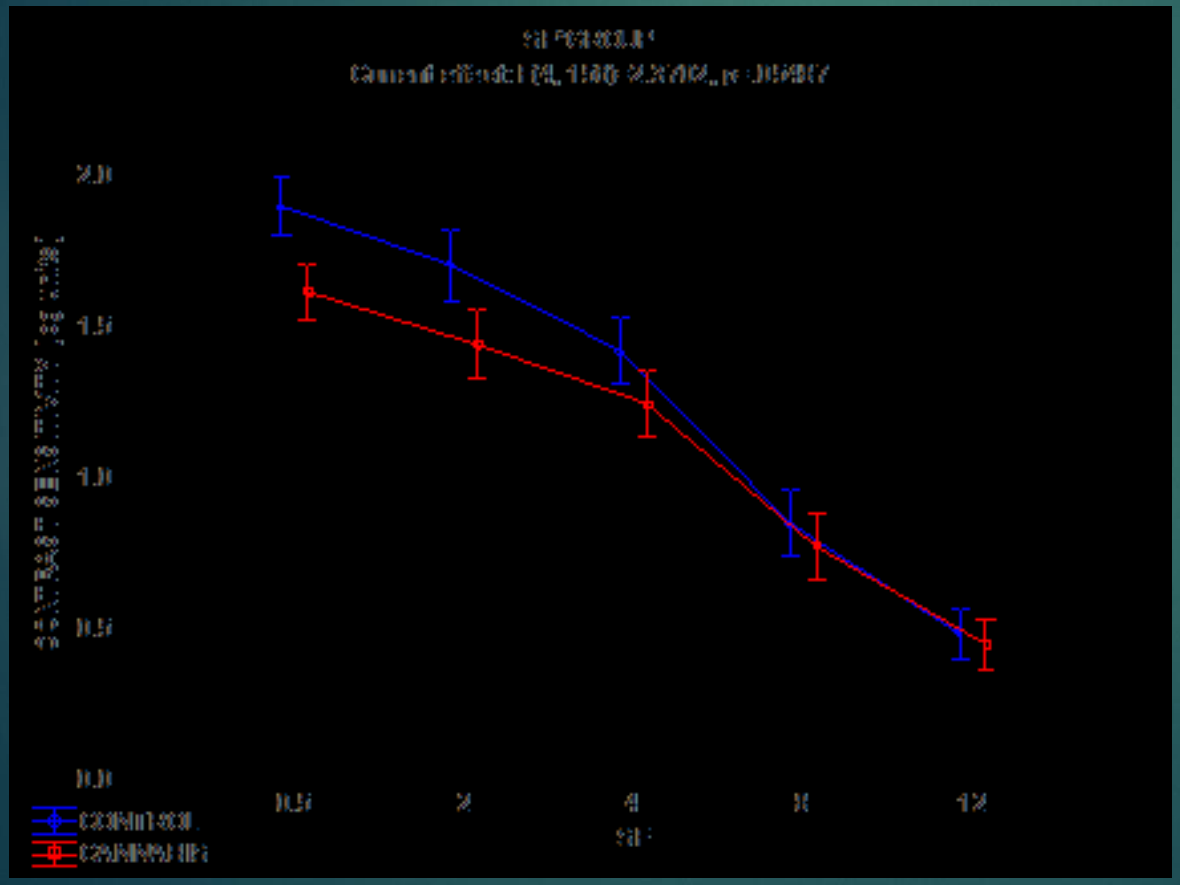
Yazilla http://www.ncbi.nlm.nih.gov/pubmed/18725316



Dopamine is in the Amacrine Layer of Retina

http://www.okulistyka.com.pl/_klinikaoczna/index.php?strona=artykul&wydanie=41&artykul=707

Dopamine Related Dysfunction? Chronic Long Term Cannabis



Contrast sensitivity is impaired at low spatial frequencies in early-onset cannabis users in low light conditions

Elena Mikulskaya and Frances Martin
School of Psychology, University of Newcastle, Australia

Recent Paper
Non Chronic Acute Use

- Reduced binocular acuities by two lines
- Reduced contrast sensitivity
- Reduced Stereo Near
- Reduced Stereo Distance
- Irregular abnormal response in maintaining car in lane – Lateral Lane Deviation
- Twenty drivers between age 21-40
- Opportunistic dosing protocol

Ortiz-Peregrina S et al Effects of Smoking Cannabis on Visual Function and Driving Performance. A Driving-Simulator Based Study. Int J Environ Res Public Health. 2020 Dec 3;17(23):9033

Chronic Abstinent User Change in Retina Structure

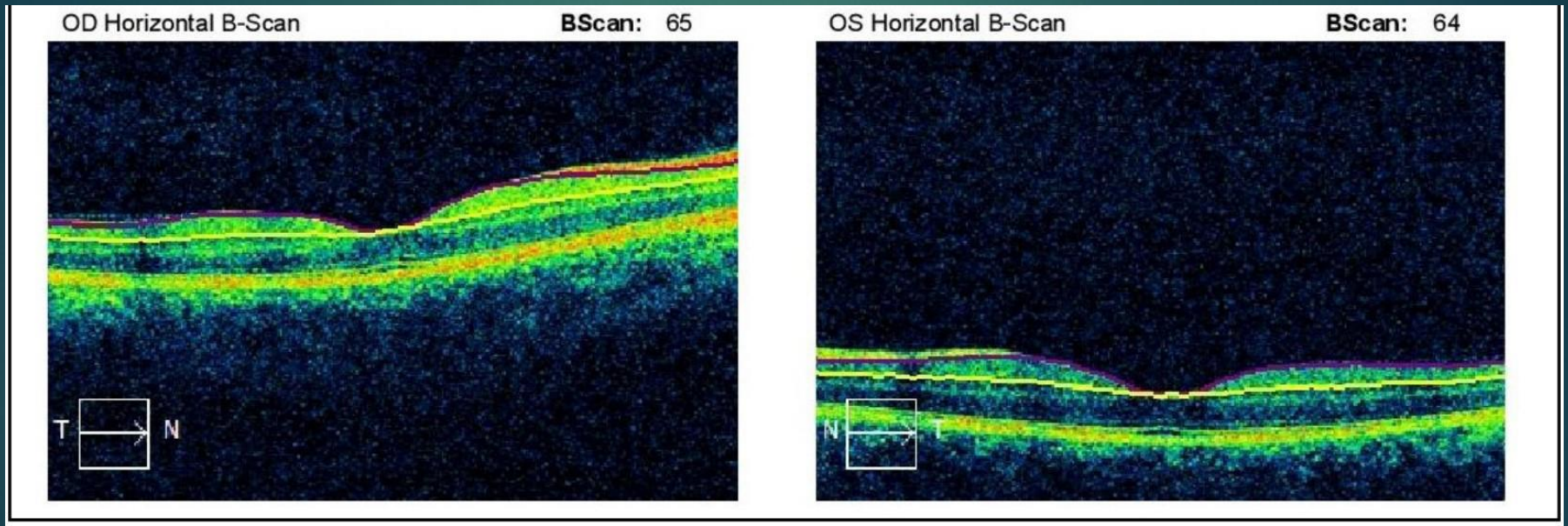
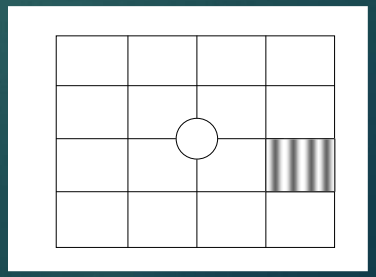


Figure 2. GCL-IPL analysis by OCT in the eye of a cannabis user participant.

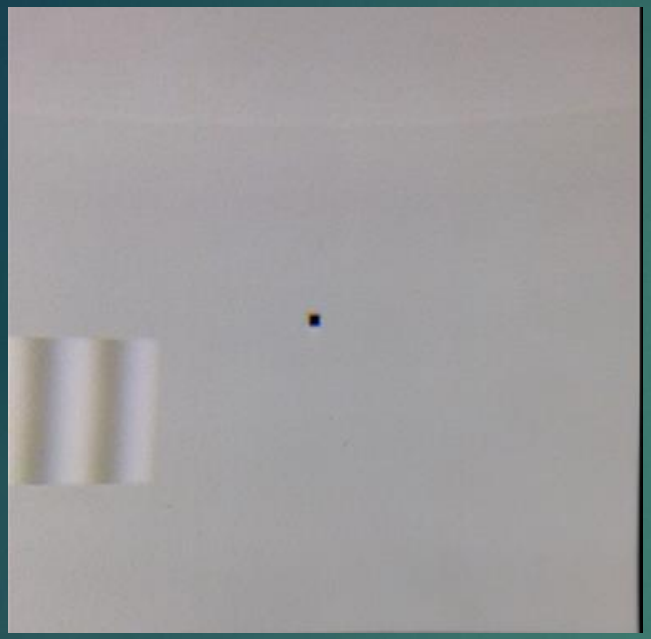
The GCL-IPL sectors for the right (OD) and left (OS) eyes and the thicknesses

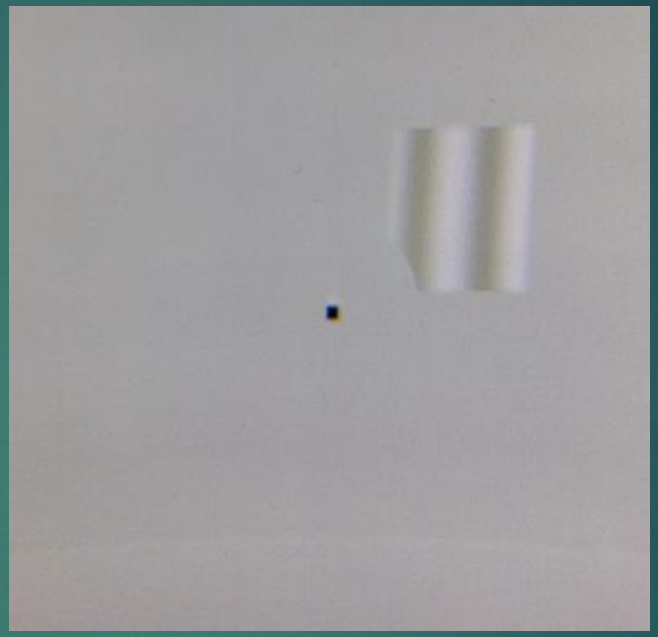
FDT Can Detect Depletion Dopamine

The stripes appear in various locations, with each presentation having less less contrast.



Test of Retina

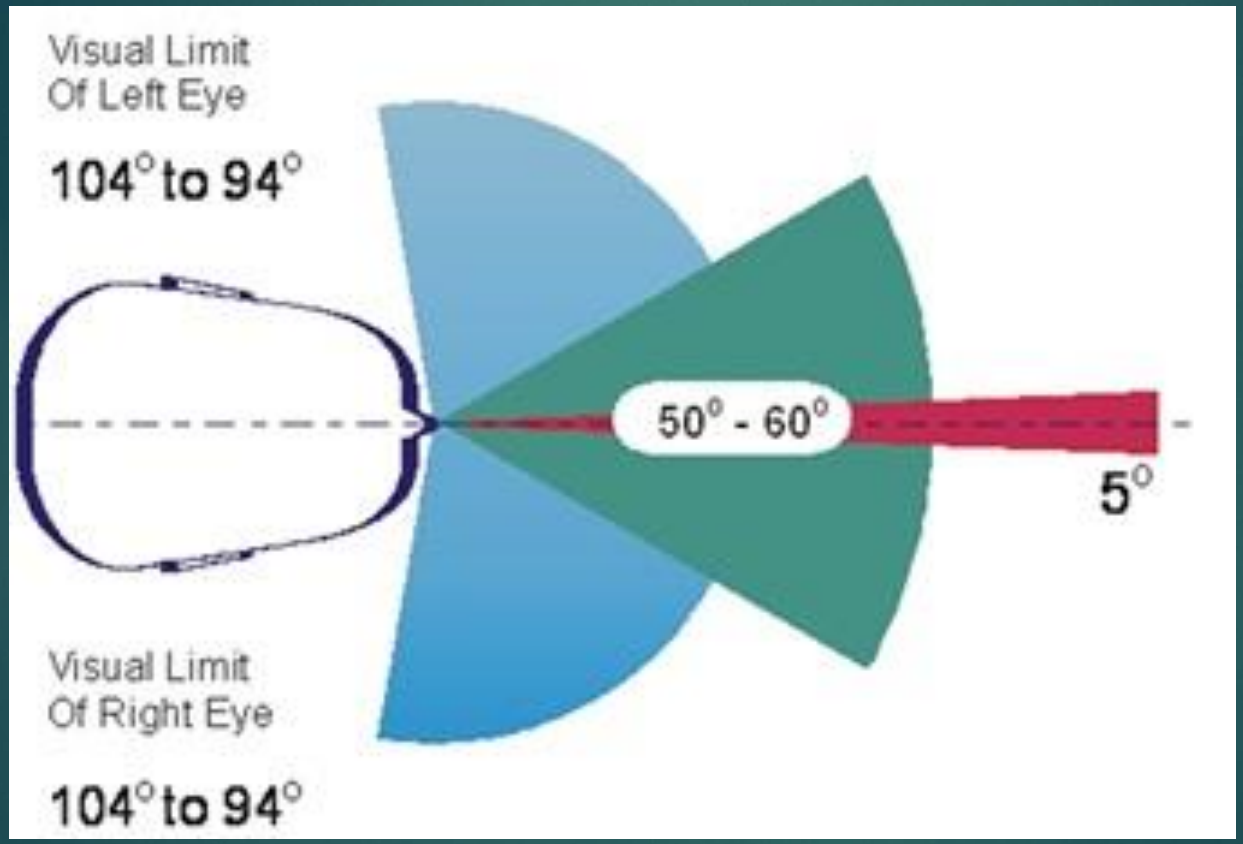




Test one eye at a time.

Chronic users have more unreliable tests, even when abstinent.

IMMAD Midperipheral Test of RGC Function

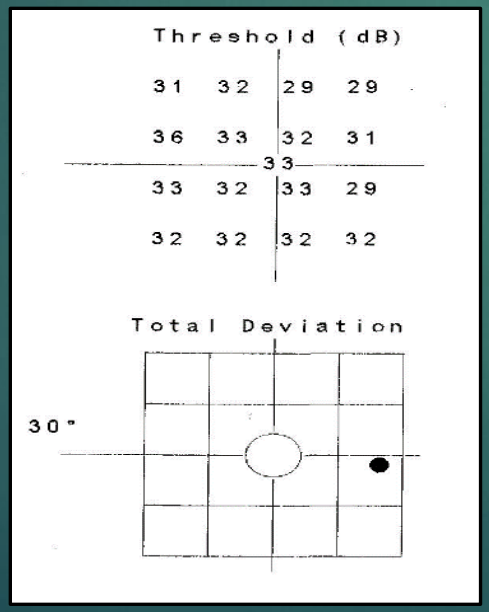


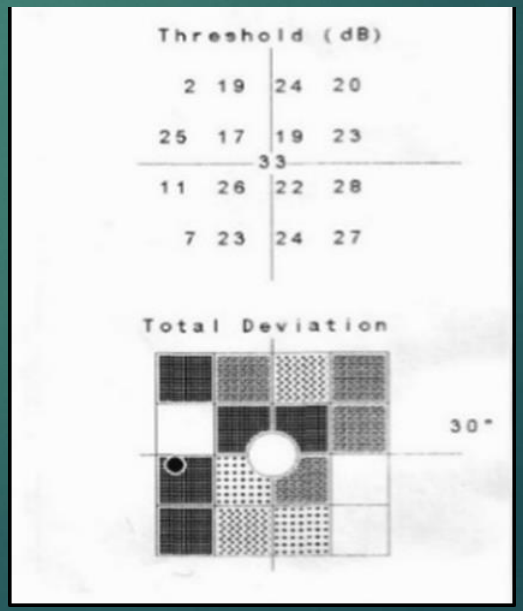
Test midperiphery 40 degrees.

Table top uses sixteen ten degree targets and a single central five degree

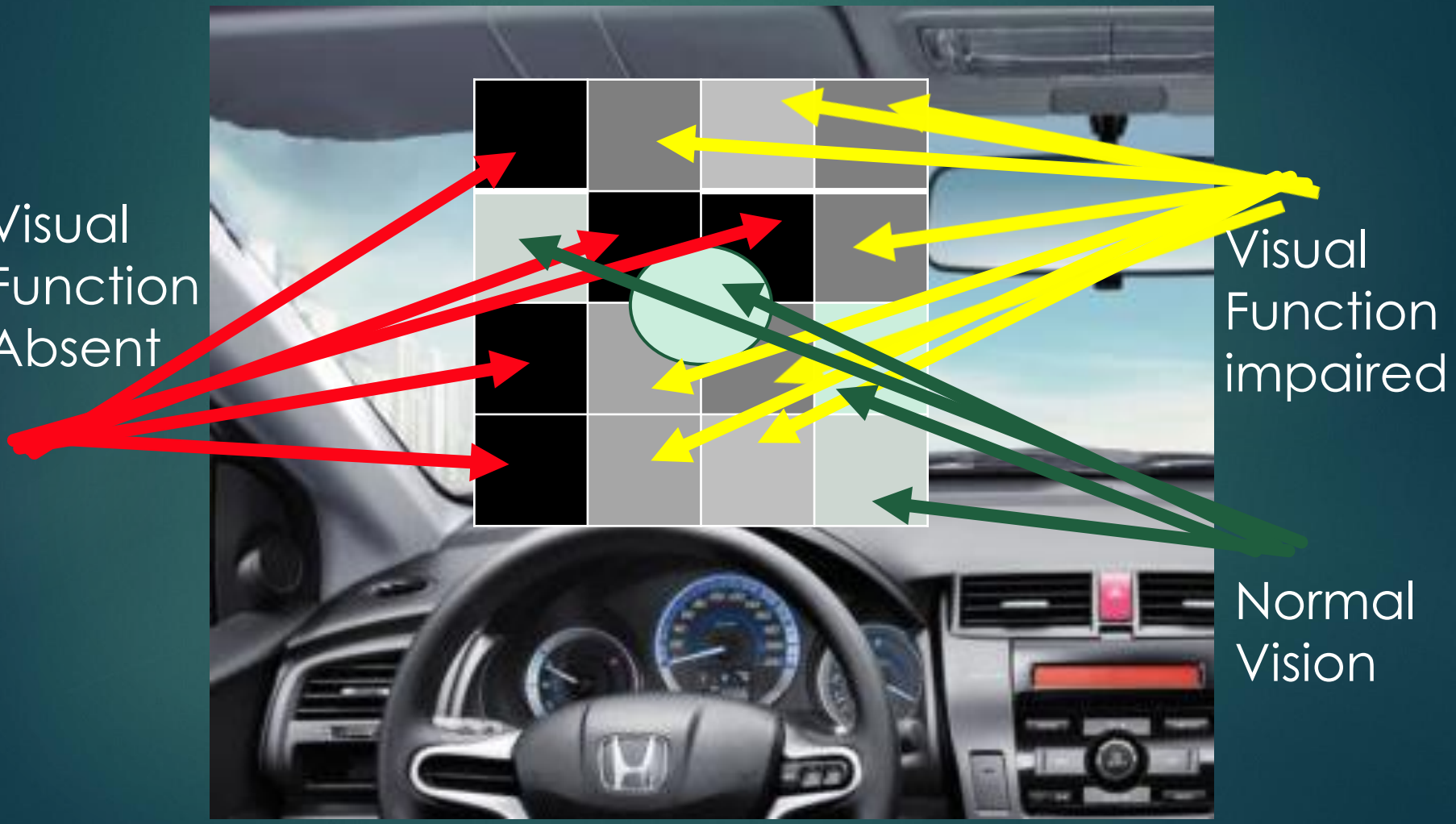
Preliminary Data With Marijuana Using FDT Test

- White is normal. The darker the grey within the squares, the worse the vision relative to a normative data base. Left is normal, right is acute use marijuana





FDT In Casual, Non Chronic User Shows Tunneling Vision



Washington Data 2015

- http://wtsc.wa.gov/wp-content/uploads/dlm_uploads/2015/10/Driver-Toxicology-Testing-and-the-Involvement-of-Marijuana-in-Fatal-Crashes_REVFeb2016-1.pdf
- A driver having tested positive for marijuana alone, no other drugs or alcohol is six times more likely to kill someone other than themselves compared to a driver positive for alcohol alone.
- Marijuana positive drivers more likely to kill a pedestrian, bicyclists, passenger or other driver.

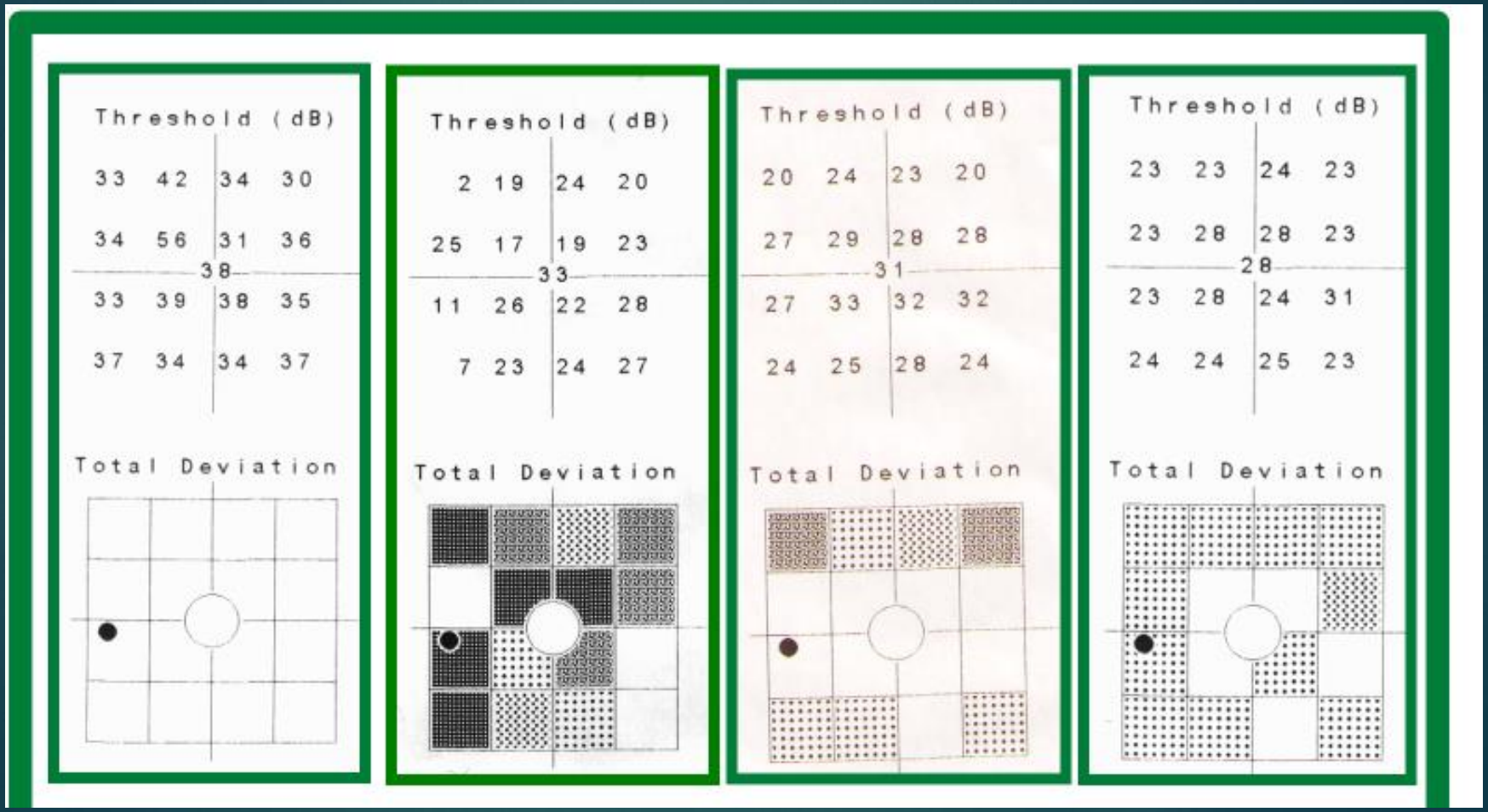
Marijuana Impaired

- Data shows a survival rate of 50% for Active THC driver in fatal crash
- Compares to 15% for alcohol only
- Given if survive can refuse and delay blood draw

Explains the data:

- All forms of THC-but no other drugs or alcohol, the rate of harm to others is Eight times greater than alcohol alone

FDT Data Casual Acute Users 10 Minutes



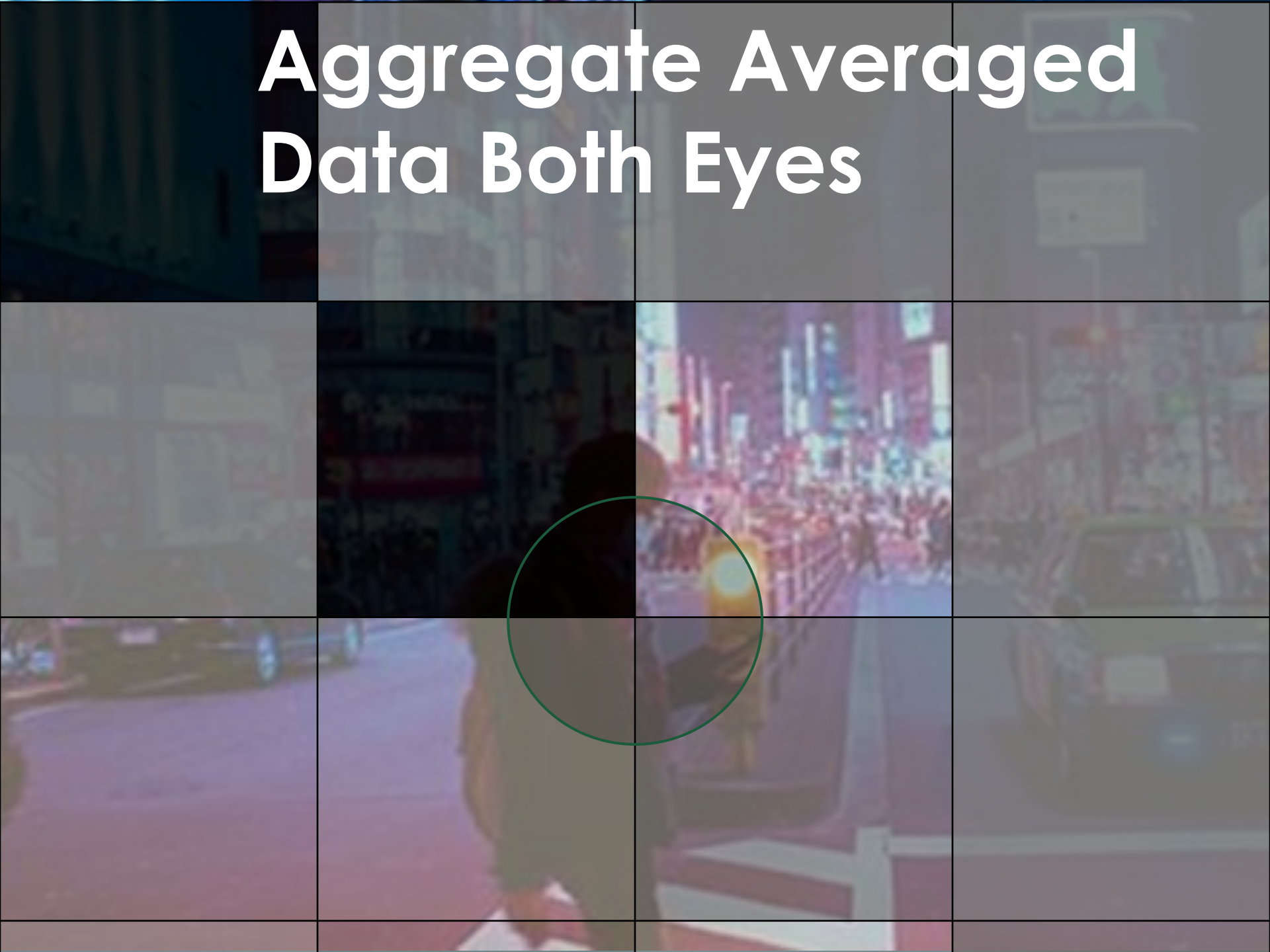
Three Participants
Six Eyes

To left is data specific to casual users. The right and left eyes are combined. N is six eyes, compared to normal control N of four eyes.

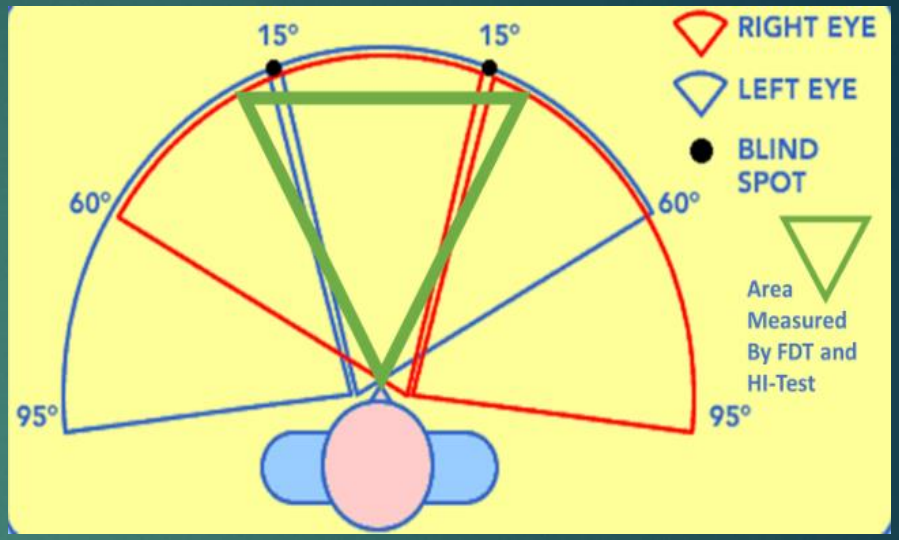
1: t-value -3.49607 p-value .008126
6: t-value -3.72385 p-value .005839
17: t-value -4.26025 p-value .00276

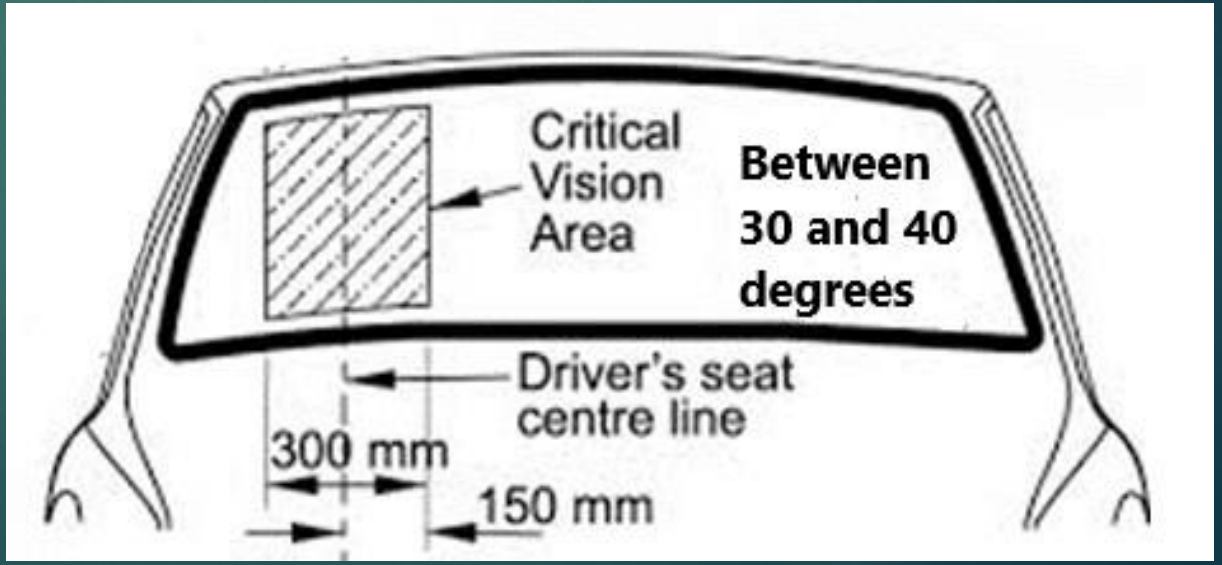
Aggregate data for nasal and temporal hemispheres were compared, with no significant differences. This indicates that brain laterality effects are unlikely. Superior and inferior visual fields were compared, with no significant differences.

Aggregate Averaged Data Both Eyes



FDT Measures Central Forty Degrees

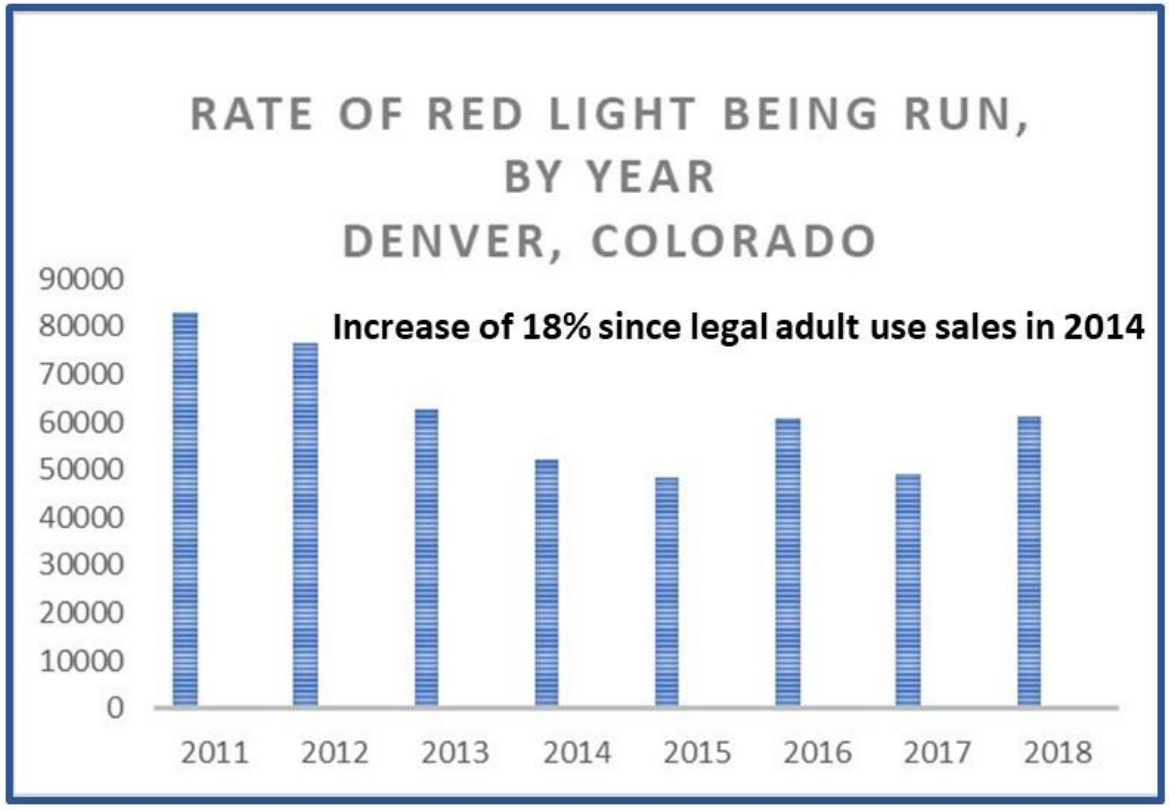




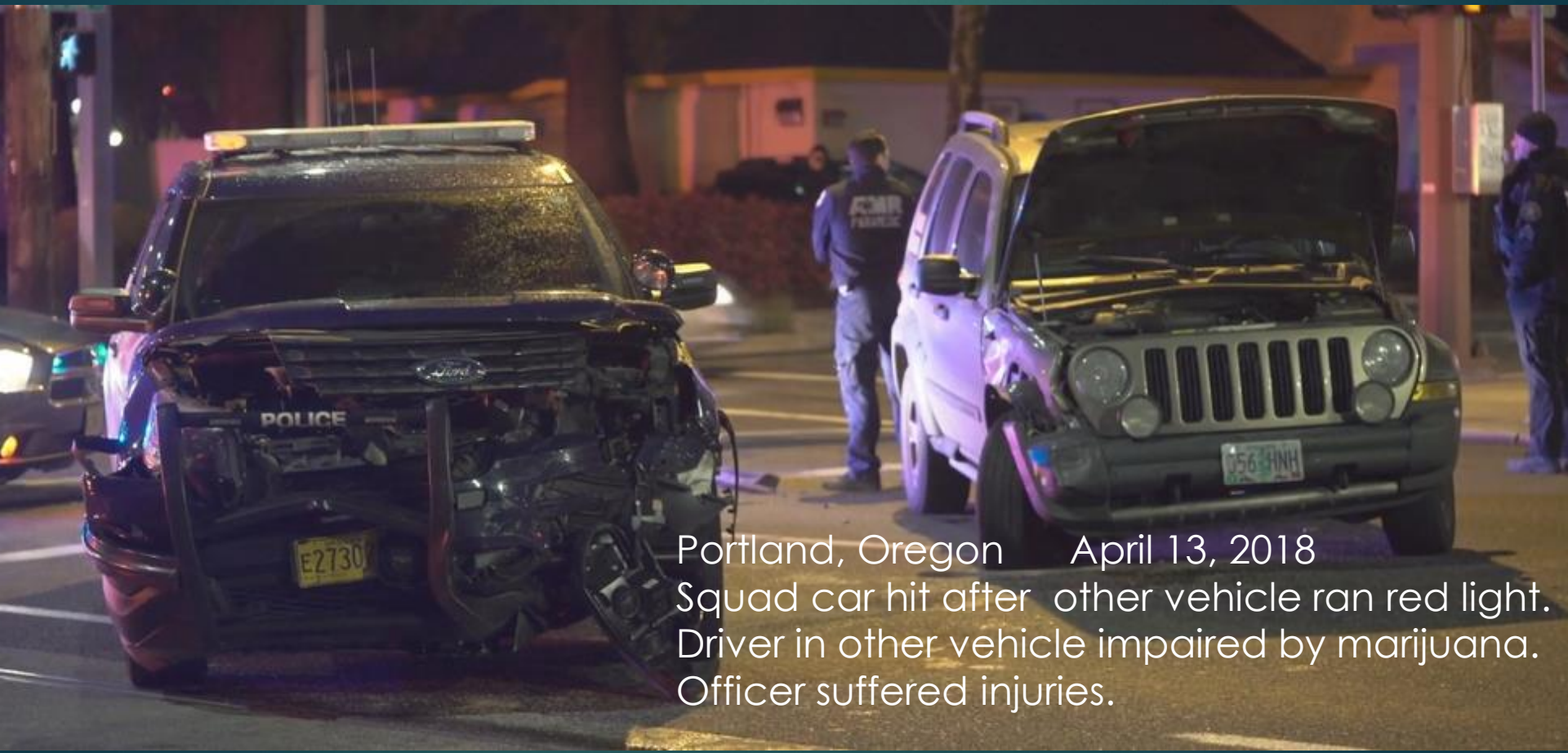
Deadly Warped Vision

The red squares are areas of significant loss with recent use of marijuana.

Increase Running Red Lights



Using Marijuana: Running Red Light Cannot See It

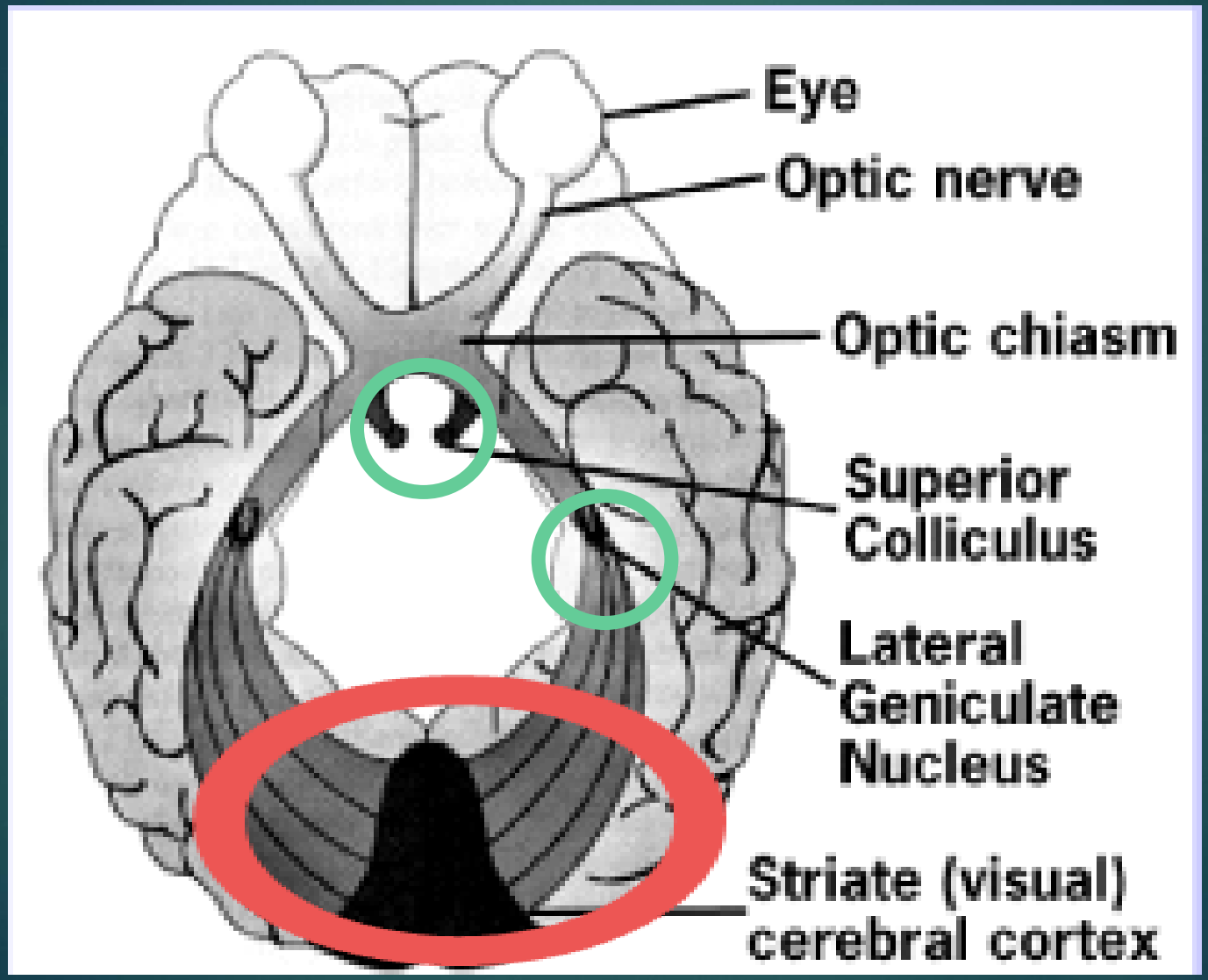


Portland, Oregon April 13, 2018
Squad car hit after other vehicle ran red light.
Driver in other vehicle impaired by marijuana.
Officer suffered injuries.

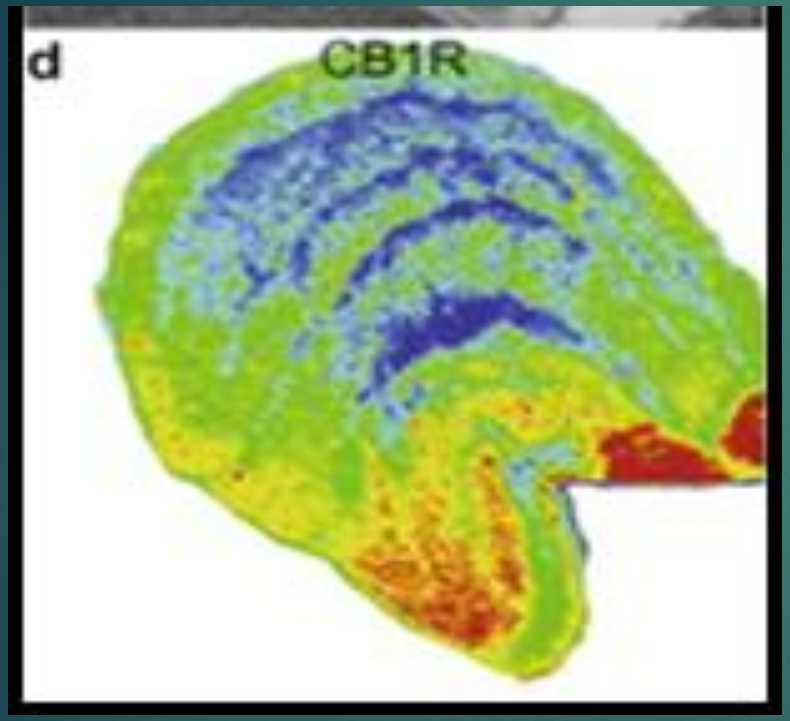
IMMAD

Headborne IMMAD-VR

On To The Brain: Side



Cannabinoid Receptors Brain Nucleus Lateral Geniculate

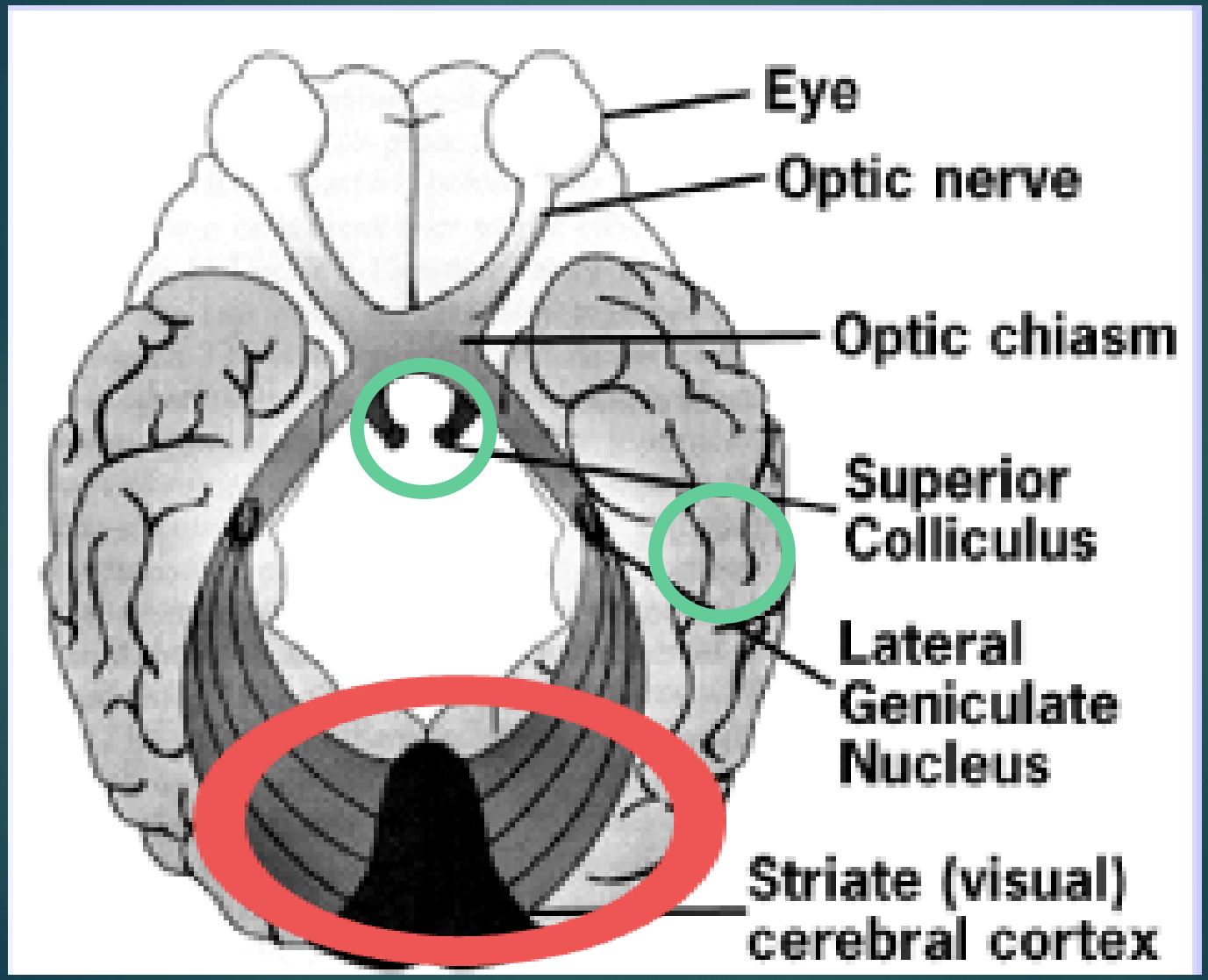


The primate lateral geniculate nucleus has cannabinoid receptors throughout.

Yellow, Red and Blue all CB1

Javadi P: Neuroscience. 2015 Mar 12;288:135-44.

Middle of Brain



Colliculii:
Rat and Cannabis Changes

- Colliculii influence eye movement.
- Chronic long term human users have probable changes.
- High potency kills cells in colliculi.

DeSalu 2017 *wjpmr, 2017,3(6), 22-26*

https://www.mysterious-times.com/wp-content/uploads/2018/08/high-rat_a49306f8.jpg

Positive or Negative? Not Known

Superior Colliculli
What do they do?

- They transform sensory input into movement output.
- The major function is orientation, particularly with eye movements, to objects of interest in the outside world.
- Dopamine is involved.

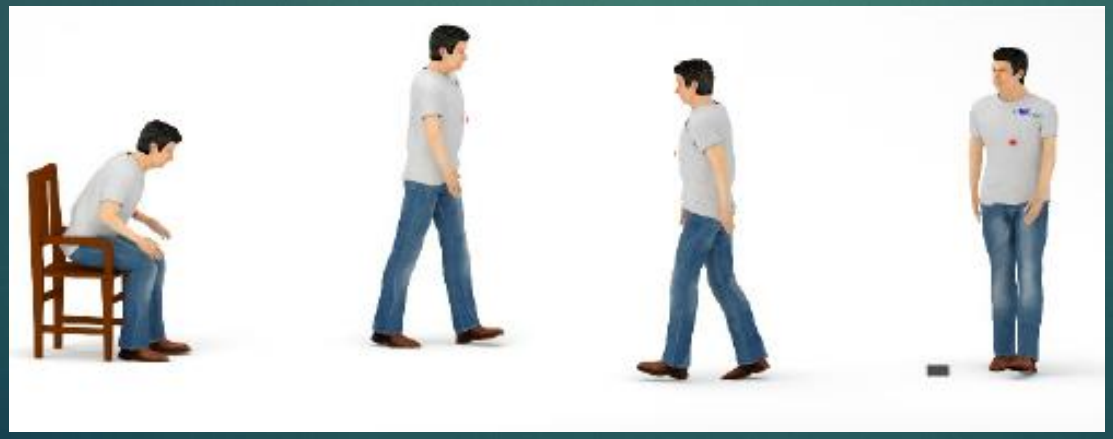
Cannabis Use: Abnormal Eye Movement

- See microsaccades in chronic users, even when not having usesd marijuana.
- Problematic for fixation and testing.
- With casual use see microsaccades with high dosing/dabbing.
- Also unusual eye tremors with high dabbing.

Colliculi Involved in Balance

- Impaired strength and balance are risk factors for unsafe driving with aging.

- One legged balance.
- Timed up and go test.



Marijuana Driving Balance Testing

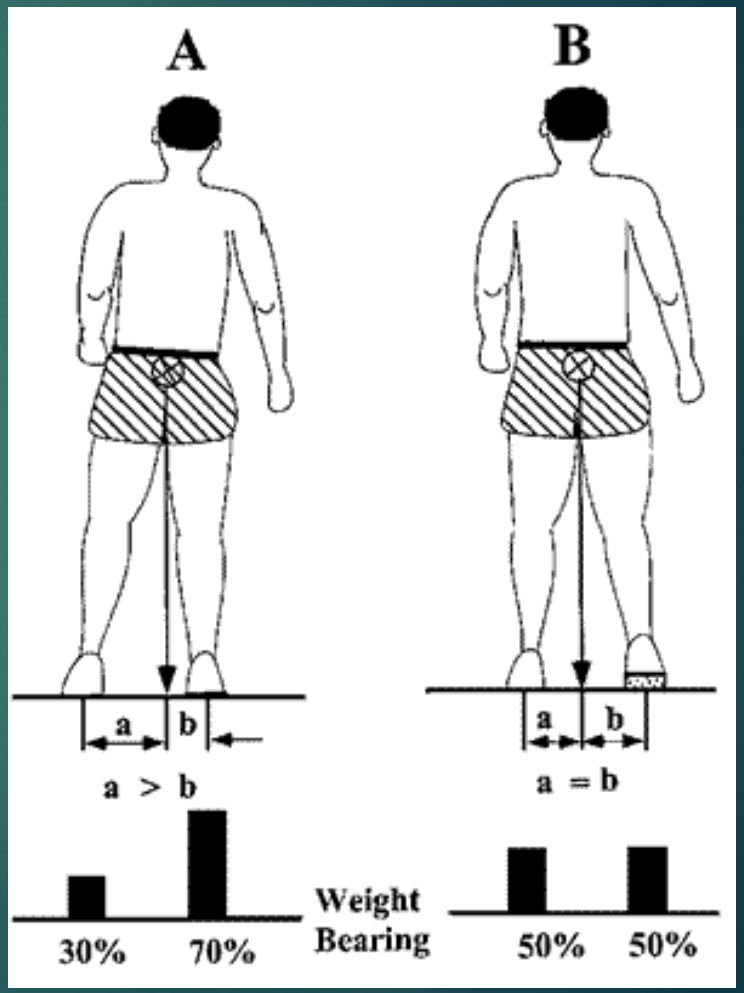
- Marijuana impairs occasional cannabis users' performance on balance tasks compared to placebo.
- One leg stand.
- Walk and turn.

J Appl Toxicol. 2017 Aug;37(8):922-932

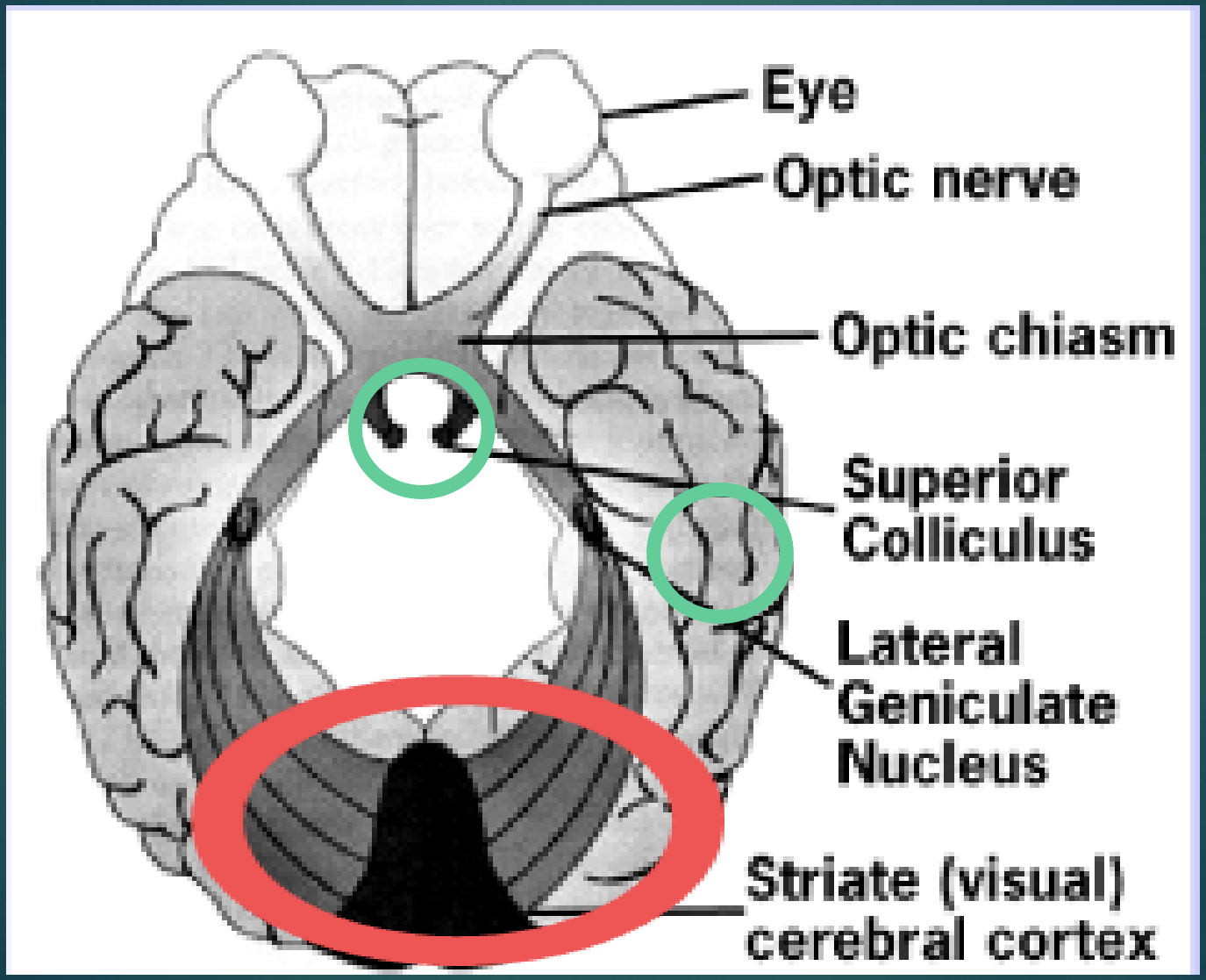
Chronic Use Impairs Gait

- History of chronic cannabis use is associated with long-lasting changes in open-chain (non weightbearing) elements of walking gait.

- Drug Alcohol Depend. 2017 Sep 1;178:215-222

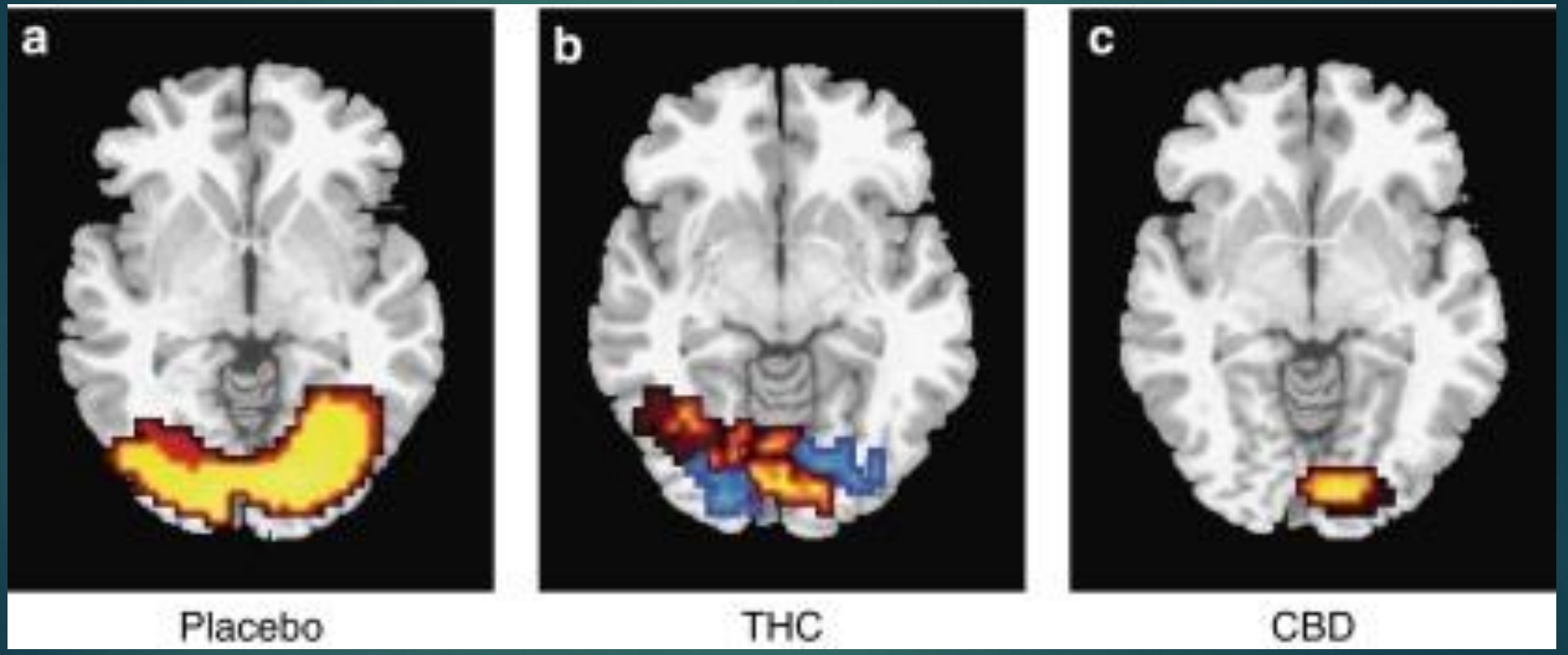


Back of Brain



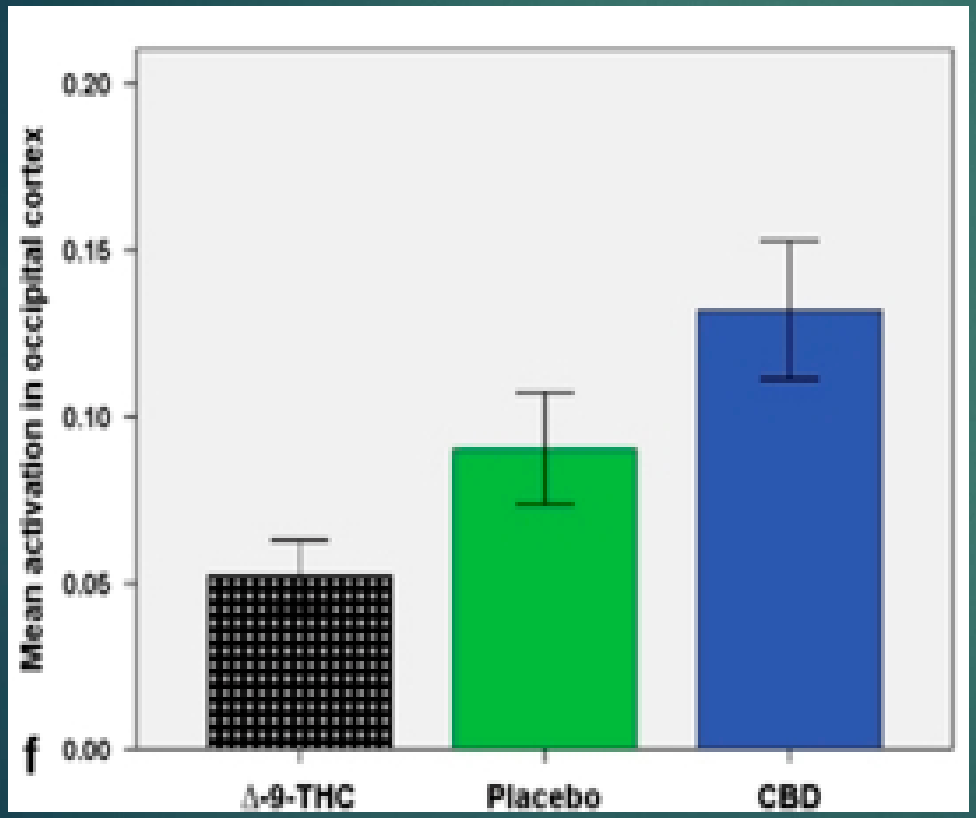
Cannabinoids: THC and CBD

Neuropsychopharmacology. 2011 Jun; 36(7): 1340–1348.

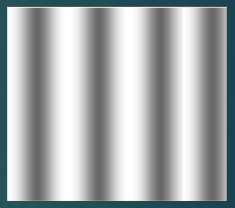


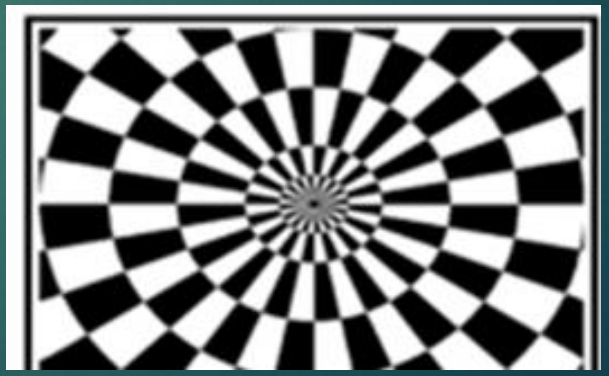
Used simple fixation cross Red indicates more activity and blue less, yellow is similar
Placebo, THC, CBD were compared to normal controls.

Cannabinoids THC and CBD fMRI Occipital Cortex



Temporal target, instead of alternating stripes used checkerboard.





Neuropsychopharmacology. 2010 Feb;35(3):764-74. doi: 10.1038/npp.2009.184. Epub 2009 Nov 18.

Cannabis, Cognition and Driving Issues

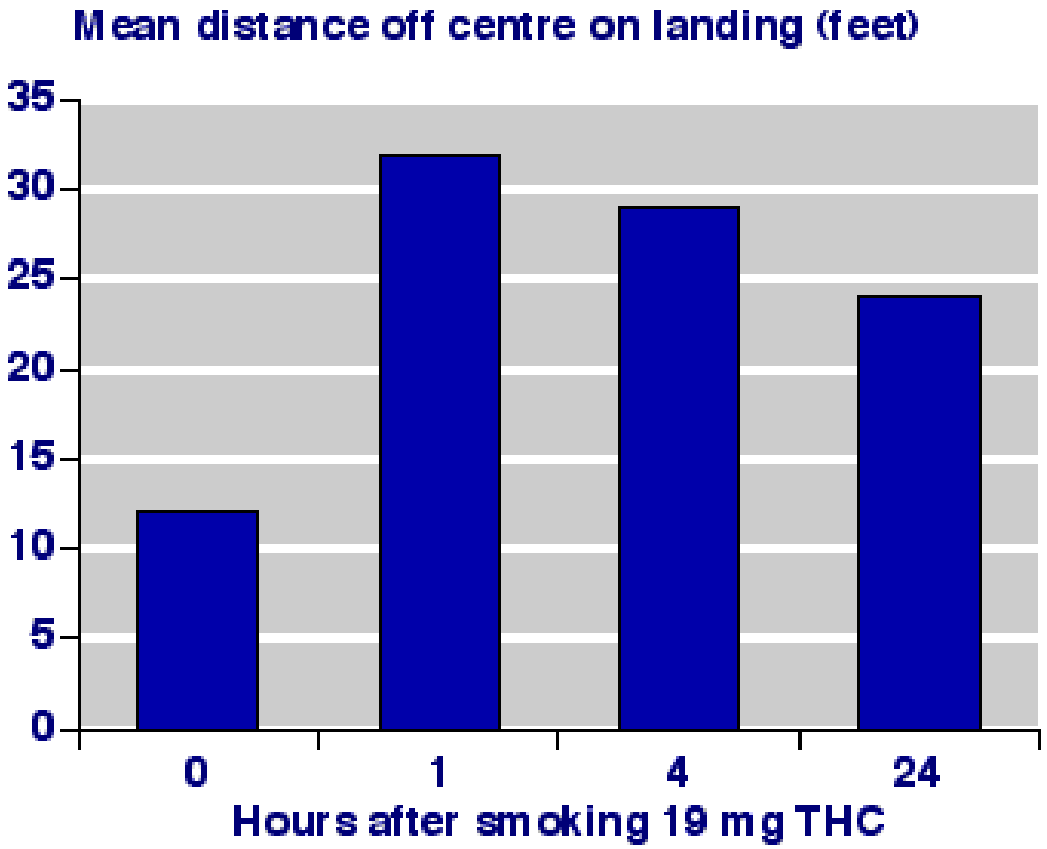
- Lane deviation is a frequent error with cannabis.
  Hartman RL: Drug Alcohol Depend. 2015 Sep 1;154:25-37.
- Alzheimer's disease impairs driving.
- Lane deviation is a prominent error with Alzheimer's disease. Griffith HR: J Geriatr Psychiatry Neurol. 2013 Dec;26(4):259-66.

Marijuana Impairment Parallels Alzheimer's

Cannabis Lack of Awareness of Impairment

- Ten experienced licensed private pilots trained on a flight stimulator landing task
- Each smoked a cannabis cigarette (19 mg)
- 24 hours later performance on the flight task showed trends toward impairment in all variables, some tasks showed significant impairment
- ***Despite the deficits, the pilots reported no awareness of impaired performance at 24 hours***
- Am J Psychiatry 1985;142:1325-1329.

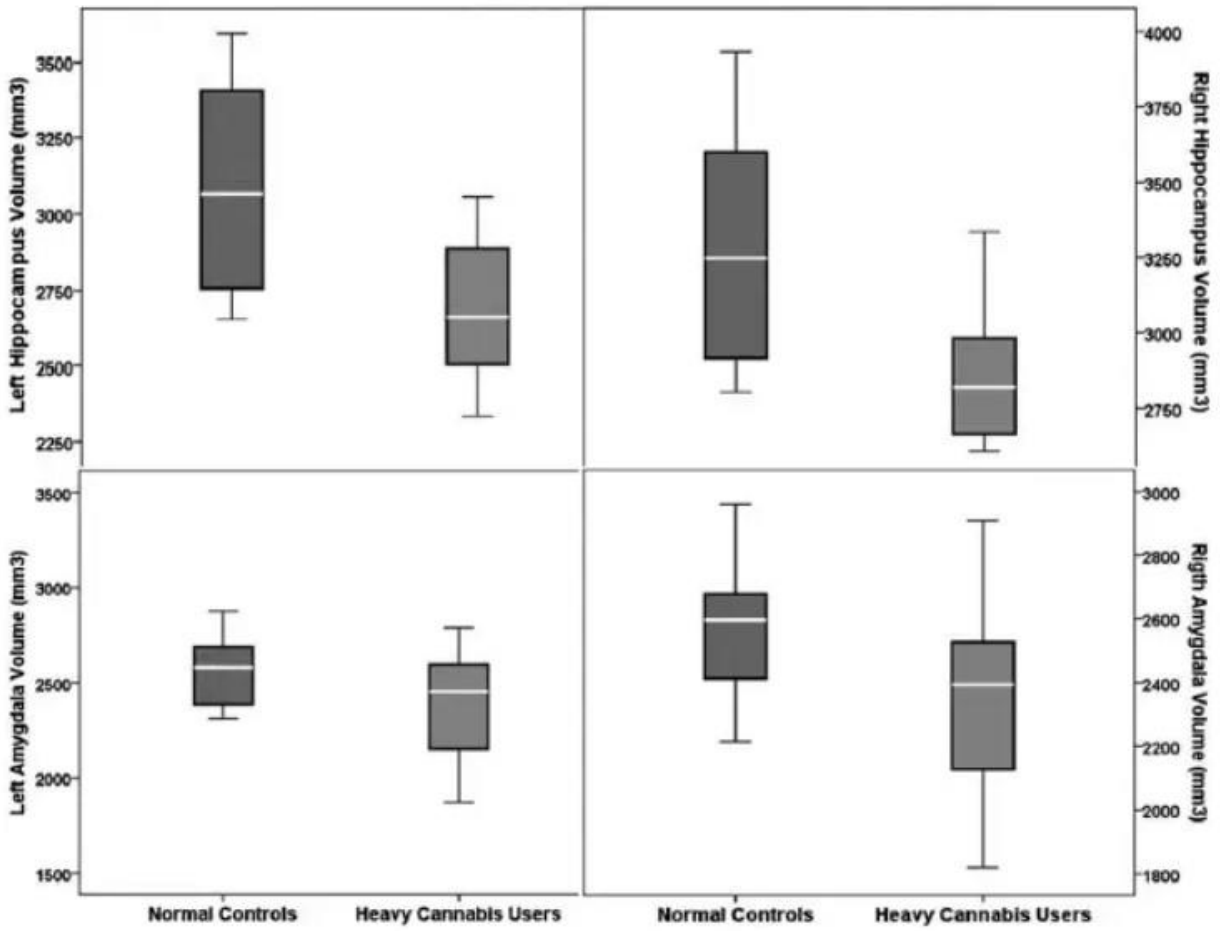
24 Hours Later Dysfunction To Land A Plane



Teens, Brain, Amygdala and Hippocampus

- Areas involved in Alzheimer's Disease

M. Ashtari et al. / Journal of Psychiatric Research 45 (2011) 1055 –1066



Initial Action: Education

IMMAD

IF YOU FEEL DIFFERENT
YOU DRIVE DIFFERENT
DRIVE HIGH GET A DUI

Further Actions

- Train additional officers.
- Change research related laws.
- Further develop technology that objectively measures biologic measures of marijuana and function impairments.

- IMMAD – Virtual Reality and IMMAD-Tears

Officer Expertise

- Advanced Roadside Impaired Driving Enforcement: ARIDE

Sixteen hour course. ARIDE bridges the gap between Standardized Field Sobriety Testing (SFST) and the roles and responsibilities of the Drug Recognition Expert (DRE).

- Drug Recognition Expert: DRE

https://www.theiacp.org/drug-recognition-experts-dres

A drug recognition expert or drug recognition evaluator (DRE) is a police officer trained to recognize impairment in drivers under the influence of drugs other than, or in addition to, alcohol. The training is extensive, taking several weeks and includes additional field training.

Urine

Probably least practical for road side testing

Oral Swabs Saliva

Oral Swabs

- Not common yet.
- Used in other countries, including Canada.

Alabama Approved Oral Fluid/Saliva

SoToxa/Alere

Draeger Drug Test 5000

Randox MultiSTAT

Oral Saliva State Programs

IMMAD

Michigan

Pokagon Tribal Police Participation

Blood Levels

Saliva compared to Blood

- Recent ruling that law enforcement does not require any sort of search warrant to obtain saliva.
- This is likely to change given amount of DNA in saliva.
- To obtain blood, must obtain a search warrant. The process can take on average two or more hours.

- Cannabis peaks at one hour.

No biologic that matches function -- YET

- There is no research demonstrating a level of THC or cannabinoids that relates directly to driving ability.
- There is for alcohol.
- States have varying laws about cannabis.
- Per Se Laws/Levels: Defines THC level
- Other states have zero tolerance, no level of THC is considered safe or legal.

Green Lab Volunteer

One Legged Stand Part of Field Sobriety

Finger To The Nose Field Sobriety Test Impaired With Cannabis Use

IMMAD

Eye Movements
Primarily used for alcohol

With marijuana there can be abnormal saccades, poor fixation.

With high dosing or chronic use, eye tremors and microfixation movements

Developing Technology

Product	Officer Risk Minimum	Expense Minimum	Directly Related Driving	Practice Has No Effect	No Variability Environment	Initiated FDA process	Used With Breath or Saliva
Brain Wave					✓		✓
Tablet		✓					✓
Smartphon		✓					✓
IMMAD-VR	✓	✓	✓	✓	✓	✓	✓

Brain function using electrodes.

Tablets & Smartphones problems variability in glare, require reading glasses for over 40 and officers express concern can be weaponized against officer.

Breathalyzers for Marijuana

Several under study
Will not likely ever be able to detect edibles.

No breathalyzer has had demonstration of an analytical device useable roadside. To date analysis is in lab using HPLC-MS/MS or other technologyin laboratory

Some Existing Forensic Tools On the Market Testing Eye Movement/Pupil

IMMAD

- DAX Evidence System – Pupils and eye movement https://dax.oculardatasystems.com/

- Omiga Visulyzer – Pupils and eye movement https://omigainc.com/

- GuardEX– Canada--- Pupil, eye movement and ocular convergence @Guard_Ex

- Battelle – Under Development---Pupil, eye movement and ocular convergence https://www.battelle.org/

Thank you!!! End of Oral Presentation

Our participant swag bag. Mask and hand sanitizer. Also comes with munchies.