



It's all about **SAFETY**

FLEET SAFETY CONFERENCE

October 29-31, 2018

M Resort Spa Casino, Henderson, NV



In conjunction with

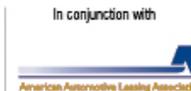


IMMAD, LLC

Dr. Denise A. Valenti

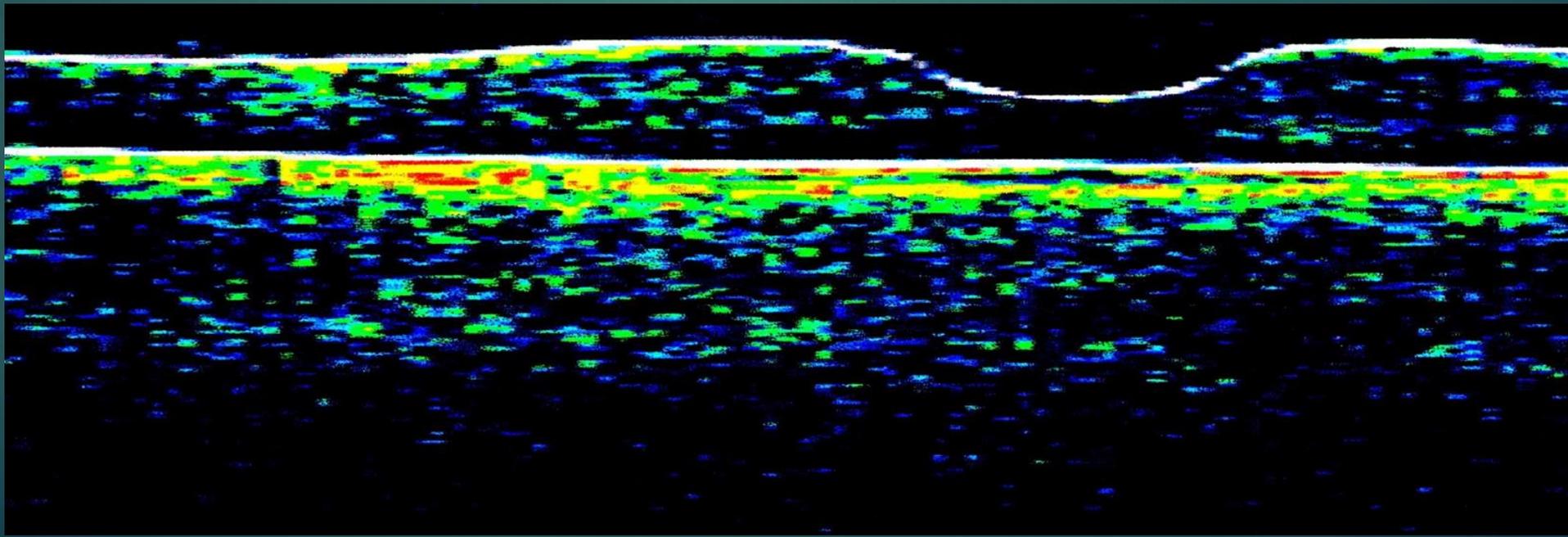
Optometrist Specializing in Neuroprocessing

It's all about
SAFETY



Marijuana: Retina Driving Impairment

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Disclosure

- ▶ Dr. Valenti has twenty five years clinical experience in sensory, physical and cognitive impairment related to driving – emphasis on bi-optic driving.
- ▶ 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.
- ▶ Previous research-NIH funding-pharmaceutical funding specific to Alzheimer's disease, cognition, retina function and structure.



IMMAD Federally Funded

- ▶ This work has been funded in whole or part with Federal Funds from the National Institute on Drug Abuse, National Institutes of Health, Department of Health and Human Services, under Contract Number HHSN271201800039C



The Components of Cannabis

- ▶ The active ingredients in cannabis are cannabinoids. The cannabinoids are concentrated in a resin that is produced in glandular structures known as trichomes, hair like formations you see at the end of buds.



Some Cannabinoids

- ▶ Delta-9-tetrahydrocannabinol (THC)
Causes the High
- ▶ Cannabidiol (CBD) Modulates THC
- ▶ Cannabinol (CBN)
- ▶ Cannabichromene (CBC)
- ▶ Cannabicyclol (CBL)
- ▶ Cannabigerol (CBG)

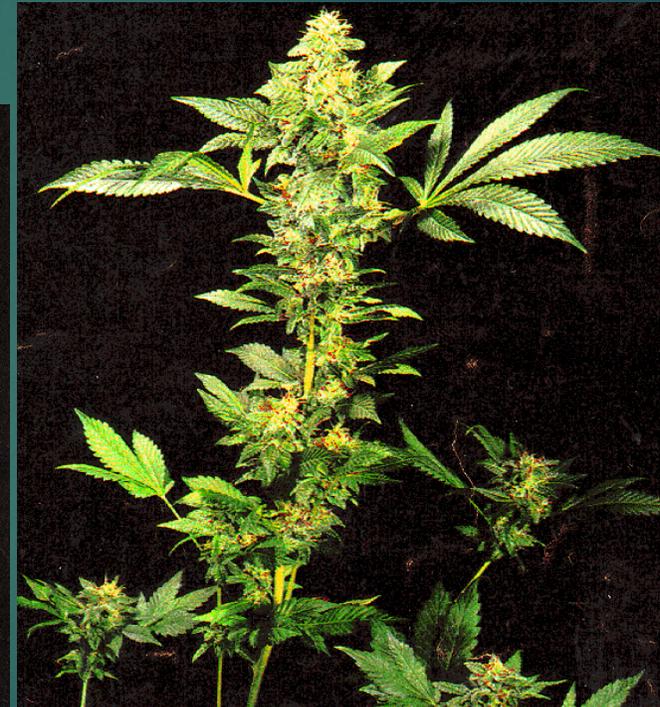
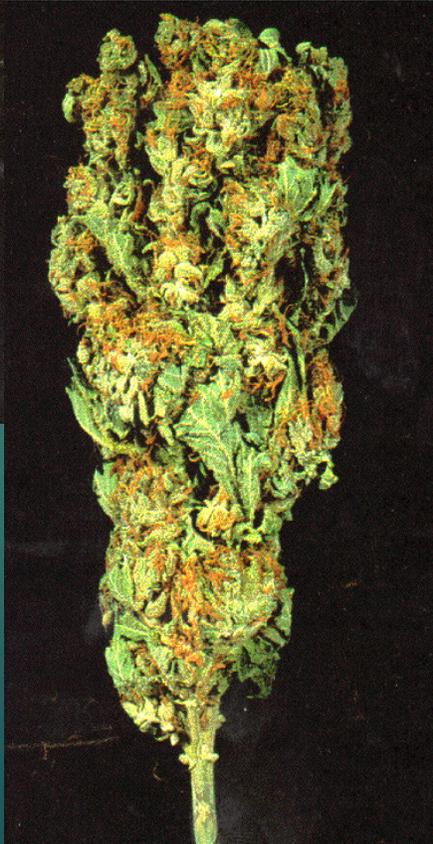
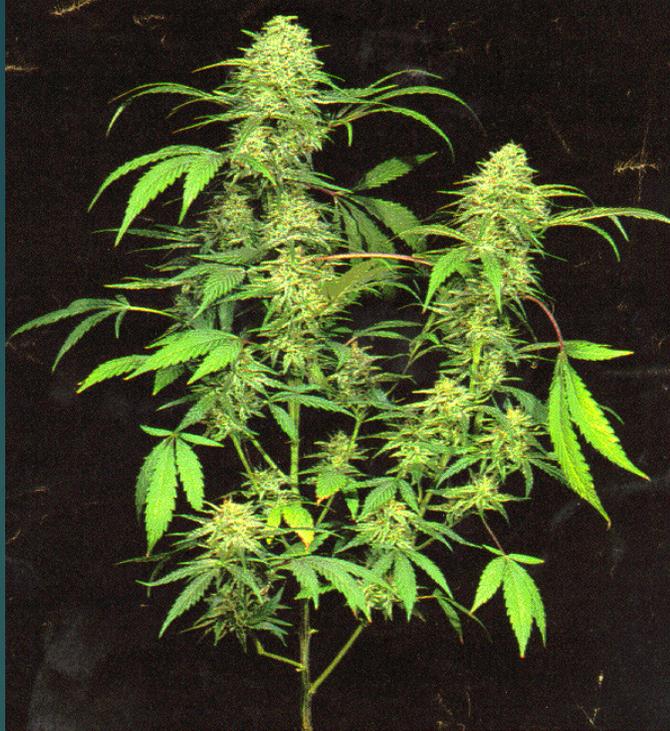


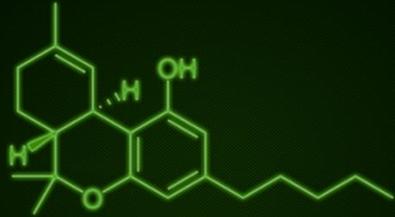
Marijuana, like grapes for wine

- ▶ Soooo many varieties



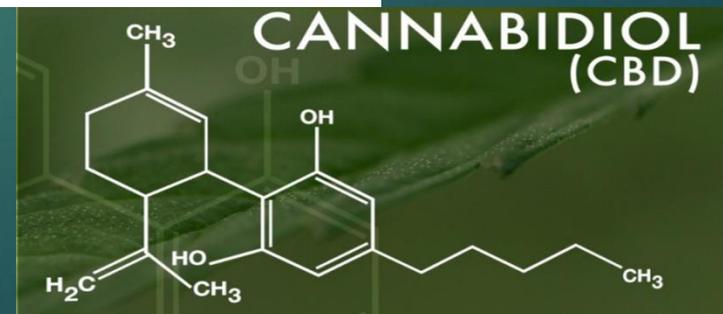
Flowers Different Strains



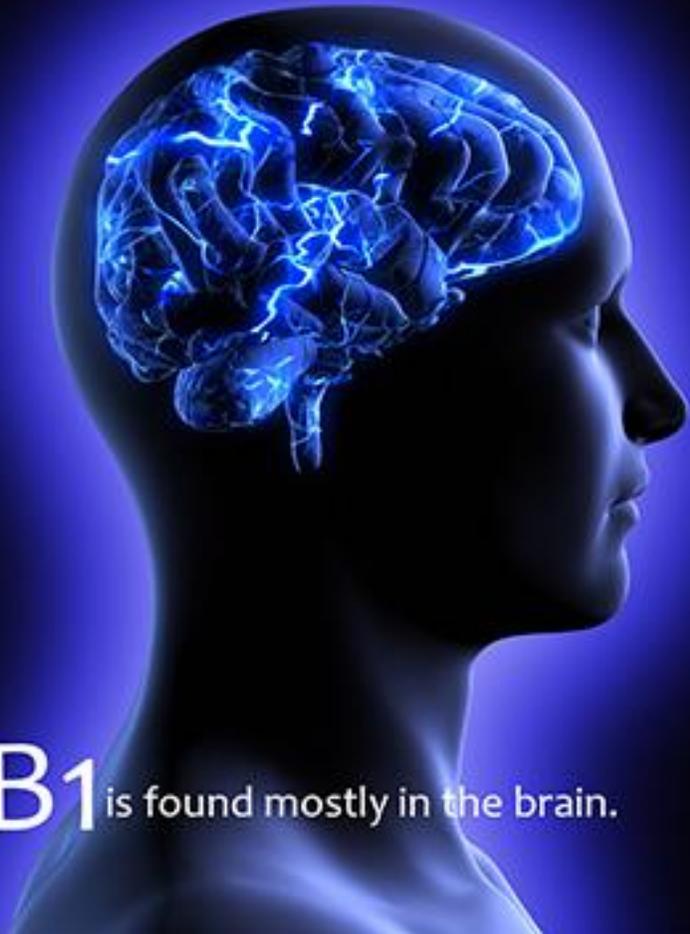


Tetrahydrocannabinol

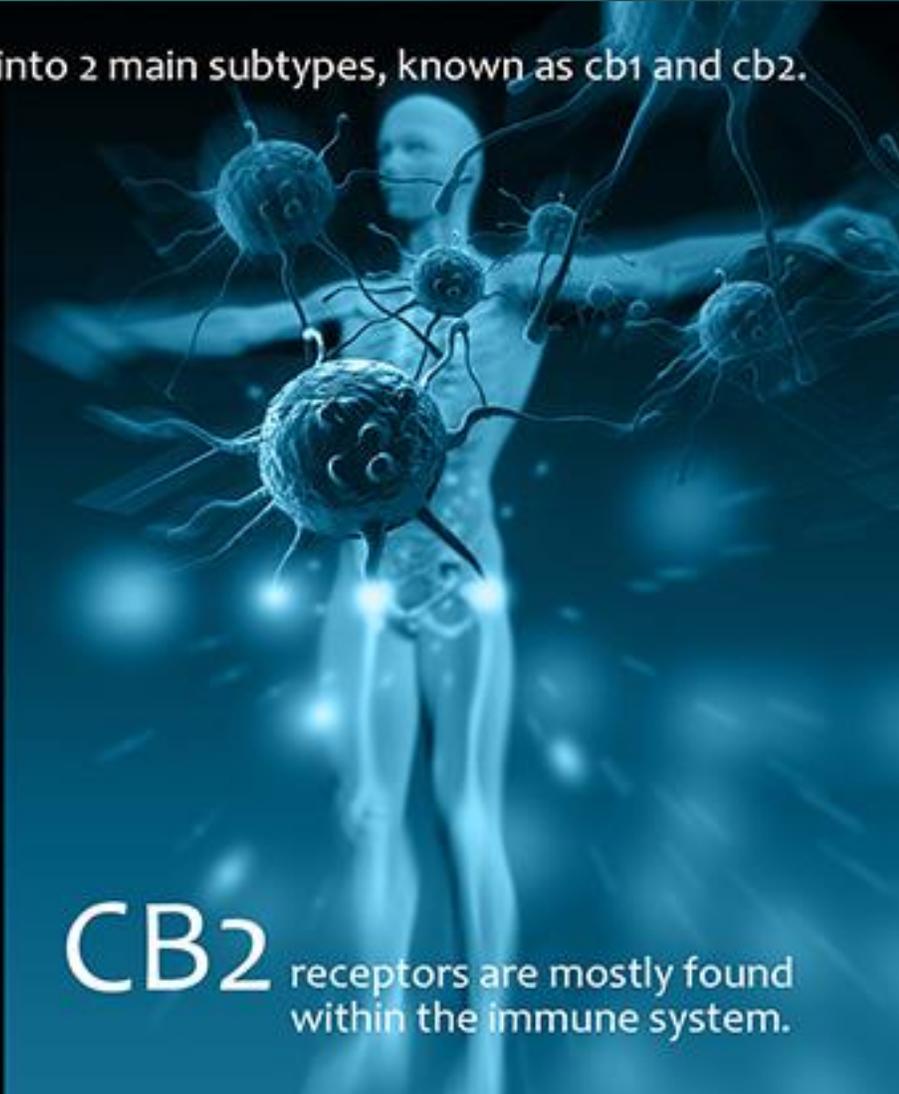
THC **CBD**



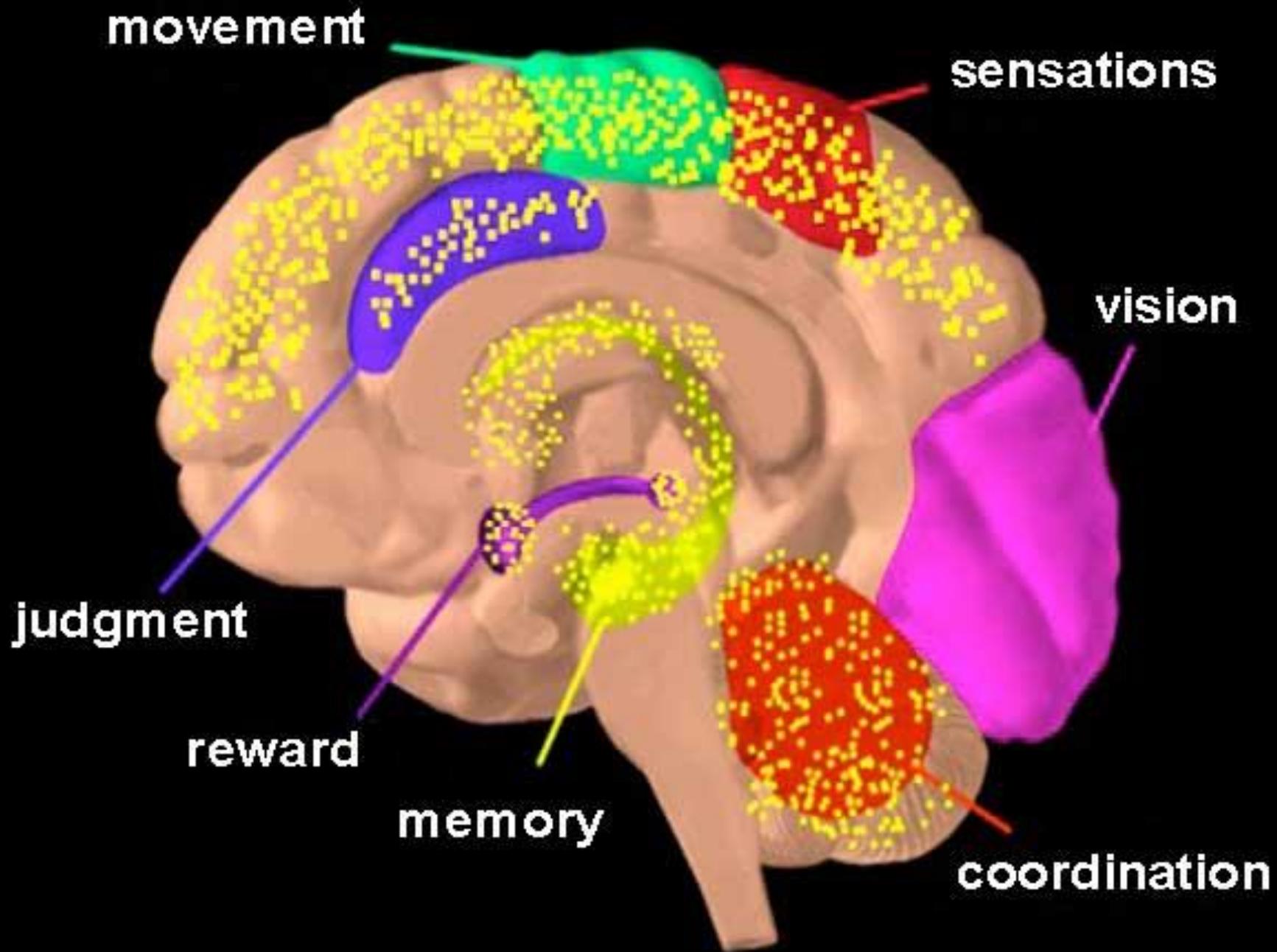
The cannabinoid receptors are further divided into 2 main subtypes, known as cb1 and cb2.



CB1 is found mostly in the brain.



CB2 receptors are mostly found within the immune system.



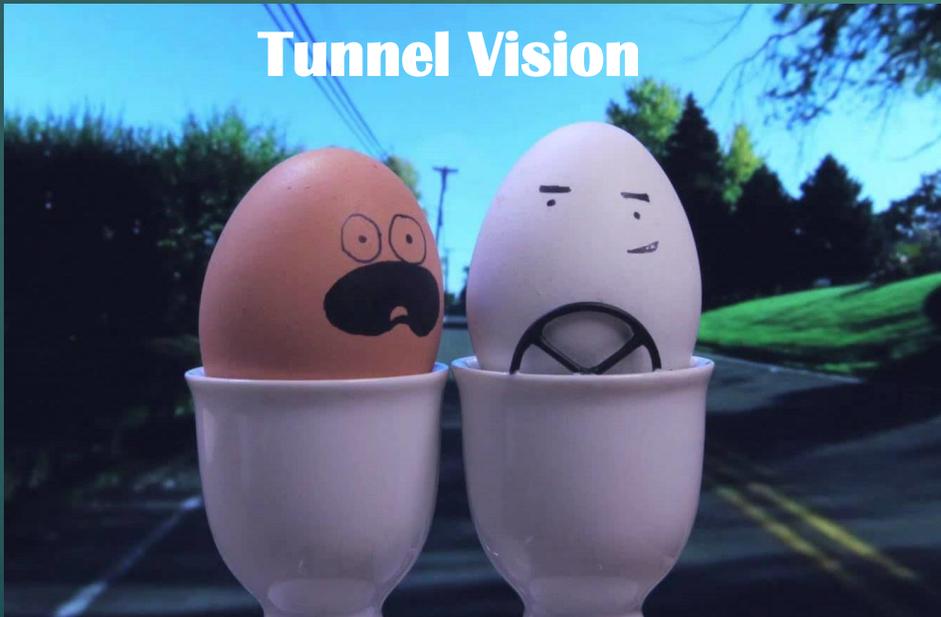
Often Hear Marijuana Tunnels Vision

- ▶ 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

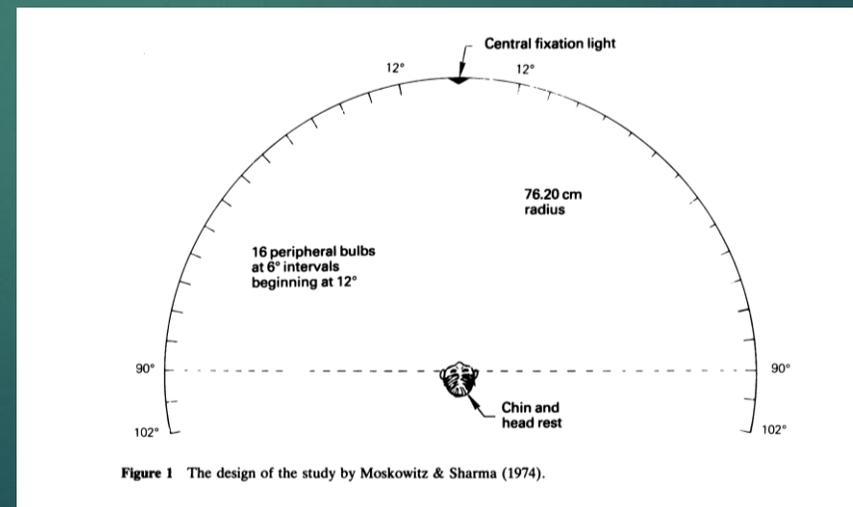
- ▶ Even education campaigns discuss tunnel vision.
- ▶ <http://eggsonweed.ca/>
Have a video on “tunnel” vision



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.
- ▶ Dark adapted.
- ▶ Test done in dark.

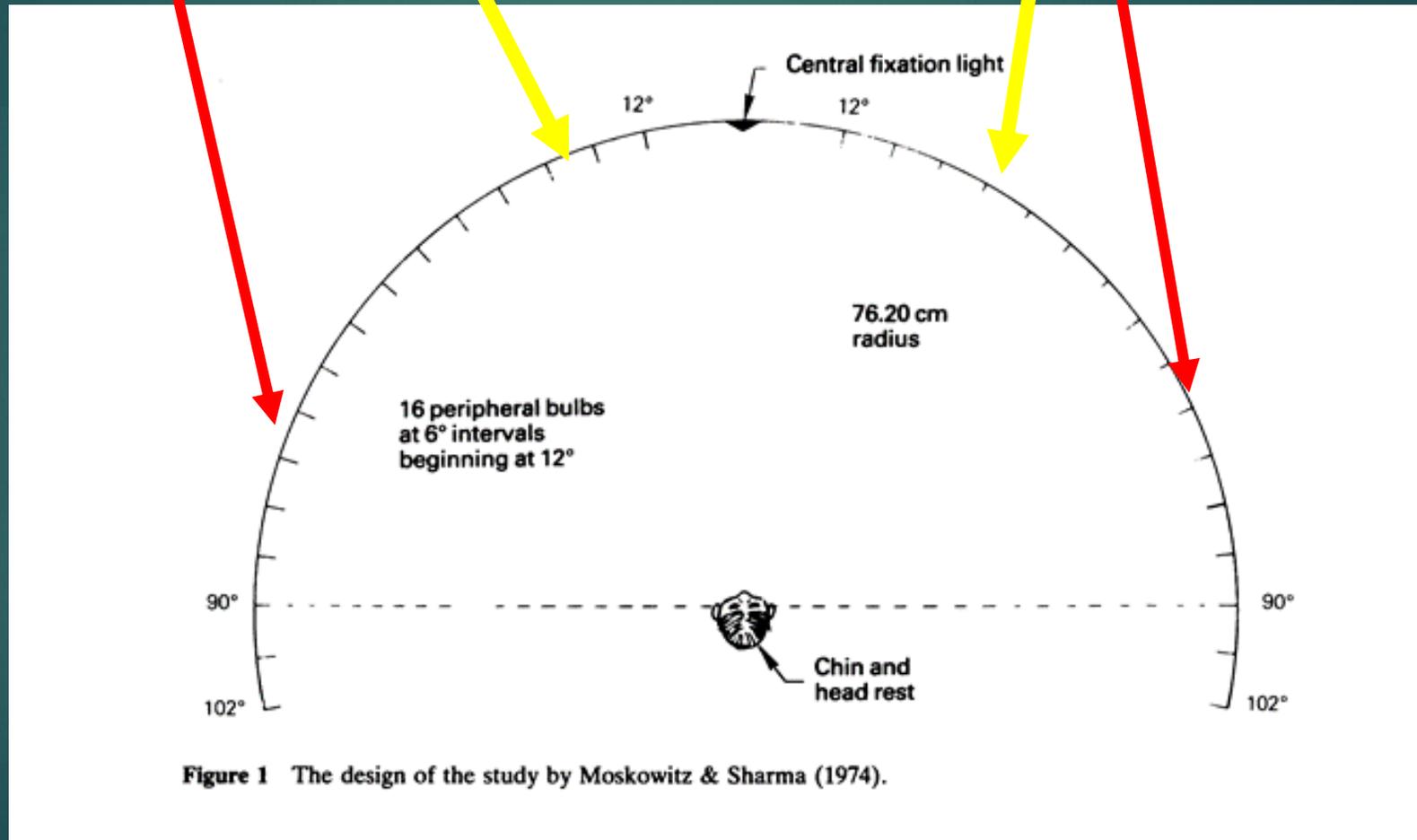
Moskowitz, H. Percept Mot Skills. 1972
Dec;35(3):875-82



Defined Limits Undosed

Outside this positive +

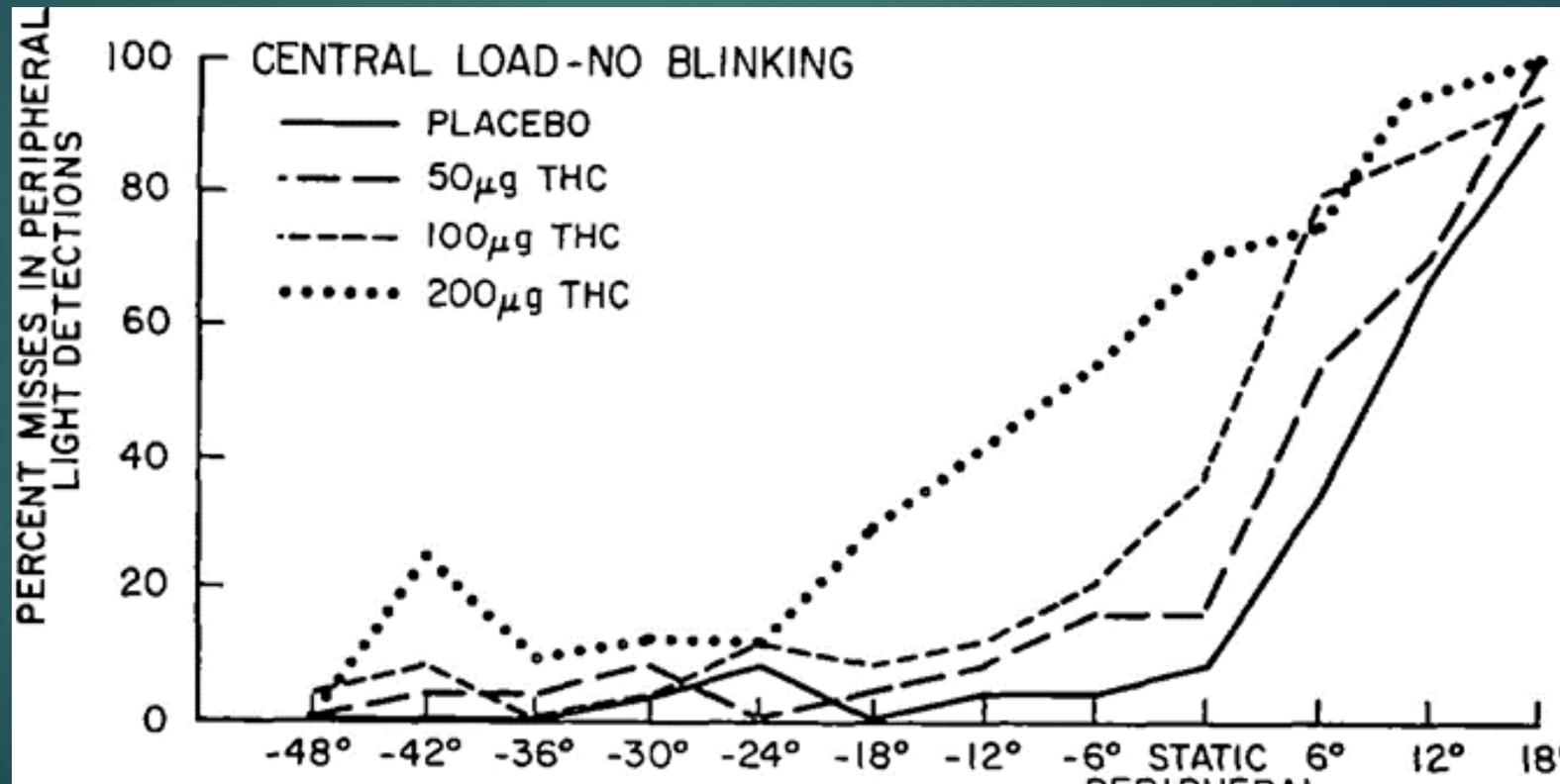
Inside this negative -



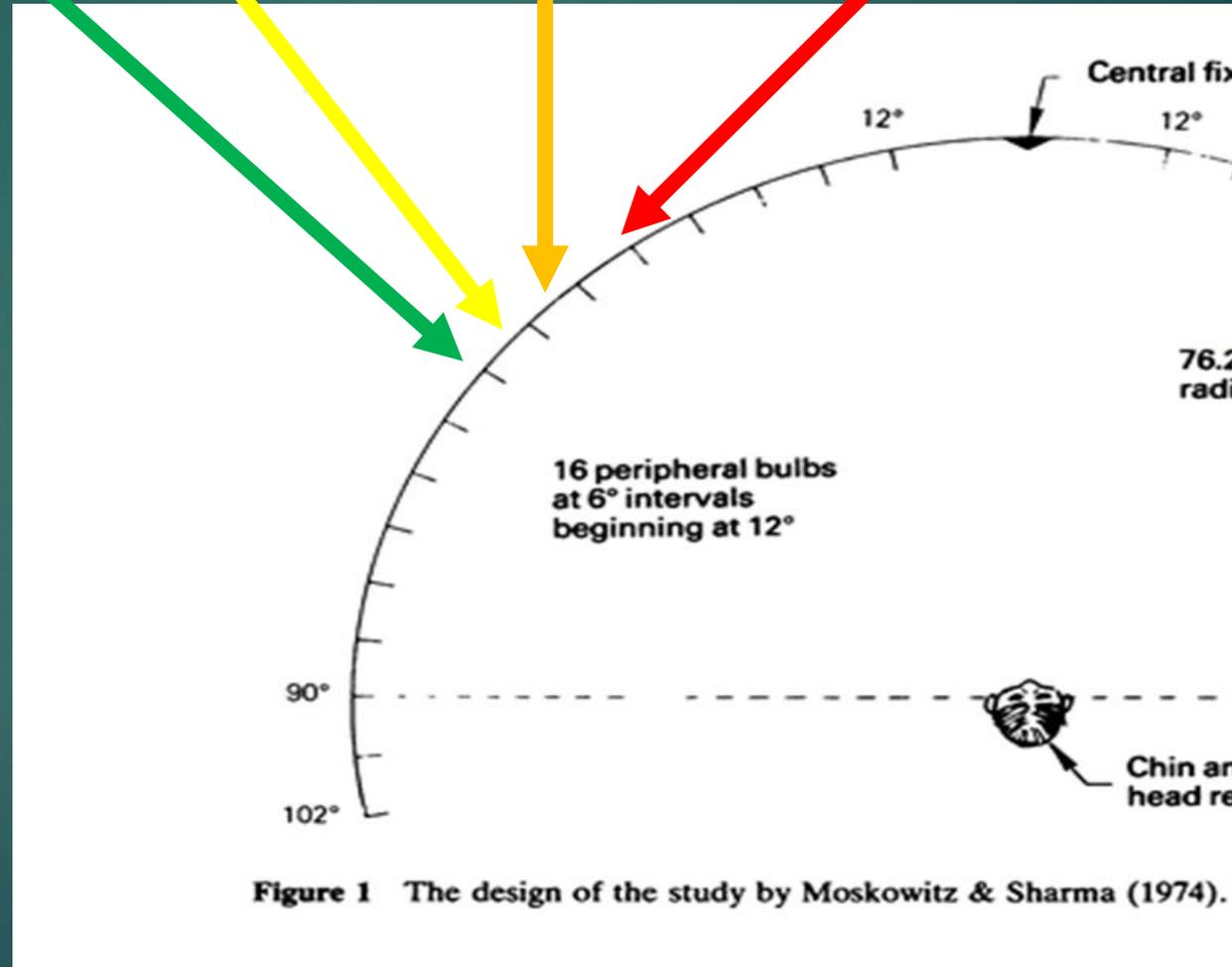
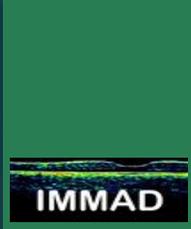
Results

Acute Marijuana Use

Both Eyes At Same Time



Placebo Low Medium High



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.

Marijuana Improves “Peripheral” Vision

- ▶ Studies have shown that marijuana may improve night vision. This was demonstrated with populations of fishermen in Jamaica and Morocco.

Russo EB,: J Ethnopharmacol. 2004
Jul;93(1):99-104.

Merzouki A,: J Ethnopharmacol. 2002
Aug;81(3):403-6



Testing Vision In Periphery

- ▶ Jamaican fishermen, Moroccan fishermen and mountain dwellers often use sifted Cannabis sativa mixed with tobacco. Merzouki A.; J Ethnopharmacol. 2002 Aug;81(3):403-6
- ▶ The populations were tested further, tested four subjects.
- ▶ Testing was double blind graduated dose of 0-20mg in the form of Marinol with placebo.
- ▶ Used portable device, the LKC Technologies Scotopic Sensitivity Tester-1 (SST-1) which has 1 Hz flicker target.

Russo EB.; J Ethnopharmacol. 2004 Jul;93(1):99-104

- ▶ See or not see dot of light.
- ▶ Saw better with dosing.



Tadpole Eye: Cannabinoid Receptor



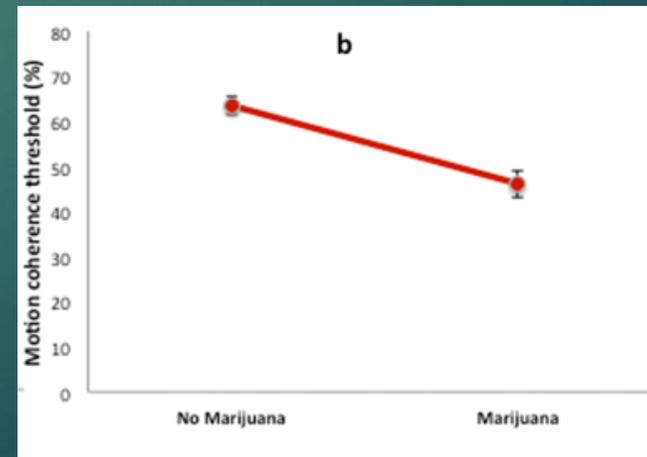
Found the tadpole could see better in extremely low light, when cannabinoid receptors were stimulated.

Marijuana Prenatal Peripheral Motion

- ▶ Tested 145 children ages 4 and 5.
- ▶ Global motion perception improved with those having prenatal exposure to marijuana.
- ▶ Global motion perception decreased with alcohol.

Sci Rep. 2015 Nov 19;5:16921

- ▶ Perception of dots in array moving in opposite direction.
- ▶ However, an increase may be at expense of other functions.



Because of These Studies: Proponents Claim MJ Safe

- ▶ Claim safe to drive after use.
- ▶ While driving.....
- ▶ Very problematic in NOT yet legal adult use states.



When Peripheral Vision Enhanced - Central Suppressed

- ▶ Generally, in the dark the central vision is suppressed and thus extreme periphery is improved.
- ▶ Night vision, cones suppressed rods enhanced.
- ▶ An example of impact on function is vision changes in dark theatre. Takes a few seconds to adapt when go outdoors.
- ▶ During full daylight may work to be more “aware” of extreme periphery, learn to ignore central. Ball sports are examples.
- ▶ The reverse are shooting sports and golf.
- ▶ If marijuana exposed child is more sensitive to peripheral may be unable to suppress normally and thus may be inattentive in school or easily distracted.

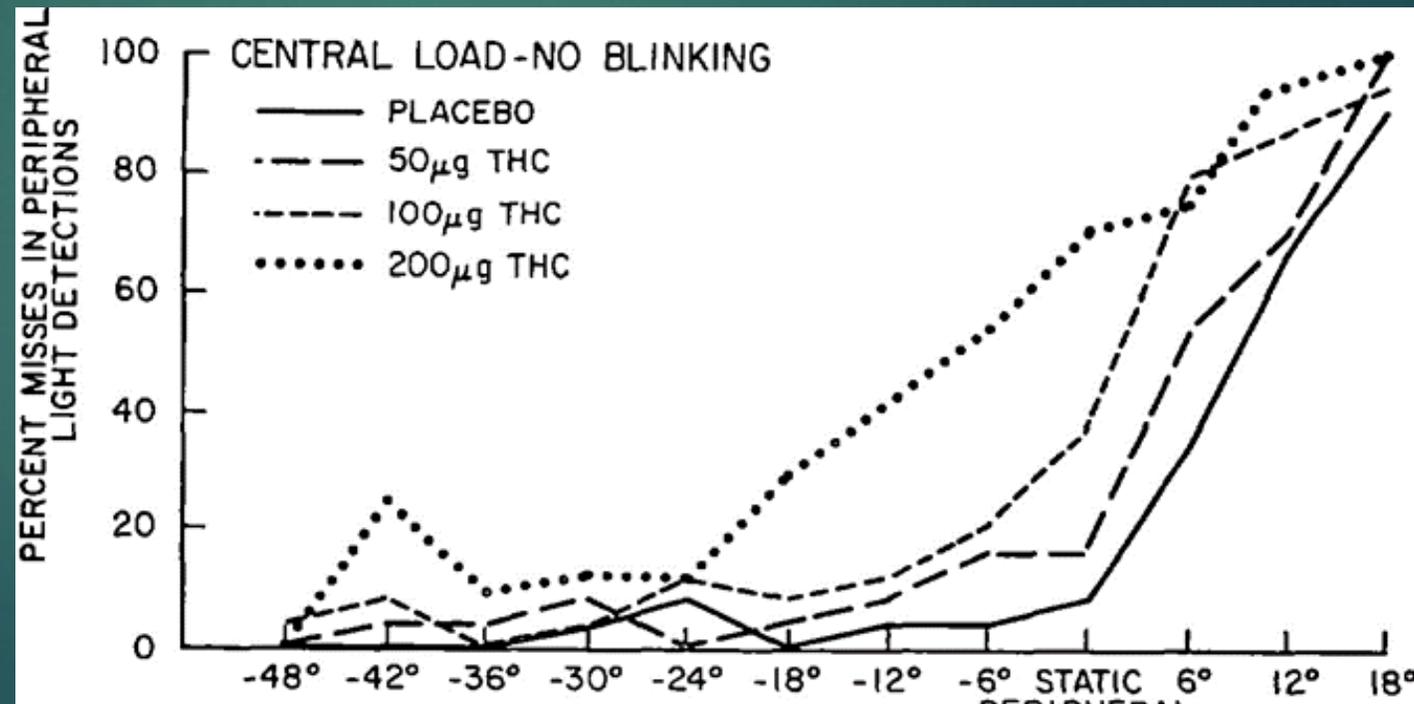
Conflicting Research Results Acute Marijuana Use

Both eyes at same time task more demanding?

Different objectives?

Different products?

Adaptation?



Unless Harvesting Wheat In Rural America



- ▶ It is very out of the ordinary to drive under circumstances of total or near total darkness.
- ▶ Driving is generally under glare situations.



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”.

Adams, Brown, Flom, Jones, Jampolsky & Haegerstrom-Portnoy

- ▶ Based out of UC Berkeley
- ▶ Did a series of human studies specific to marijuana.
- ▶ Rare for then and now, they were double blind and placebo controlled.
- ▶ Used NIH marijuana.
- ▶ Wonderful set of research.

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

Marijuana Consumption Dysfunction In Glare Response

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

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



Glare Recovery

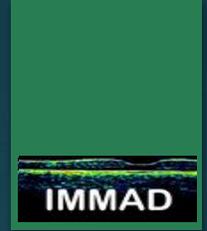
- ▶ Used dosing of marijuana alone, alcohol alone and in combination.
- ▶ Both produced glare dysfunction and impaired recovery.
- ▶ Doses for marijuana were 8 or 15 mg.
- ▶ When combined with alcohol used 15 mg.
- ▶ The impairment with marijuana was dose related.
- ▶ Dysfunction lasted about two hours.
- ▶ Did not increase impairment when alcohol and marijuana dosing was combined.

Adams et al; Pupils Marijuana

- ▶ In low photopic light marijuana produced a dose dependent constriction of the pupils
- ▶ Tested ten subjects
- ▶ Alcohol had no effect.
- ▶ Combination had no effect.



This Differs From Today's SFST/DRE



- ▶ Law Enforcement look for “rebound” dilation.
- ▶ Was found in 71% of cases.
- ▶ Why different from research?
- ▶ Products?
- ▶ Ratios THC/CBD?
- ▶ Other cannabinoids?
- ▶ Chronic users differ?
- ▶ Standard lighting?
- ▶ Something else?

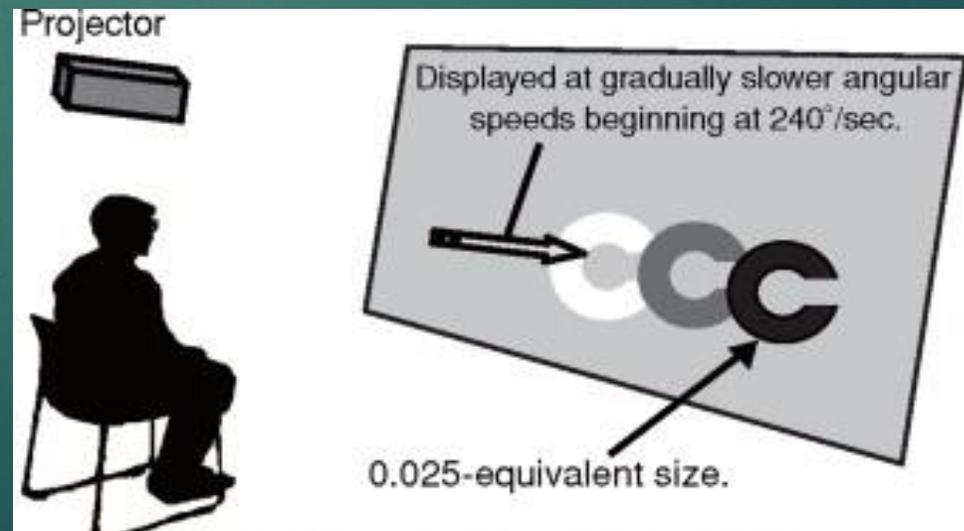
Adams et al; Marijuana Eye-tracking

- ▶ Found dysfunction with alcohol.
- ▶ No dysfunction with marijuana or placebo.
- ▶ Tested central 7.5 degrees. Very small area.
- ▶ Gradually went from .5 to 3 Hz in 40 seconds.

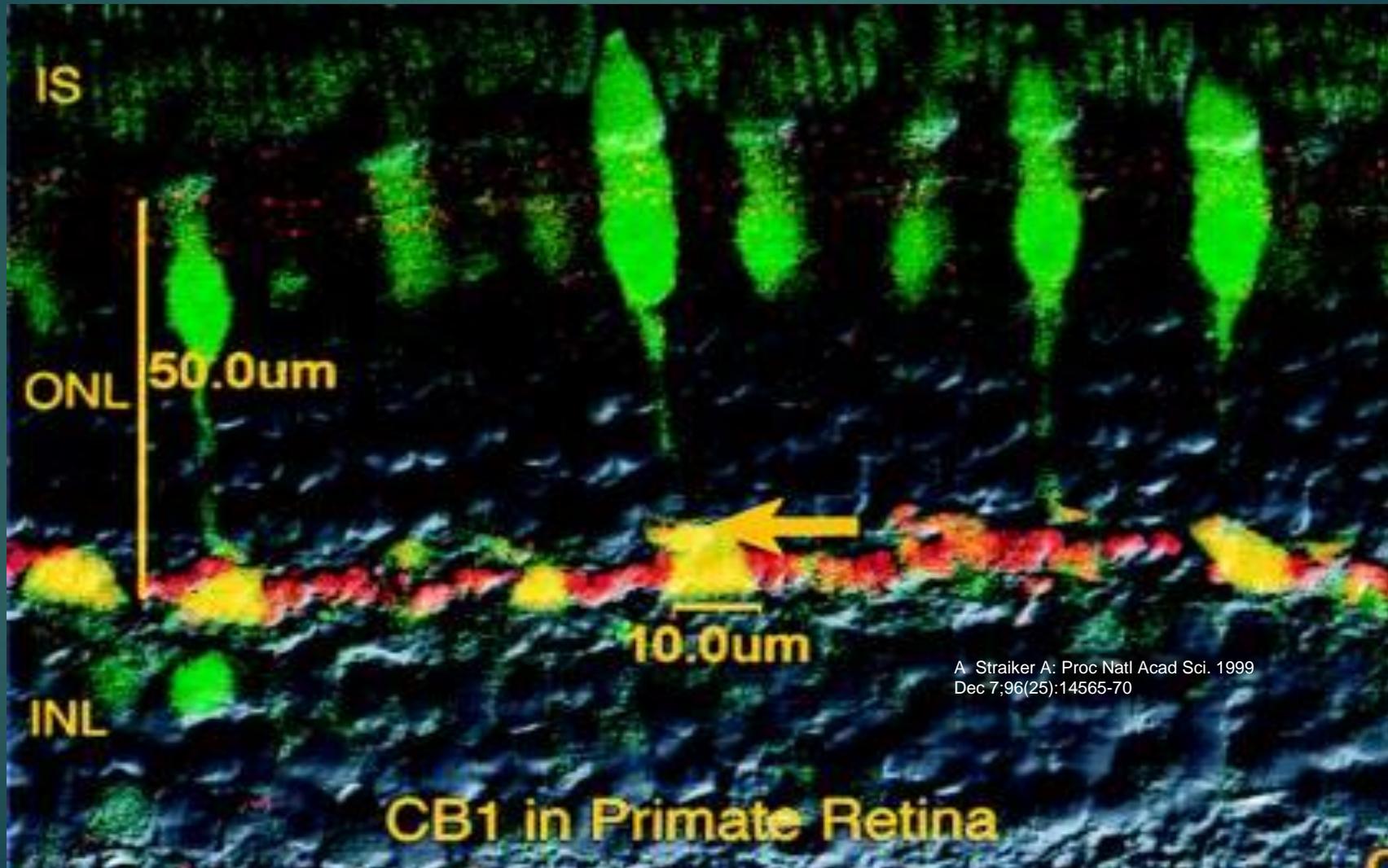


Adams et al; Marijuana Acuity

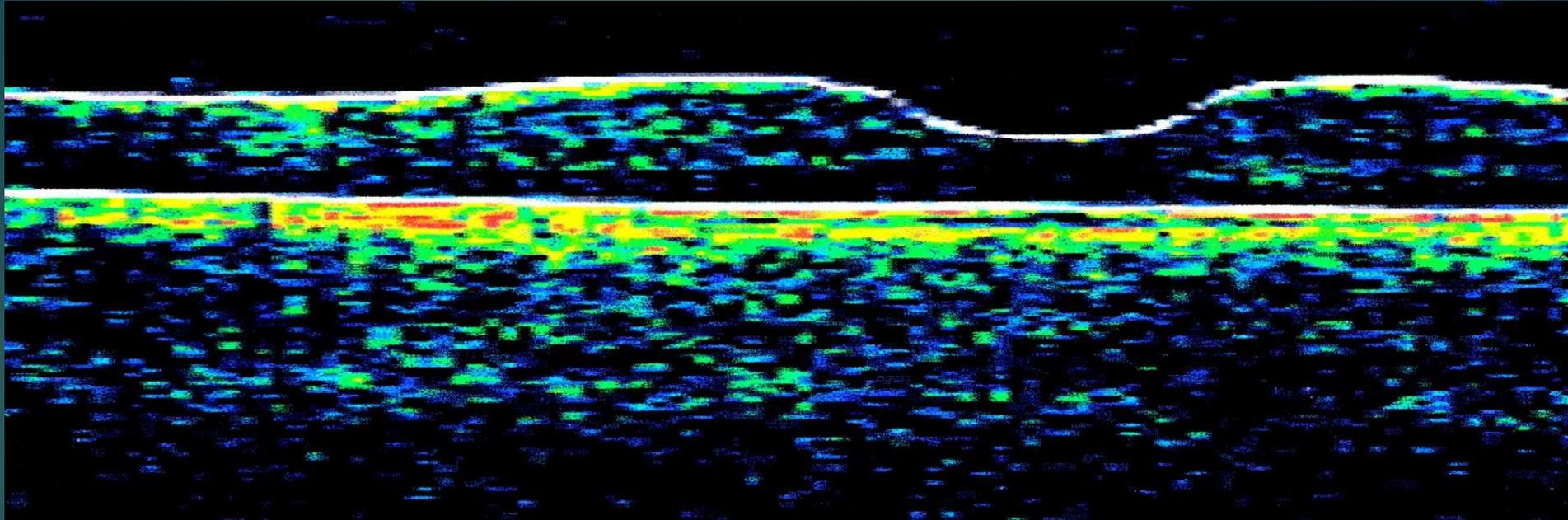
- ▶ No dysfunction when acuity testing was static-not moving.
- ▶ Reductions occurred with 12% contrast and with 49% contrast using dynamic acuity, motion contrast target.
- ▶ Dysfunction in dynamic acuity occurred with two different doses of marijuana, 8 mg and 15 mg.



Cannabinoid Receptors Numerous In Human Retina



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

Marijuana Chronic Abstinent Users Changes In Retinal Response

JAMA Ophthalmol. 2017;135(1):54-60. doi:10.1001/jamaophthalmol.2016.4761

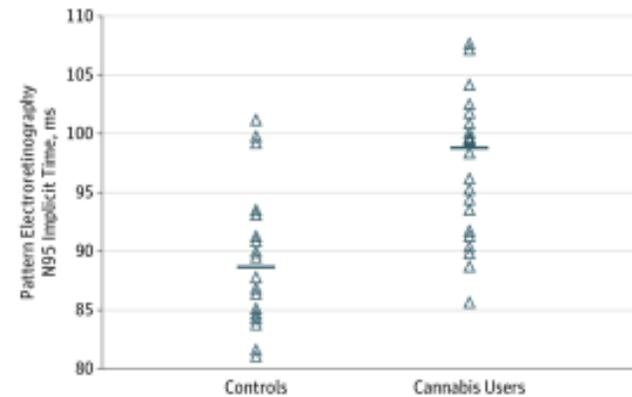
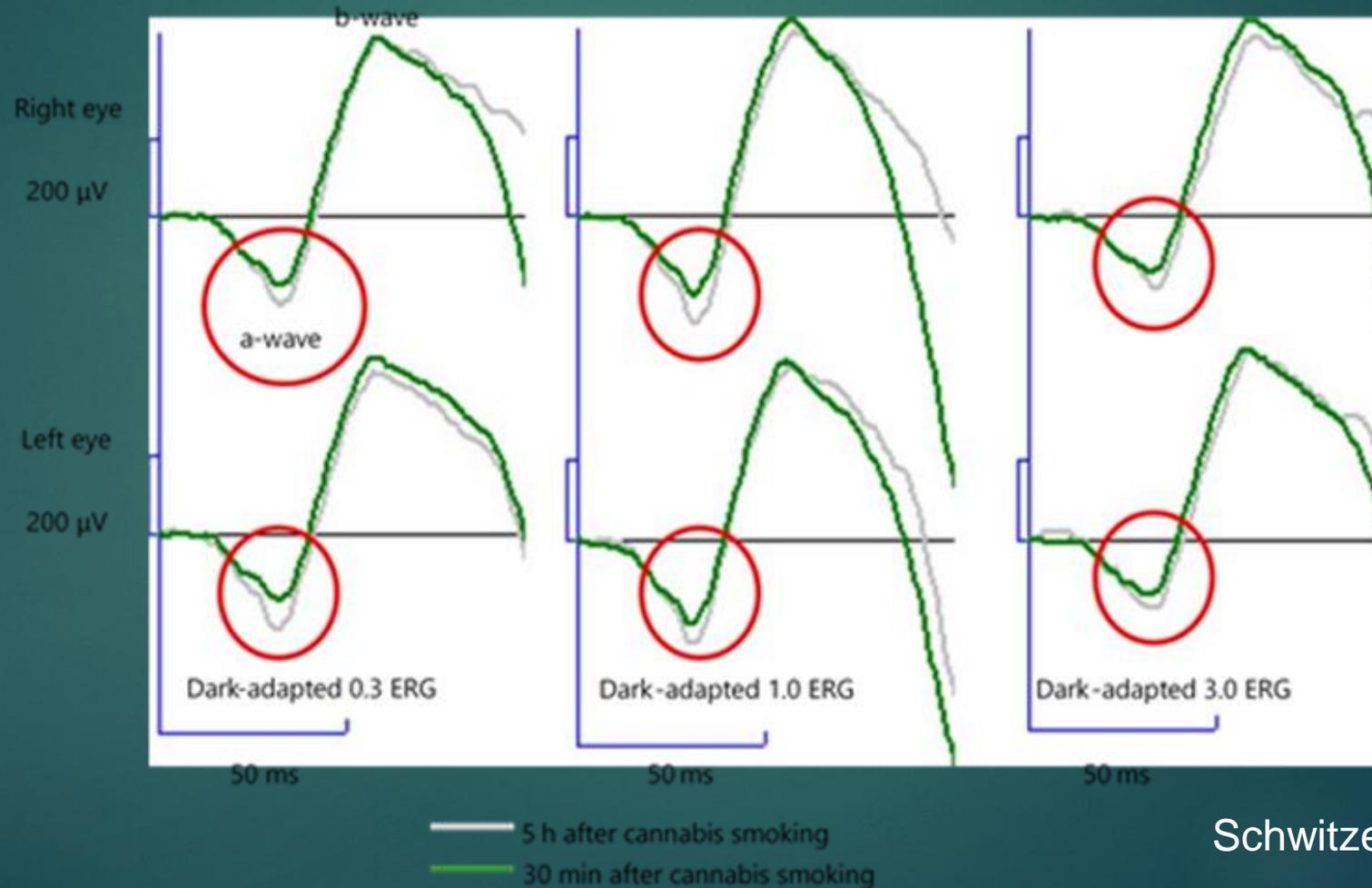


Figure Legend:

Dot Plot of Pattern Electrophoretography N95 Implicit Time for Cannabis Users and Controls For controls: n = 24; median implicit time, 88.4 milliseconds (95% CI, 85.0-91.1). For cannabis users: n = 28; median implicit time: 98.6 milliseconds (95% CI, 93.4-99.5). Median of the differences between the 2 groups: 8.4 milliseconds (95% CI, 4.9-11.5; P < .001, Mann-Whitney test). The black horizontal lines indicate medians.

Marijuana Acute Use Changes Retinal Response

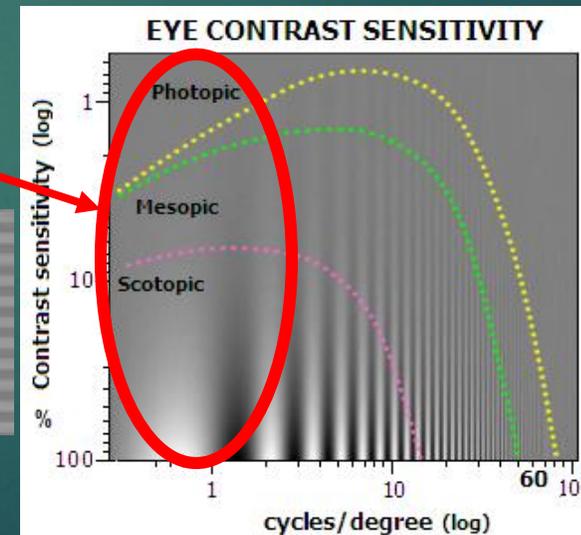


Color version available

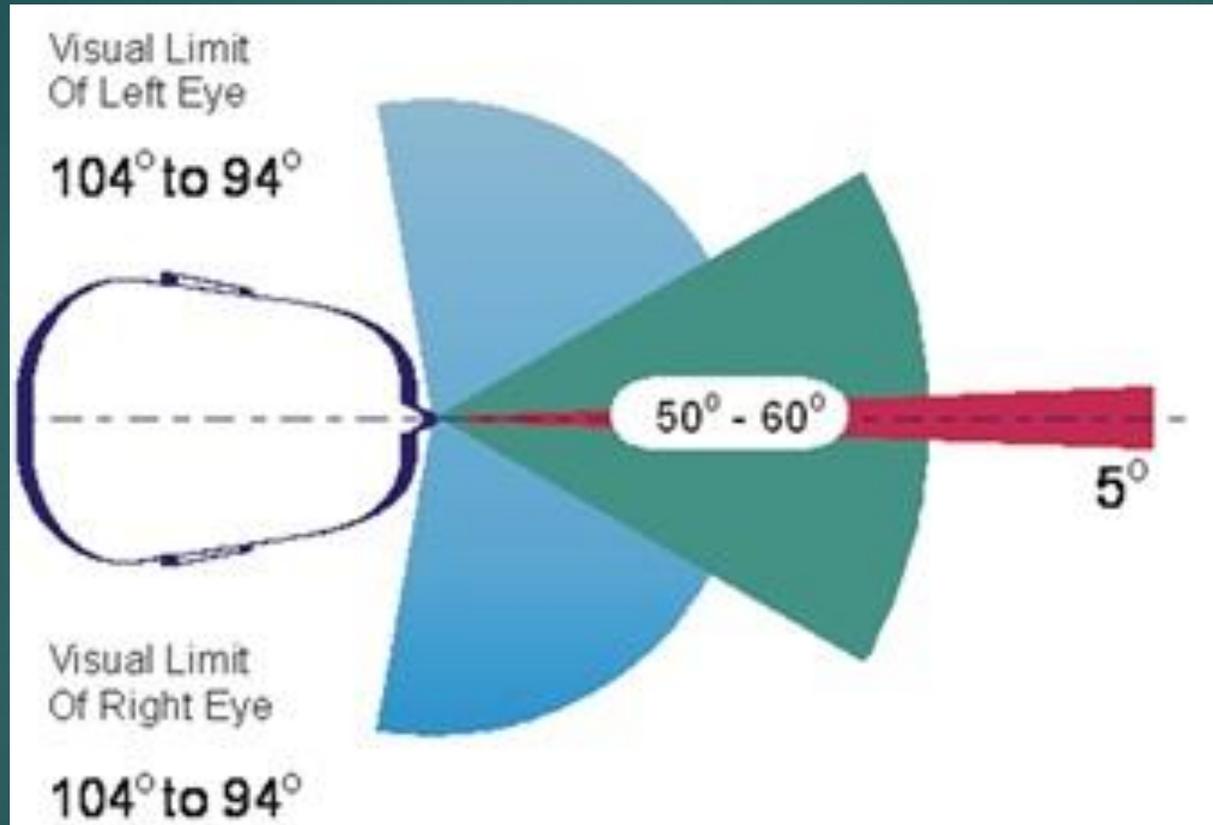
Marijuana Early Onset Use Chronic Abstinent Users Contrast Function

- ▶ 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



IMMAD Midperipheral Test RGC Function Using Contrast



Test
midperiphery
40 degrees.

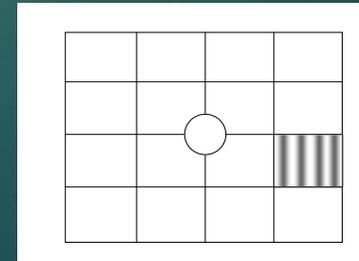
Table top
uses sixteen
ten degree
targets and a
single central
five degree

FDT Is Table Top Version Used To Demonstrate Efficacy

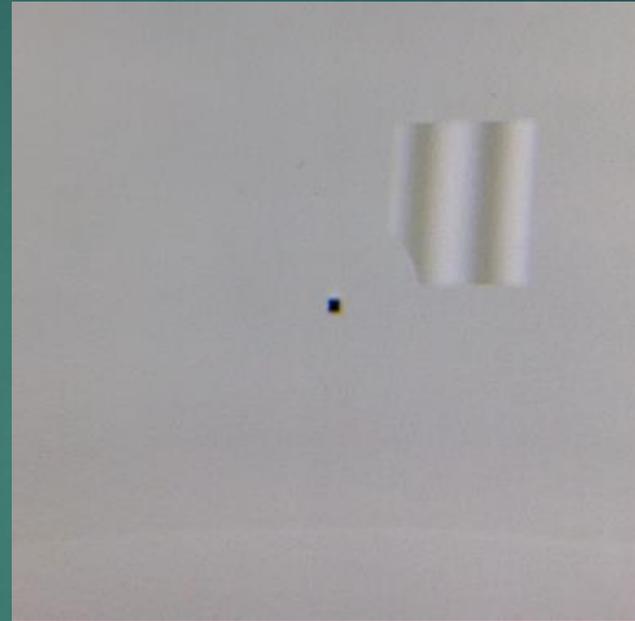
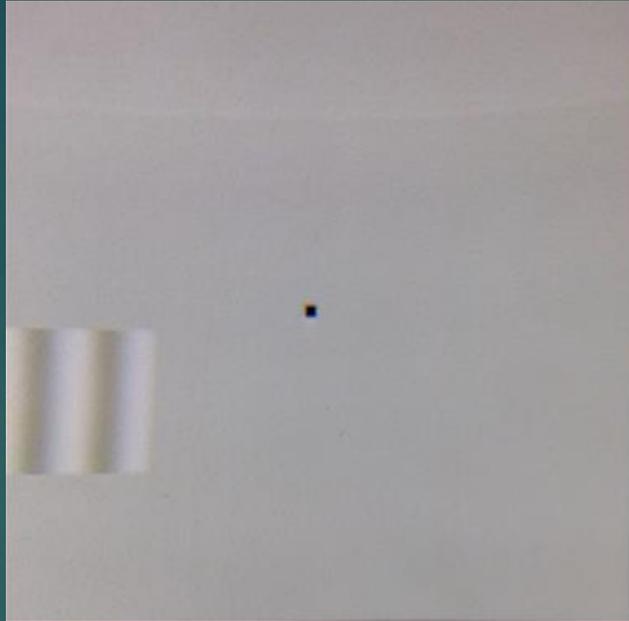


The stripes appear in various locations, with each presentation having less contrast.

If a person is impaired due to marijuana, they can not see the lower contrast targets.



IMMAD Has Patent Pending



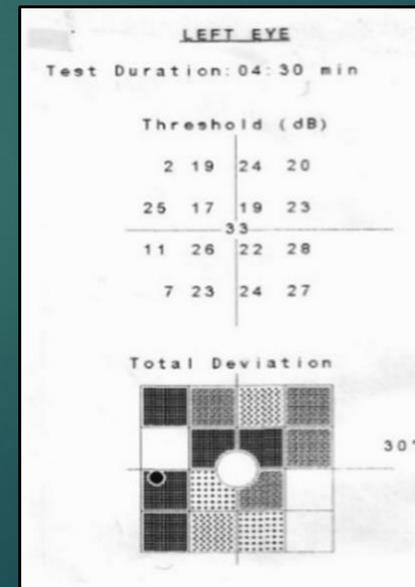
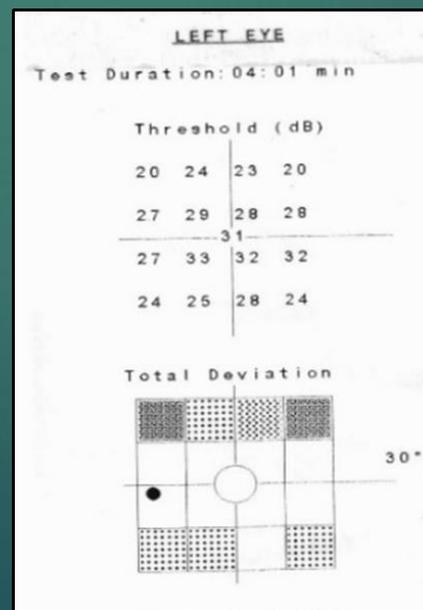
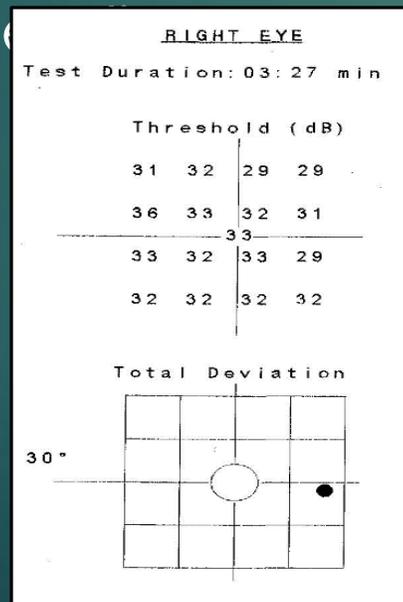
Test one
eye at a
time.



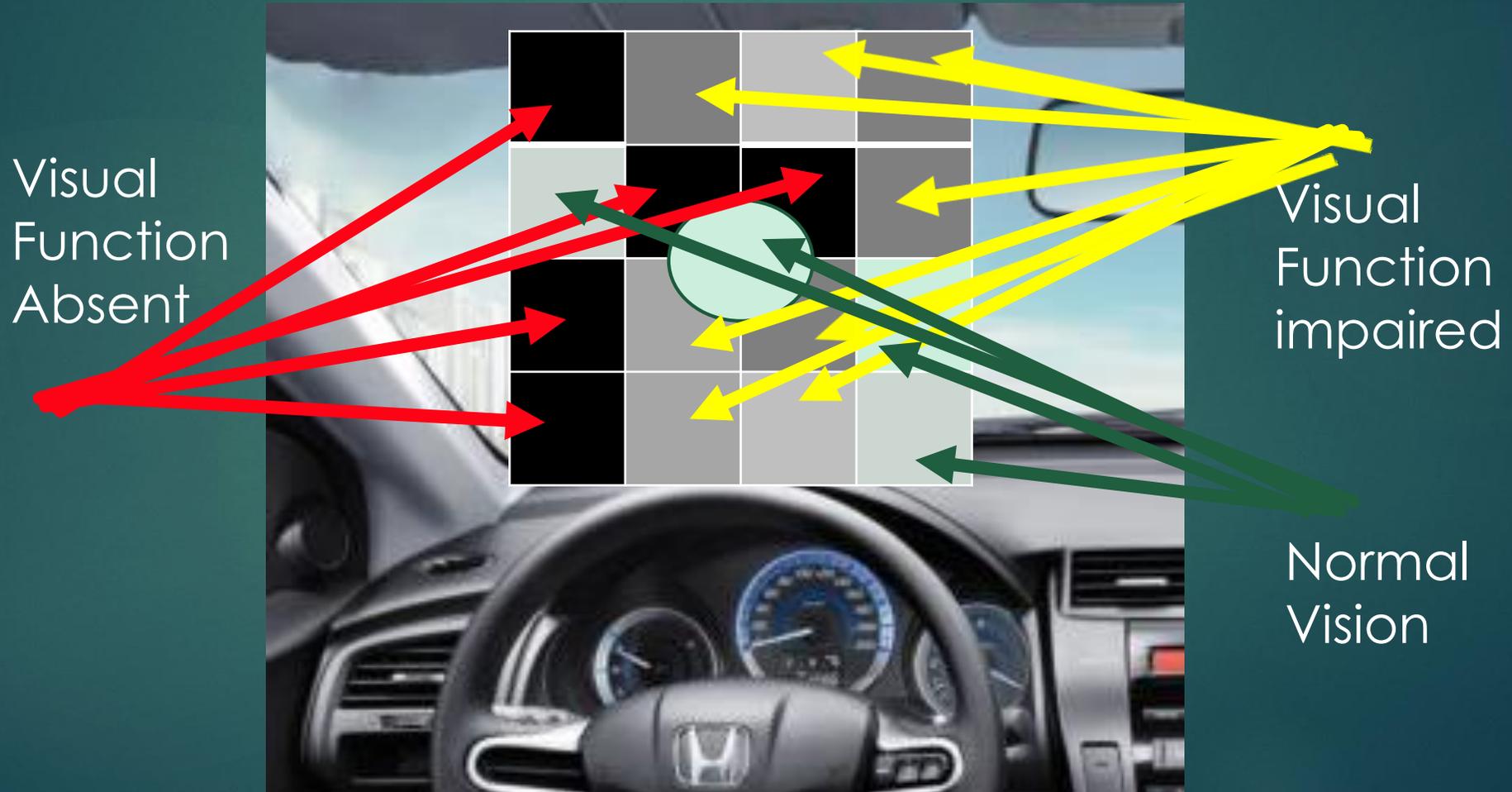
Chronic
users
have more
unreliable
tests, even
when
abstinent.

Preliminary Data With Marijuana Using FDT Test

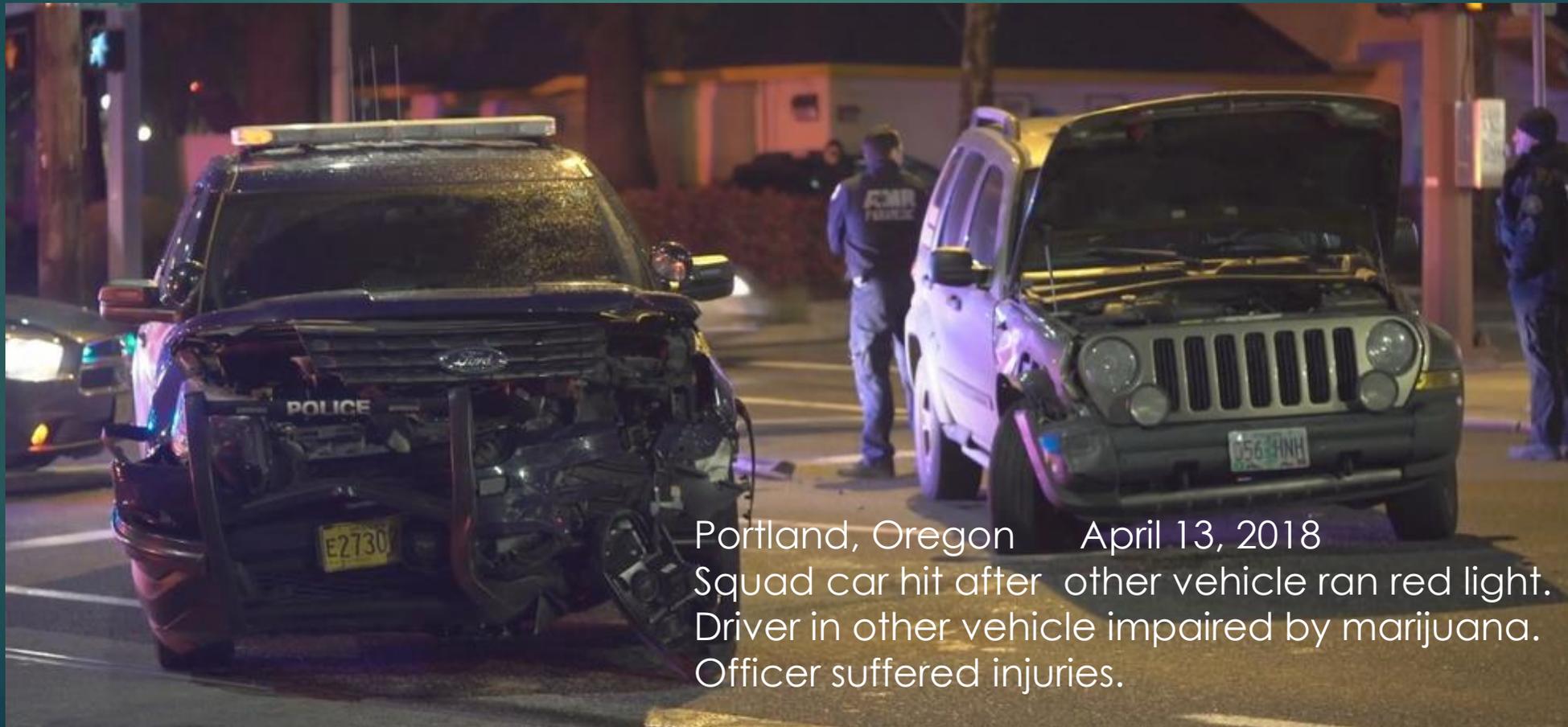
- ▶ White is normal. The darker the grey within the squares, the worse the vision. The tests middle and right were with casual (not chronic) users having consumed marijuana twenty minutes



IMMAD In Casual User Shows Tunneling Vision



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.

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

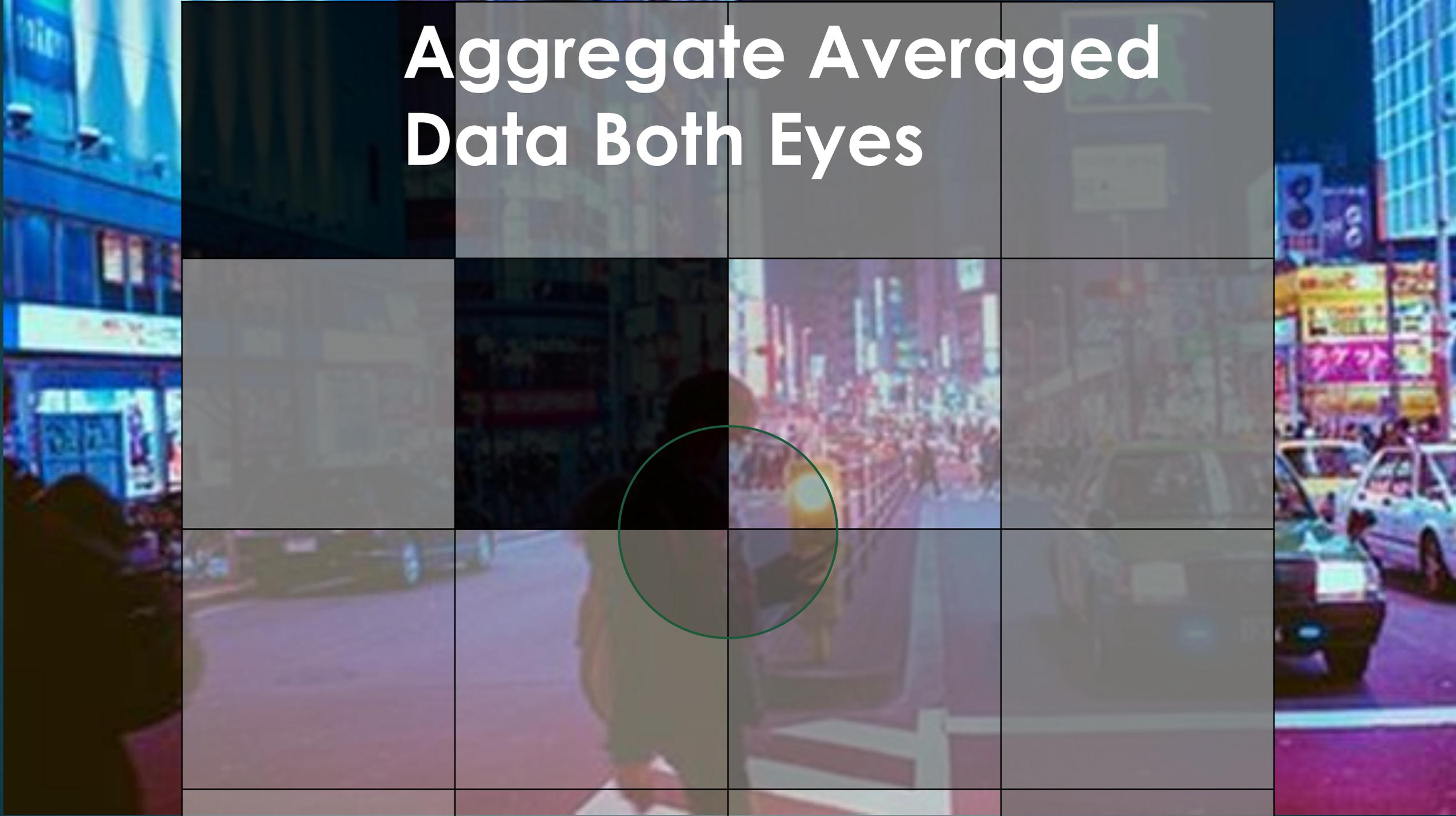
- ▶ Data shows a survival rate of 50% for Active THC driver in fatal crash
- ▶ Compares to 15% for alcohol only
- ▶ Given if survive can refuse and delay blood draw

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



Aggregate Averaged Data Both Eyes



Increase Pedestrian Death GHSA Study

- ▶ While the study did not identify a direct relationship, found an increase in pedestrian deaths in those state with legal adult use of marijuana.

<https://www.ghsa.org/resources/spotlight-pedestrians18>



Law Enforcement Technology

IMMAD-Impairment Measurement

Marijuana and Driving

- ▶ Is in virtual reality goggle coupled with smartphone and blue tooth response button.
- ▶ Results in percent contrast able to see.
- ▶ Threshold related.
- ▶ Takes about four minutes.



Fleet Technology

RRIPT-Rapid Retinal Impairment Performance Test

- ▶ Simple test pass/fail.
- ▶ Touch the square when it is seen.
- ▶ Takes one minute per eye.



Marijuana Pupil Response

- ▶ Responses roadside, there is not always a finding positive to rebound dilation with marijuana use.

Accid Anal Prev. 2016 Jul;92:219-29

- ▶ Research shows mixed findings.

- ▶ Such as constriction in low light.

Am J Ophthalmol. 1977 Mar;83(3):350-4



More Marijuana and Pupil Response.

- ▶ Pupil sizes after oral dosing under the direct lighting condition were significantly larger than after placebo by mean (SE, 95% CI) 0.4 (0.1, 0.2-0.6) mm at 1.5 h and 0.5 (0.2, 0.2-0.8) mm at 3.5 h among all participants.
- ▶ Used NIH marijuana.
- ▶ Lighting different than for Adams et al. work.



Sphincters of Eye – Pupil Have Cannabinoid Receptors



http://www.notey.com/@cannabisdigest_unofficial/external/10802523/cannabinoid-receptors-in-the-body-and-their-importance.html

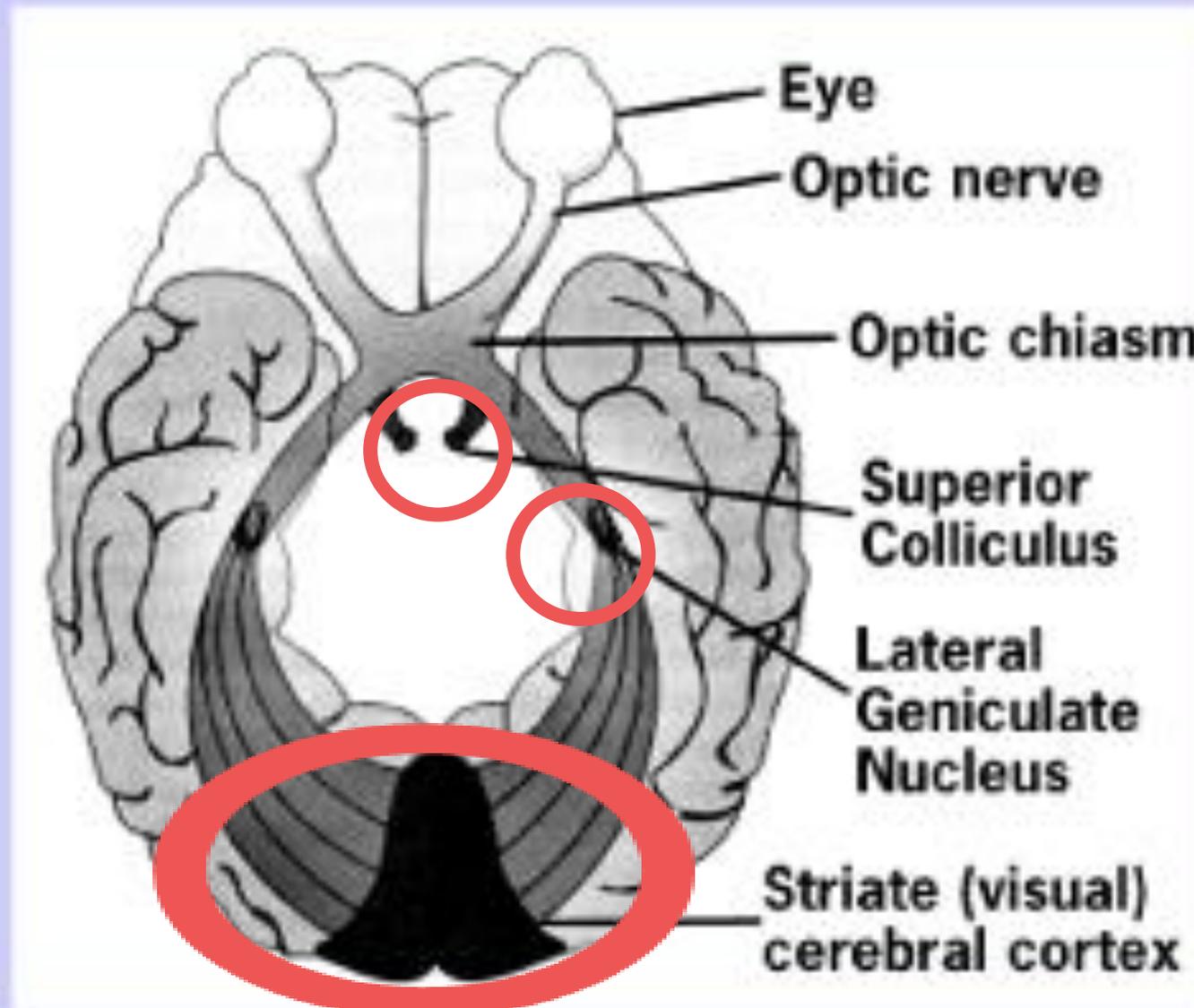
Cannabinoids: THC CBD



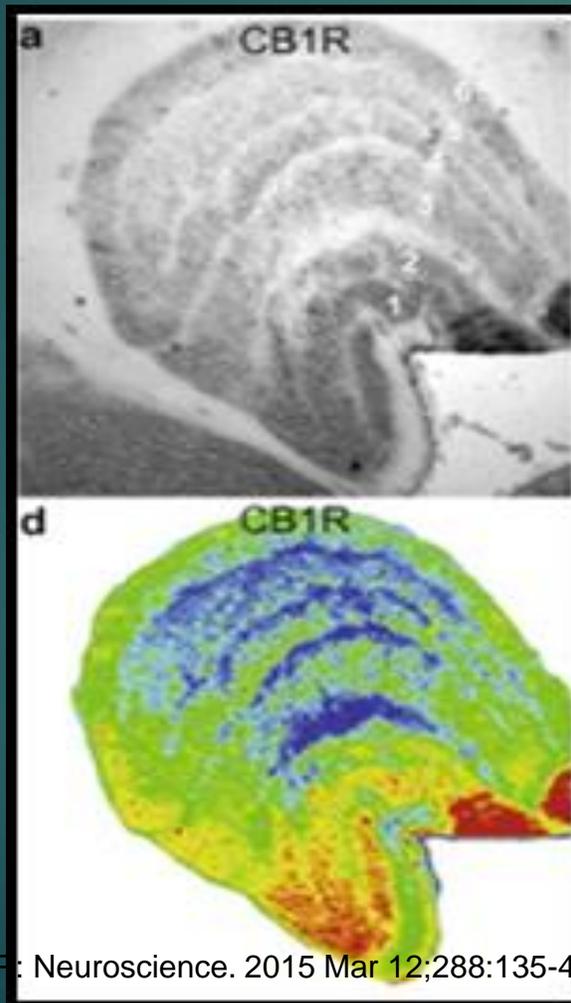
- ▶ THC has one action.
- ▶ CBD has opposite.
- ▶ Probable influence on variability of pupil response.

Tomida: J Glaucoma. 2006 Oct;15(5):349-53

On to the Brain



Cannabinoid Receptors Brain Nucleus Lateral Geniculate



The primate lateral geniculate nucleus has cannabinoid receptors throughout.

Yellow, Red and Blue all CB1

Cannabis Excitation/Inhibition CB1

- ▶ The LGN has two populations of CB1 cells
- ▶ 28% are excited
- ▶ 72% are inhibited

3/4 of cells
NOT
Functional?



Photo by: Sebastian Kaulitzki

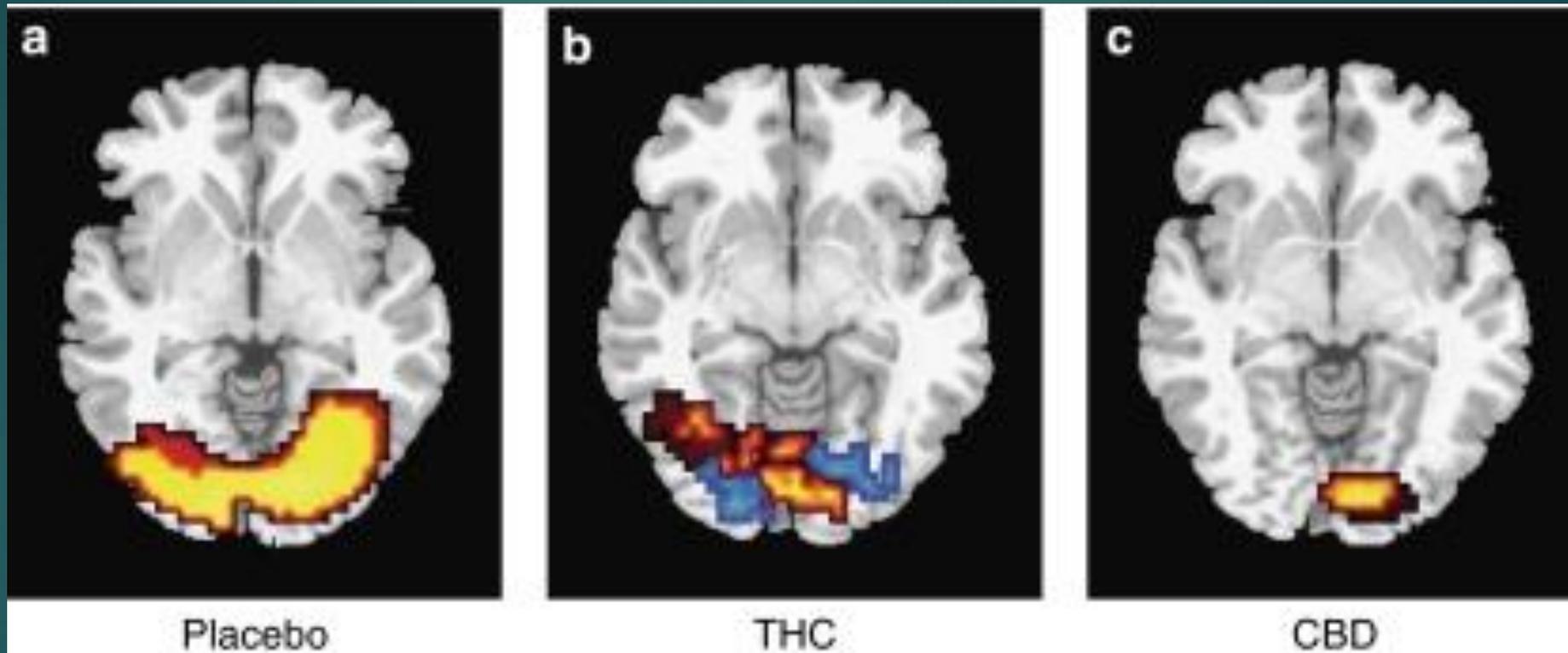
Colliculii: Rat and Cannabis Changes

- ▶ Colliculii influence eye movement.
- ▶ Chronic longterm human users have probable changes
- ▶ Eye microsaccades, tiny movement.
- ▶ Is this good adaptation or bad when it comes to driving.



Cannabinoids: THC and CBD

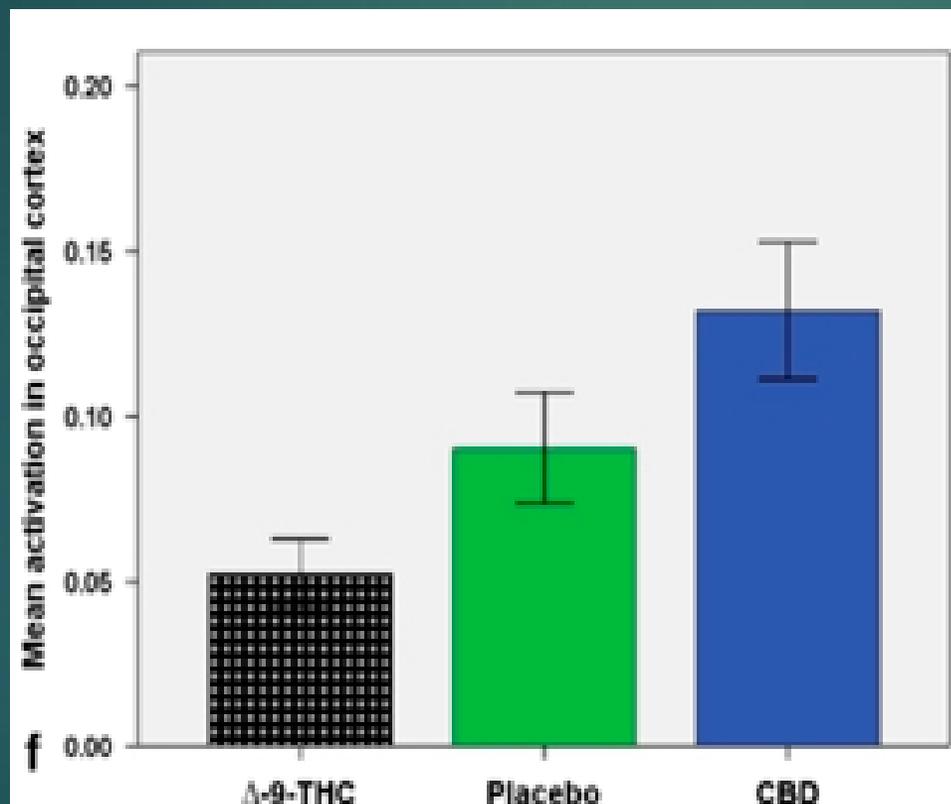
Neuropsychopharmacology. 2011 Jun; 36(7): 1340–1348.



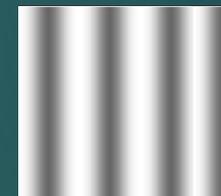
Used simple fixation cross. Red indicates more activity and blue less, yellow is similar. Placebo, THC, CBD were compared to normal controls.

Cannabinoids THC and CBD

fMRI Occipital Cortex



Temporal target,
instead of
alternating
stripes used
checkerboard.



Marijuana, Cognition and Driving Issues

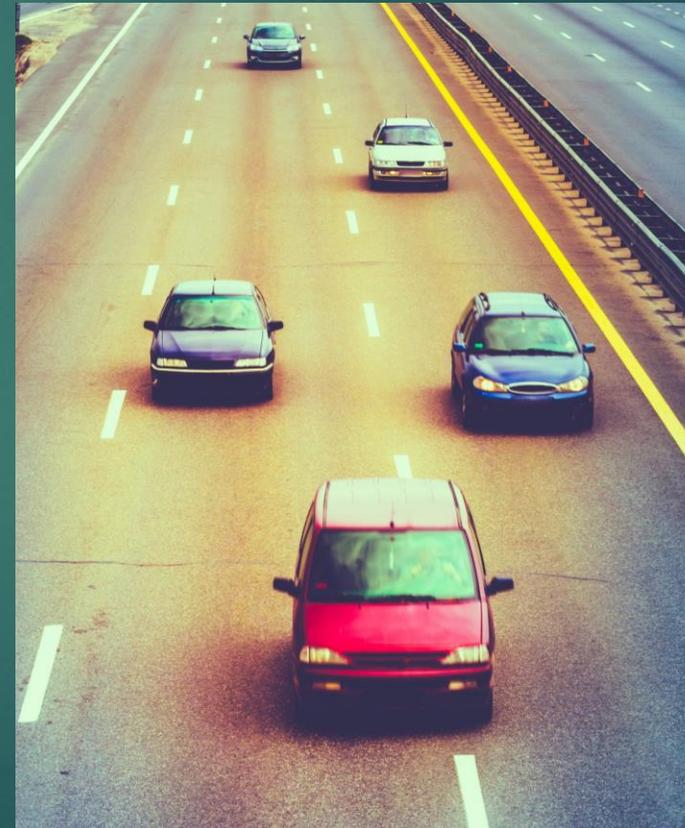
- ▶ Lane deviation is a frequent error with cannabis.

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.





Cognitive Dysfunction: Temporal, Spatial, Memory



- ▶ MyCanary

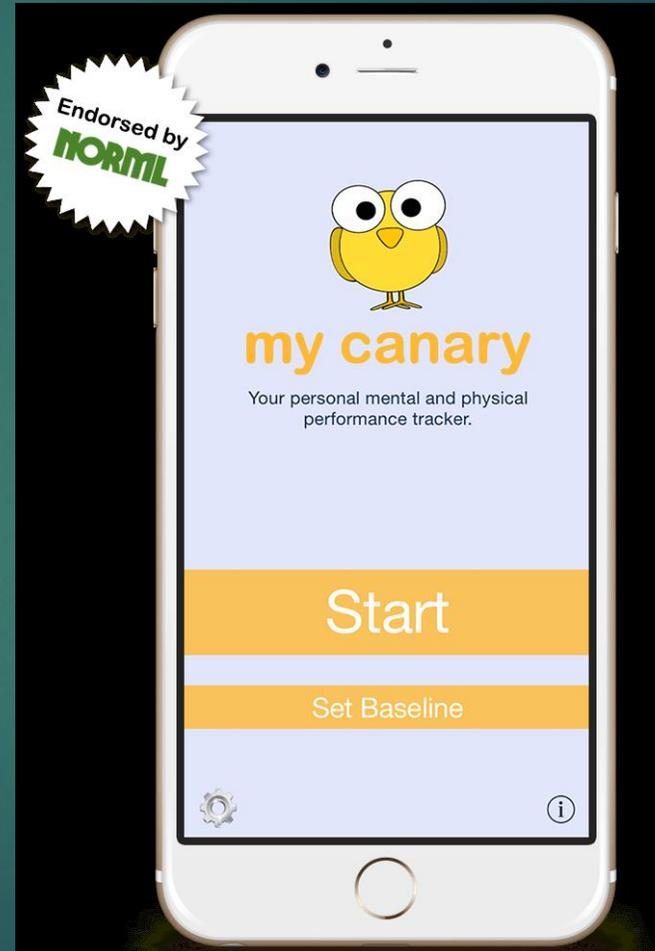
Marc Silverman

Tests memory, balance, time perception, reaction time and divided attention.

- ▶ DRUID

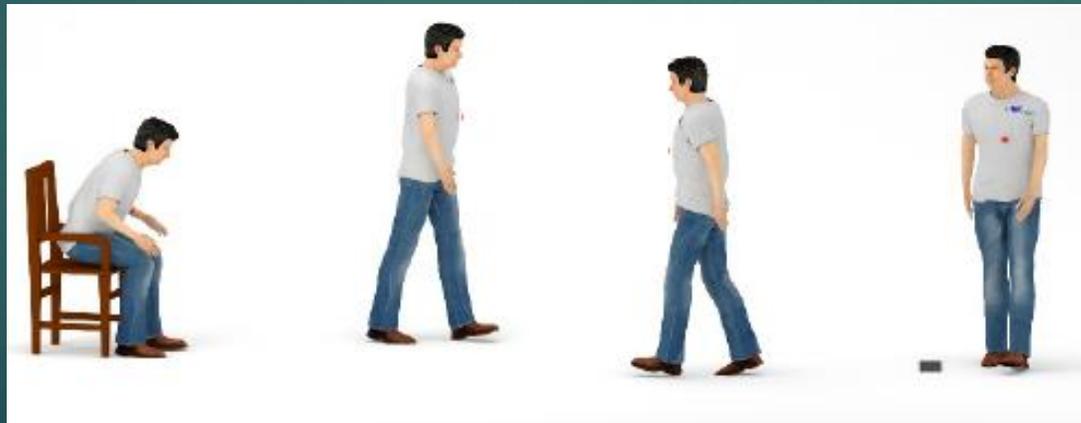
Michael Milburn, PhD

Tests reaction time/spatial, time perception, tracking, balance.



Aging, Driving Balance Testing

- ▶ Impaired strength and balance are risk factors for unsafe driving with aging.
- ▶ Gait changes sign of Alzheimer's.
- ▶ One legged balance.
- ▶ Timed up and go test.



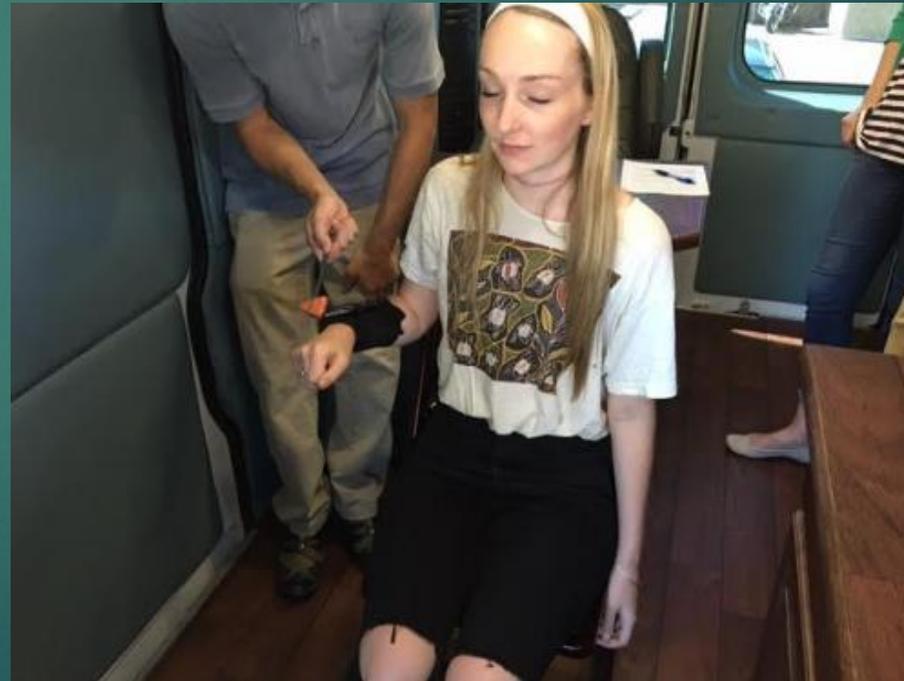
Marijuana Driving Balance Testing

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



Balance Test Specific to Marijuana

- ▶ Test under development in Colorado related to marijuana. Using participants who have consumed dabbing products.
 - ▶ Dr. Brian Tracy CSU

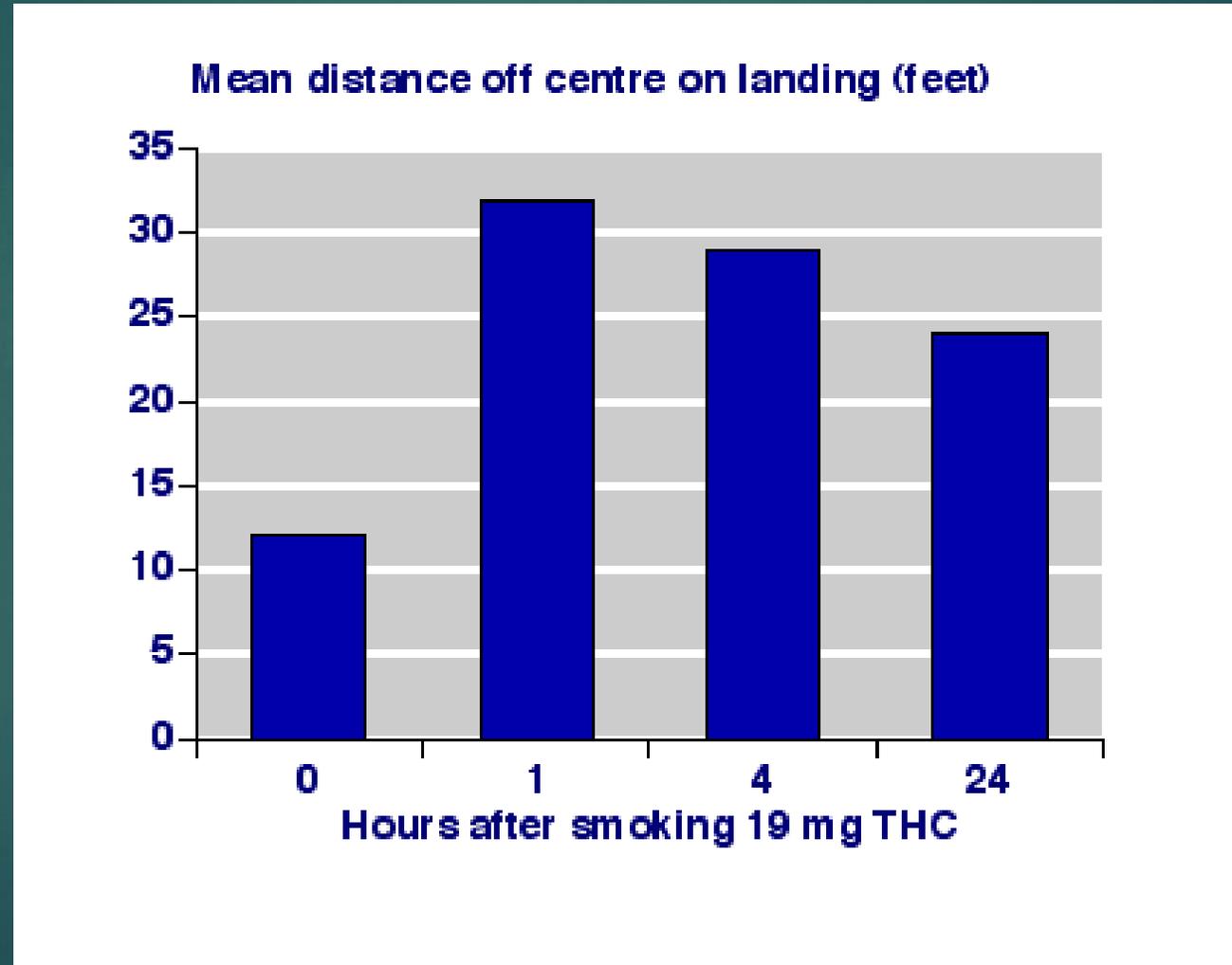


Marijuana Lack of Awareness of Impairment

- ▶ Ten experienced licensed private pilots trained on a flight simulator landing task
- ▶ Each smoked a marijuana 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



Any Amount Probably Too Much When Flying Plane

- ▶ The Cessna 208B Caravan aircraft was operating under visual flight rules, under which the pilot must maintain constant visual reference to the ground, in daylight hours when it crashed into a cliff.
- ▶ Pilot Matthew Brody, 28, and passenger Timothy Harris, 54, were killed.
- ▶ Toxicology tests revealed “concentrations of cannabinoids found in the pilot’s bloodstream were sufficient to have impaired pilot performance and decision-making during the flight.”



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Quick Tests For Marijuana Impairment



