



THE UNIVERSITY  
OF AUCKLAND

FACULTY OF SCIENCE

School of Psychology



CENTRE FOR  
BRAIN RESEARCH

THE UNIVERSITY OF AUCKLAND

Te Whare Wānanga o Tāmaki Makaurau

## The Teen Brain: puberty, drugs & rock n roll

Associate Professor Karen E Waldie, PhD

Brain Day, Saturday 28 March 2015

Young people today love luxury, they have bad manners, contempt for authority and disrespect for older people. They're too lazy to train; they'd rather sit and chat. They no longer rise when elders enter the room, they contradict their parents, can't hold their tongues in company, gobble their food, and tyrannize their teachers.

Socrates

Common theme: Why do teens do the risky things they do?

Answer lies in brain development:

1. frontal lobes; 2. sex hormones; 3. dopamine

## Outline: 2 major themes

1. My background: longitudinal research, brain scanning
2. What is adolescence?
  - Timing of puberty, risky behaviour and mental health problemsQuestion period
3. The brain and neurodevelopment
  - The typical teen brain, the ADHD brainQuestion period

## 1. My background: longitudinal research

### The Relationship Between Learning Disabilities and Persisting Delinquency

Karen Waldie and Otfried Spreen

*Recidivism of delinquency in juveniles with learning disabilities (LD), the focus of the present study, has been virtually unexplored in previous research. Data from a longitudinal study initiated in 1978 are examined. Sixty-five subjects with LD (47 males and 18 females) who had been diagnosed and assessed between the ages of 8 and 12 years were located and, during a personal structured interview at the median age of 18 years, reported police contact. This population was subdivided into two groups on the basis of whether police contact had continued or discontinued, as reported in a second personal interview at the age of 25 years. Discriminant analysis on parent and subject variables correctly classified 75% of the subjects and revealed that certain personality characteristics, such as impulsivity and poor judgment, discriminate between persisting and nonpersisting delinquency in youth with learning disabilities.*

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Journal of Learning Disabilities, 26(6), 1993, 417-23.

1. My background: longitudinal research



# NZ Longitudinal Research

1. DMHDS
2. ABC Study
3. Growing Up in NZ ([www.growingup.co.nz](http://www.growingup.co.nz))

# 1. My background: brain scanning



fMRI allows us to map increases in oxygenated blood flow that accompany local brain activity during mental tasks

# 1. My background: brain scanning

129 EEG electrodes

## 2. What is adolescence?

Adolescence is an evolutionary novelty: new phase of life

It doesn't really exist in hunter-gatherer societies

It did not really exist in 18<sup>th</sup> century Europe

It is a 20<sup>th</sup> century development

Young people became teenagers because we had nothing better for them to do...



## 2. Rites of passage: From Child to Adult

### **The Ancient Spartan Helot Killing**

### **Satere-Mawe Bullet Ant Glove**

Military training began at age seven when boys would be taken from their families and placed in the *Agoge* system

### **Vanuatu Land Diving**

### **Mardudjara Aborigines Subincision**

## 2. Vulnerability of today's youth

- Teens have only been 'teenagers' for the past 75 years
- Prior to 1940, teens were away on farms or put to work in factories – closely supervised
  - range of movement and access to information was limited
  - the potential for bad consequences of risky acts were limited
- Society is more dangerous now:
  - social media, internet,
  - roads busier, international travel more accessible,
  - alcohol/drugs readily available (THC concentrations much stronger)

## 2. What is puberty?

Sudden surge of **sex hormones**.

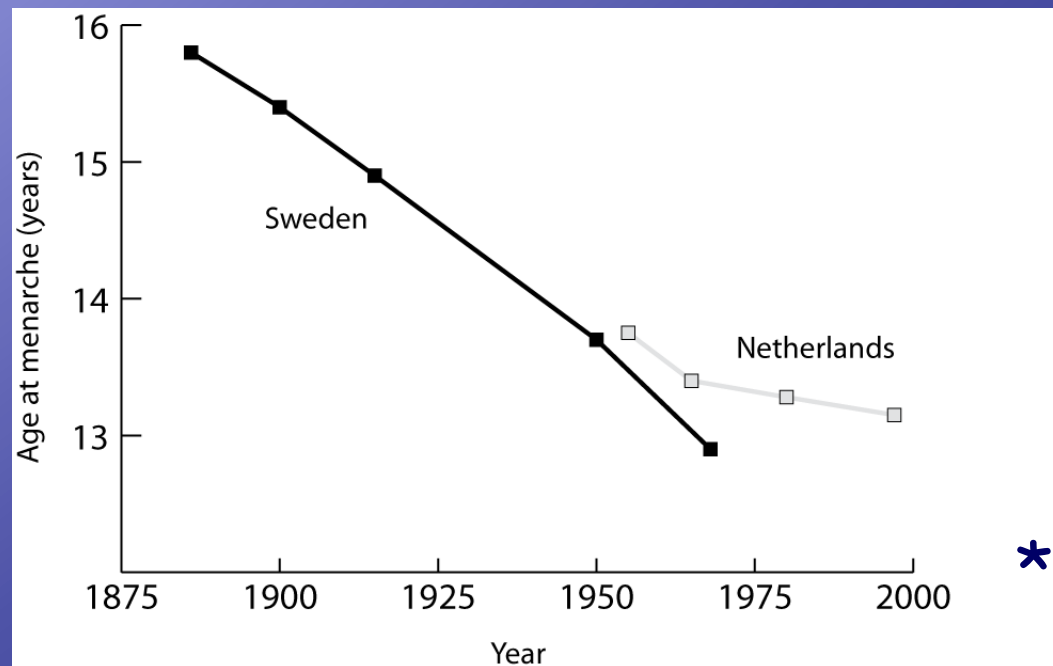
- Very active in the **limbic system** (emotional centre)

Brain exposed (at this concentration) for the first time

- **Causes growth spurt, aggression, risk-seeking behavior, delinquent behavior:**
  - 1 in 3 adolescents commit a crime: theft; breaking and entering; vandalism
  - delinquent behaviour decreases in late teens: development of frontal cortex (inhibits impulsiveness)

## 2. The general timing of puberty is changing

1. **Genes** set the timing of puberty in motion
2. **Hormones** responsible for changes
3. **Environment** has an impact (better nutrition = earlier maturation)



\* In NZ in 2015: 12 for girls, 13 for boys

## 2. Gender differences in perceived ideal weight

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### **Weight Distribution**

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#### **Normal**

- Female 59.6%
- Male 55.5%

#### **Overweight**

- Female 24.3%\*
- Male 34.4%

#### **Obese**

- Female 14.2%
  - Male 09.9%
-

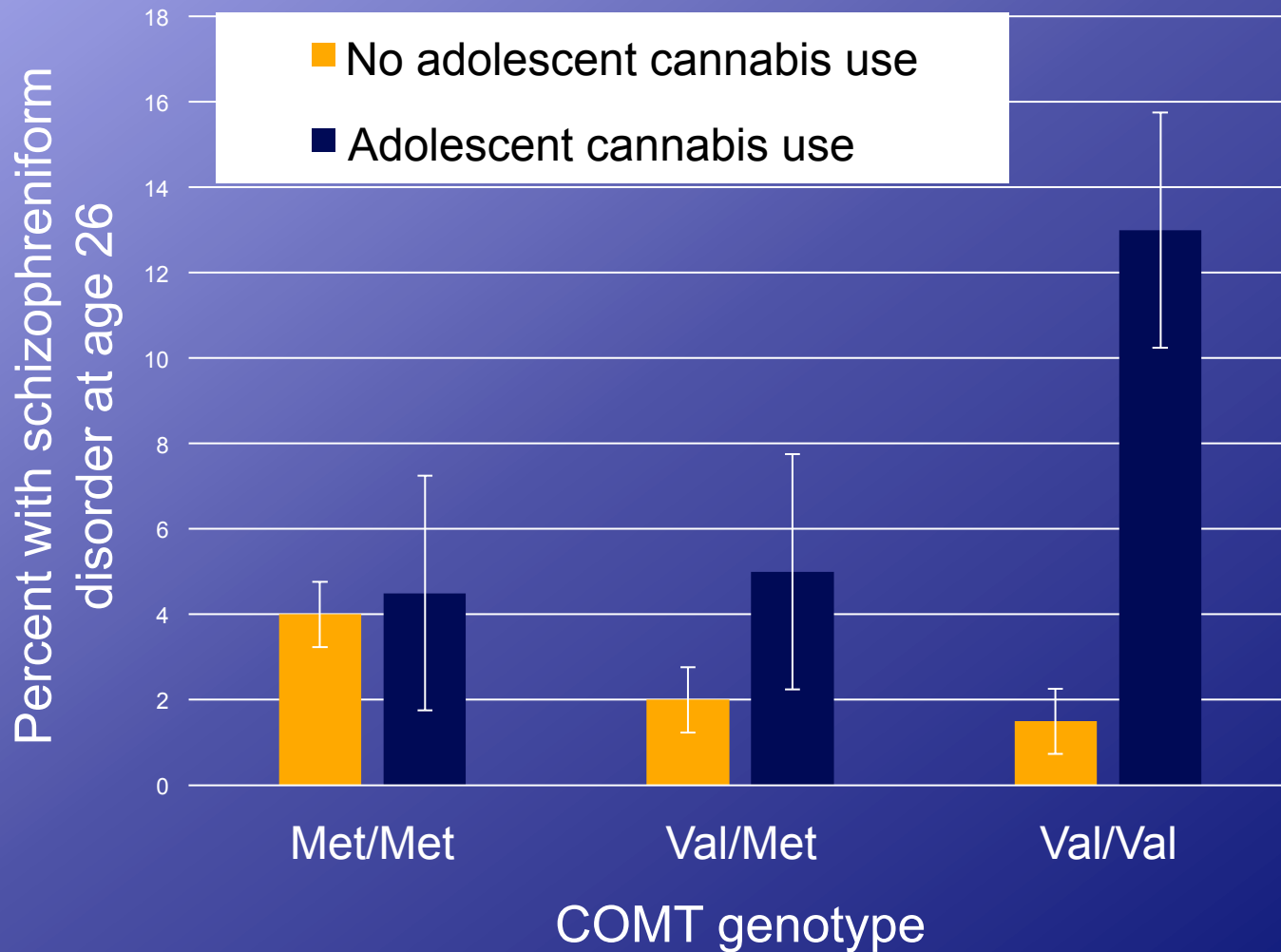
## 2. Gender differences in perceived ideal weight

	<b>Weight Distribution</b>	<b>Perceived Overweight</b>	<b>Losing Weight</b>
<b>Normal</b>			
• Female	59.6%	19.8%*	21.1%*
• Male	55.5%	07.1%	5.1%
<b>Overweight</b>			
• Female	24.3%*	80.2%*	57.0%*
• Male	34.4%	42.7%	28.4%
<b>Obese</b>			
• Female	14.2%	96.7%*	69.8%*
• Male	09.9%	75.0%	42.9%

## 2. Adolescence and risky choices

- Leading causes of death:
  - Motor vehicles, suicide, violence
  - 55,000 die annually of alcohol poisoning or in traffic accidents in which alcohol was involved.
- Alcohol and drug use
  - Age 15, 52% of boys, 46% of girls
  - Alcohol and drugs can cause permanent brain damage
  - Also results in risky choices
- What can happen when teens smoke marijuana?

## 2. Adolescence and cannabis use



Caspi et al., 2005)



## 2. Adolescence and mental health

- Heightened vulnerability to psych disorders
- Prevalence of mental health disorders:
  - 20% of teens: anxiety, depression, substance dependence
  - 50% have more than one diagnoses

Only 10% have their first psychiatric episode as adults

= Most people diagnosed with a mental health problem in adulthood have a history of mental health disorder

### 3. The brain and neurodevelopment

My 1<sup>st</sup> developmental psychology lectures:

1. Born with 100 billion brain cells
2. Following ~ the first 3 years of life the brain was relatively static

Neuroplasticity: The capacity of the brain to rewire through experience

Focus on very young and very old: Adolescence has been neglected

### 3. The brain and neurodevelopment

#### The frontal lobe (seat of reason)

- Planning, organization
  - Inhibition (controls impulses)
  - Response selection
  - Allocation of attention
  - Regulation of emotion
  - Working memory
- 
- The ability to quickly grasp the general contours of a situation and make a good judgment about costs versus benefits arises from activity in the frontal cortex

### 3. Neuroplasticity and synapse elimination

#### Frontal cortex:

- Planning, thinking through consequences of actions, decision-making, inhibiting risky behavior

**1-2 years:** neurons and connections at maximum levels

**5-7 years:** rapid elimination of newly formed cells/connections:  
100,000/sec!

- elimination of synapses coincides with increasing motor & cognitive skill

**15-18 years:** rapid elimination of newly formed cells/connections:  
5,000/sec! (adult levels) – only the strongest connections survive

**18-25 years:** strength of connections continues; with *Myelination*

"I'm perfectly incomplete, I'm still workin' on my masterpiece"  
Jessie J

### 3. Explaining teen behavior:

#### Why do teens do the risky things they do?

- Temporary insanity...self-centered, moody, impulsive, reckless, risky behaviour, stupid, rude, poor judgment, immediate gratification
- Hormones and prefrontal brain development –
  - Remodeling, reorganizing
  - Multitasking poor, panic in emergency
- Neurotransmitters: Dopamine
  - peak levels in prefrontal & limbic system:
    - nucleus accumbens, ventral tegmental area
  - Enhanced response to dopamine:
    - hormone and neurotransmitter
    - more active sense of reward than adult brains
    - more vulnerable to addiction
    - detox much harder
- What happens in the ADHD brain?

### 3. ADHD and the frontal lobe:

- These areas under-active because of neurotransmitter depletion
- Faulty metabolism of dopamine and/or norepinephrine at the synapse  
= poor transmission of neural impulses in fronto-striatal pathway

Neurocase (2007) 13, 301–310  
<http://www.psypress.com/neurocase>  
ISSN: 1355-4794 print / 1465-3656 online  
DOI: 10.1080/13554790701770850

Psychology Press  
Taylor & Francis Group

#### Dexamphetamine Normalises Electrophysiological Activity in Attention Deficit-Hyperactivity Disorder during the Stroop Task

S. L. HORROBIN, N. A. MCNAIR, I. J. KIRK and K. E. WALDIE

*Department of Psychology, Research Centre for Cognitive Neuroscience, University of Auckland, Auckland, New Zealand*

A case study was conducted to investigate whether dexamphetamine enhances interference control in an adult with attention deficit/hyperactivity disorder. Continuous electroencephalography was recorded both on and off dexamphetamine during performance on a Stroop task. An age-, gender- and IQ-matched control also completed the same task. Event related potentials for the control participant revealed a positive potential to incongruent stimuli between 270 and 440 ms, whereas for the participant with attention deficit/hyperactivity disorder off medication, the reverse polarity was observed in a later time window. Following administration of dexamphetamine, however, the event-related potentials for the incongruent condition closely resembled those in the control, suggesting that dexamphetamine successfully normalises electroencephalographic activity.

Challenge: non-pharmaceutical intervention to normalize the frontal lobe (see: <http://movincog.org/public.html>)

### 3. ADHD and the frontal lobe:

20% completely outgrow ADHD after ~ 18 years of age

- 80% will not: 60% mild residual, 20% severe residual

Impossible to complete projects, procrastination, 'tune out', difficult to relax, frustration, organization, addiction, verbal impulsivity, spend \$, poor memory, risks...



### 3. Teens: High rates of learning and memory

#### Super brain:

- Processing speed increases
- Heightened synaptic plasticity
- Supercharged hippocampus
  - =advantage over adults: so primed to learn
  - =window of opportunity: ‘open’ and excitable brain = increased capacity for remarkable achievements

#### Vulnerable brain:

- Can be adversely affected by stress, alcohol, drugs
- Vulnerable to learning the wrong things...
  - Anything that is learned (good or bad) stimulates the production of dopamine & is construed by the brain as a reward



### 3. The teen brain: Take home messages

- Parents must function as their teen's temporary frontal cortex
- While the frontal cortex is still developing, parents have to be responsible for a child's planning, organisation, moral framework and limits
  - set limits because their brains won't
  - limit digital socialising 1-2 hours/day

### 3. The teen brain: Take home messages

- Be proactive: Talk and talk and talk....
  - risky behaviour (alcohol, drugs, sex, violence, driving, multitasking) and potential consequences / costs versus benefits
  - risks of social media/internet, energy drinks (caffeine overdose)
  - what is going on in their brain and how it's still developing
- Brain is an explanation, not an excuse
- Ask questions, stay connected, seek medical and counselling advice, get passwords
- Reinforce you are there for them
- You are their 1<sup>st</sup> and most important role model

### 3. The teen brain: Take home messages

**Resilience:** the ability to deal with stressful life events. The most important factor: One supportive relationship in childhood

- Doesn't matter who
  - parent, aunt, teacher, neighbour
  - Whoever YOU are, you can make a real difference in a young person's life