Aggression: the biology of war and peace
Aggression:
the biology of war and peace

Professor Keith Kendrick
Violent crime rose 37% in London last year
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In the USA there are 3 million violent crimes a year.
Violent crime rose 37% in London last year

In the USA there are 3 million violent crimes a year

In the USA nearly 1 in 4 women say they have been raped or sexually assaulted
Violent crime rose 37% in London last year.

In the USA there are 3 million violent crimes a year.

In the USA nearly 1 in 4 women say they have been raped or sexually assaulted.

Nearly half of all rapes and violent crimes are associated with alcohol consumption.
Why are we so aggressive and can we do anything about it?

What is aggression and why has it evolved?

Is aggression an inevitable trait in all species?
Why are we so aggressive and can we do anything about it?

What is aggression and why has it evolved?

Is aggression an inevitable trait in all species?

How is aggression controlled by the brain?
Why are we so aggressive and can we do anything about it?

What is aggression and why has it evolved?

Is aggression an inevitable trait in all species?

How is aggression controlled by the brain?

What hormonal, biochemical and genetic factors may contribute to excessive aggression?

Testosterone
Why are we so aggressive and can we do anything about it?

What effects does experience have on levels of aggression?

Low-Level Aggression
First steps on the ladder to violence
Arnold P. Goldstein
Why are we so aggressive and can we do anything about it?

What effects does experience have on levels of aggression?

Why do some species engage in group-based aggression in order to kill neighbours?
Why are we so aggressive and can we do anything about it?

What effects does experience have on levels of aggression?

Why do some species engage in group-based aggression in order to kill neighbours?

Can we learn anything from other species about how to live more peacefully?
What is aggression and why has it evolved?
What is aggression and why has it evolved?

Aggression:
'Overt behaviour intended to inflict damage on another individual'
Predatory and affective aggression
Predatory and affective aggression

For humans affective aggression tends to be reactive and predatory aggression tends to be proactive
Predatory and affective aggression

For humans affective aggression tends to be reactive and predatory aggression tends to be proactive

Predatory aggression is no longer about putting food on the table
Predatory and affective aggression

For humans affective aggression tends to be reactive and predatory aggression tends to be proactive

Predatory aggression is no longer about putting food on the table

Premeditated acts of aggression towards people or property are reinforced by learning
Predatory and affective aggression

For humans affective aggression tends to be reactive and predatory aggression tends to be proactive

Predatory aggression is no longer about putting food on the table

Premeditated acts of aggression towards people or property are reinforced by learning

Pathological killers often seem to operate in predatory mode
Some physiological characteristics of violent criminals

Criminals, murderers and psychopaths are often hypoaroused.

They may have lower heart rates, skin conductance and slower frequency brain waves (EEG).
Some physiological characteristics of violent criminals

Criminals, murderers and psychopaths are often hypoaroused

They may have lower heart rates, skin conductance and slower frequency brain waves (EEG)

A chronic state of underarousal may be aversive, and crime could provide a buzz!
Some physiological characteristics of others

Extreme sports activities may be a better option!
Some physiological characteristics of others

Individuals in some professions seem to benefit from underarousal......
So why develop an affective aggression response?

Why have most species developed an affective aggression response?
So why develop an affective aggression response?

Why have most species developed an affective aggression response?

An affective response will mobilise stress hormones and improve defense.
So why develop an affective aggression response?

Why have most species developed an affective aggression response?

An affective response will mobilise stress hormones and improve defense

Better risk assessment for offensive action
So why develop an affective aggression response?

Why have most species developed an affective aggression response?

An affective response will mobilise stress hormones and improve defense

Better risk assessment for offensive action

Increased chance of avoiding a fight
Aggression and dominance

A key aim of aggression is to dominate over someone or something.

It is used to obtain/control key resources of survival or reward value.
We also use negotiation, cheating and deceit
Aggression and dominance

Physical aggression does not necessarily lead to social dominance
Aggression and dominance

Physical aggression does not necessarily lead to social dominance

For most species real physical aggression is relatively rare
Physical aggression does not necessarily lead to social dominance

For most species real physical aggression is relatively rare

Threat displays and submissive gestures are used extensively
'So that in the nature of man, we find three principal causes of quarrel. First, competition; secondly, diffidence; thirdly, glory

'The first maketh men invade for gain; the second, for safety; and the third, for reputation'

Thomas Hobbes 'Leviathan' (1651)
Is aggression an inevitable trait in all species?

There are two opposing views of aggression:

Like other motivated behaviours it is an inherited spontaneous tendency – i.e. it is in our 'nature'

Freud  Konrad Lorenz  Churchill  Pinker
Is aggression an inevitable trait in all species?

There are two opposing views of aggression

Violence is learned behaviour and therefore avoidable
The Seville statement
The Seville statement

It is scientifically incorrect to say:

We have inherited a tendency to make war from our animal ancestors.

War or any other violent behaviour is genetically programmed.

In the course of human evolution there has been a selection for aggressive behaviour more than other kinds of behaviour.

Humans have a 'violent brain'.

War is caused by 'instinct' or any single motivation.
Konrad Lorenz – Hydraulic model

Energy input

Valve (innate release mechanism)

Responses (fixed action pattern)

Weights (stimulus)
If Lorenz is right, then this makes for some disturbing conclusions:
If Lorenz is right, then this makes for some disturbing conclusions:

Aggression is inevitable – accumulating energy must find an outlet.

Humans and other animals will actively look for fights.

After a fight has occurred individuals will become less aggressive.

Even animals reared in isolation will show aggressive behaviour.
'Thus it is manifest that during the time men live without a common power to keep them all in awe, they are in that condition which is called war; and such a war as is of every man against every man'

The result of this being:
'.... continual fear, and danger of violent death; and the life of man, solitary, poor, nasty, brutish, and short'
(Thomas Hobbes)

'The story of the human race is war. Except for brief and precarious interludes there has never been peace in the world; and long before history began murderous strife was universal and unending'
(Winston Churchill)
Sex differences in aggression:

Is it true that men are from Mars, and women are from Venus?
Sex differences in aggression:

Sex Difference in US Crime Statistics

Percentage

Simple assaults
Aggravated assaults
Murders

Males
Females
Sex differences in aggression:

Males:

Are both physically stronger and reproduce their genes best by mating with as many females as possible.
Sex differences in aggression:

Females:

Cannot normally physically dominate males
Sex differences in aggression:

Females:

Cannot normally physically dominate males

Have only a limited potential for choosing a mate
Sex differences in aggression:

Females:

Cannot normally physically dominate males

Have only a limited potential for choosing a mate

The best reproductive strategy is to nurture and defend offspring...
Sex differences in aggression:

...and to reproduce with males who can best protect them
Sex differences in aggression:

Female aggression is restricted to protecting young and obtaining resources.

It is less to do with dominance which is far more important for males.
Sex differences in aggression:

Females are more fearful of potential threats than males...
Sex differences in aggression:

Females are more fearful of potential threats than males...

...and may use social psychology instead of physical aggression!
Sex differences in aggression:

Prediction:
The absence of aggressive males might increase physical aggression in females and concern for social dominance.
Sex differences in aggression:

Prediction:
The absence of aggressive males might increase physical aggression in females and concern for social dominance.

Levels of violent crime by females appear to be on the increase.
Sex differences in aggression:

Prediction:
The absence of aggressive males might increase physical aggression in females and concern for social dominance

Levels of violent crime by females appear to be on the increase

In Bonobo apes females dominate males and are more concerned about social dominance
Sex differences in aggression:

Females may not be an inherently peaceful sex
Sex differences in aggression:

Females may not be an inherently peaceful sex.

Lower aggression may owe more to social structure and political expediency than to biology.
Sex differences in aggression:

Females may exert positive selection for aggressive males

David Perrett
Sex differences in aggression:

Females may exert positive selection for aggressive males

ARTICLE IN PRESS

Manipulations of fundamental and formant frequencies influence the attractiveness of human male voices

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How is aggression controlled by the brain?

Animal models, mainly cats and rats
How is aggression controlled by the brain?

Animal models, mainly cats and rats

Affective aggression – pupillary dilation, increased heart rate and blood pressure, urination and piloerection
How is aggression controlled by the brain?

Animal models, mainly cats and rats

Affective aggression – pupillary dilation, increased heart rate and blood pressure, urination and piloerection

Predatory aggression – pupillary dilation only
How is aggression controlled by the brain?

Different brain regions are involved in predatory and affective aggression.
How is aggression controlled by the brain?

Different brain regions are involved in predatory and affective aggression.
How is aggression controlled by the brain?

Kluver-Bucey Syndrome
How is aggression controlled by the brain?

Kluver-Bucae Syndrome

Amygdala brain tumour in a mass murderer

Charles Whitman
The 'Texas Tower' sniper
How is aggression controlled by the brain?

Kluver-Bucey Syndrome

Amygdala brain tumour in a mass murderer

Rabies
How is aggression controlled by the brain?

Smell and aggression

Head-butting (rejection)
How is aggression controlled by the brain?

Sex and aggression

- medial hypothalamus
- corticomedial amygdala
- olfactory bulb
How is aggression controlled by the brain?

Levels of higher control over aggression
How is aggression controlled by the brain?

Levels of higher control over aggression

Orbitofrontal, prefrontal and cingulate cortices

- Cingulate gyrus
- Septum
- Fornix
- Olfactory bulb
- Hypothalamus
- Amygdala
- Mammillary body
- Hippocampus

- Cingulate cortex
- Prefrontal cortex
- Orbitofrontal cortex
How is aggression controlled by the brain?

Levels of higher control over aggression

Orbitofrontal, prefrontal and cingulate cortices

The orbitofrontal cortex

Phineas Gage
How is aggression controlled by the brain?

Levels of higher control over aggression

Orbitofrontal, prefrontal and cingulate cortices

The orbitofrontal cortex

The frontal and cingulate cortices are less strongly activated by emotive stimuli in murderers (Reiss et al 1998)
How is aggression controlled by the brain?

Females have a larger orbitofrontal cortex in proportion with amygdala.
What factors may contribute to excessive aggression?

Hormonal, biochemical and genetic factors?

The positions of our glands, the hormones they release and the effects of these hormones
Is aggression just a testosterone-based thing?
Testosterone

Is aggression just a testosterone-based thing?

Testosterone is produced by gonads and adrenals in both sexes.
Is aggression just a testosterone-based thing?

Testosterone is produced by gonads and adrenals in both sexes

Adult males have 7 times higher testosterone levels than females
Testosterone maketh man and muscle:
Testosterone maketh man and muscle:

Testosterone changes in early development and at puberty make a male brain.

At 12, you'll probably still have a young boy's body. At 15, you might look like a child or a young man; either one is normal. At 18, you'll see less difference between you and your friends.
Testosterone maketh man and muscle:

Testosterone changes in early development and at puberty make a male brain

High testosterone levels do not necessarily make males more sexual or aggressive
Testosterone

Testosterone maketh man and muscle:

Testosterone changes in early development and at puberty make a male brain

High testosterone levels do not necessarily make males more sexual or aggressive

They will however boost muscle development!
Castration will reduce male sex, aggression and muscle!
High testosterone, fighting and football:
High testosterone, fighting and football:

Socially dominant animals have high testosterone levels
Testosterone

High testosterone, fighting and football:

Socially dominant animals have high testosterone levels

When males win a fight testosterone is increased

When they lose it is decreased
Testosterone

The same is true of football supporters!
High testosterone and crime:
High testosterone and crime:

Prisoners with a prior record of violent and aggressive crimes
High testosterone and crime:

Prisoners with a prior record of violent and aggressive crimes

Rapists who are most violent during the act

The Rape of Helene
Primaticcio 1539
High testosterone and crime:

Prisoners with a prior record of violent and aggressive crimes

Rapists who are most violent during the act

Individuals exhibiting high levels of antisocial violence
High testosterone and marriage:

Men with high basal testosterone levels are less likely to marry.

If they do marry they tend to have higher divorce rates due to extramarital sex and aggression.
High testosterone in women:
High testosterone in women:

In females only dominance shows some correlation with testosterone.
Testosterone: driver or facilitator?

"The absolute amount of testosterone is highest in humans, followed by lower values in the bonobo, chimpanzee, gorillas, and orangutan."

Derived from Fig 4., Page 68 "Comparative urinary androstanes in the great apes," L.R. Hagey and N.M. Czekala, General and Comparative Endocrinology 2003; 130: 64-69.
Testosterone

Testosterone: driver or facilitator?

Giving testosterone does not cause aggression
Testosterone

Testosterone: driver or facilitator?

Giving testosterone does not cause aggression

Highest testosterone levels are when you are asleep!

[Brenner et al. JCEM 56: 1278-1281 (1983)]
Testosterone: driver or facilitator?

Giving testosterone does not cause aggression

Highest testosterone levels are when you are asleep!

Female aggression is not preceded by a rise in testosterone
Testosterone: driver or facilitator?

Giving testosterone does not cause aggression.

Highest testosterone levels are when you are asleep!

Female aggression is not preceded by a rise in testosterone.

Winning football supporters are not all bad!
Testosterone: driver or facilitator?

Giving testosterone does not cause aggression

Highest testosterone levels are when you are asleep!

Female aggression is not preceded by a rise in testosterone

Winning football supporters are not all bad!

In the brain testosterone facilitates responses to sensory cues
(Kendrick & Drewett Science 1979)
Brain neurochemical systems and aggression

Serotonin and aggression

Percentage

CSF-5HIAA Concentration Quartile:
- Low
- Low-mid
- High-mid
- High

Dead
Alive

[Bar chart showing the relationship between CSF-5HIAA concentration quartiles and serotonin levels.]
Serotonin and aggression

Low serotonin is also associated with poor social skills
Brain neurochemical systems and aggression

Serotonin and aggression

Low serotonin is also associated with poor social skills

Serotonin transporter gene (5-HTT)
Brain neurochemical systems and aggression

Serotonin and aggression

Low serotonin is also associated with poor social skills

Serotonin transporter gene (5-HTT)

Diets low in tryptophan can increase aggression
Brain neurochemical systems and aggression

Serotonin and aggression

Low serotonin is also associated with poor social skills

Serotonin transporter gene (5-HTT)

Diets low in tryptophan can increase aggression

What about Prozac?
Other inhibitors of aggression

Gamma-aminobutyric acid (GABA), endogenous opioids, endorphins (barbiturates, benzodiazepines and morphine)
Other inhibitors of aggression

Stimulators of aggression:
Acetylcholine, noradrenaline and dopamine, cholecystokinin, substance P, and arginine vasopressin


Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Arg-Gly-NH₂
Other inhibitors of aggression

Increased aggression:
Tricyclic antidepressants and monoamine oxidase inhibitors

- Amitriptyline
- Imipramine
- Dothiepin
- Desipramine
- Amoxapine
- Doxepin
- Protriptyline
Other inhibitors of aggression

Decreased aggression:
Beta-blockers and haloperidol
Other inhibitors of aggression

Arginine vasopressin and male aggression
Other inhibitors of aggression

Arginine vasopressin and male aggression

Modulates serotonin, noradrenaline and dopamine
Other inhibitors of aggression

Arginine vasopressin and male aggression

Modulates serotonin, noradrenaline and dopamine

High levels in brains of aggressive humans
Other inhibitors of aggression

Vasopression also stimulates social bonds in male voles and mice.
Other inhibitors of aggression

Vasopression also stimulates social bonds in male voles and mice

Oxytocin, which stimulates bonds in females inhibits aggression!

Cys-Tyr-Ile-Gln-Asn-Cys-Pro-Leu-Gly-NH₂
Alcohol, drugs and aggressive behaviour

In half of violent crimes perpetrators have consumed alcohol or drugs.
Alcohol, drugs and aggressive behaviour

In half of violent crimes perpetrators have consumed alcohol or drugs

Alcohol inhibits brain centres controlling aggression

![Brain diagram]

- Emotion
- Voluntary motor skills
- Involuntary system
- Judgement
Alcohol, drugs and aggressive behaviour

In half of violent crimes perpetrators have consumed alcohol or drugs

Alcohol inhibits brain centres controlling aggression

Interferes with perception and interpretation of social signals
Alcohol, drugs and aggressive behaviour

Amphetamine increases aggression by releasing noradrenaline and dopamine
What effects does experience have on levels of aggression?

Increased media/computer game violence, and weapon ownership?
What effects does experience have on levels of aggression?

Increased media/computer game violence, and weapon ownership?

Violent crime rates have declined during the 1990's
What effects does experience have on levels of aggression?

Increased media/computer game violence, and weapon ownership?

Violent crime rates have declined during the 1990's

Exposure to violence does increase aggression but not violent crime (Savage 2004)
What effects does experience have on levels of aggression?

Increased media/computer game violence, and weapon ownership?

Violent crime rates have declined during the 1990's

Exposure to violence does increase aggression but not violent crime (Savage 2004)

Macho, frontiersman American culture?
What effects does experience have on levels of aggression?

Children raised by aggressive parents have an increased risk of becoming aggressive.

Children suffering early physical abuse are more likely to become abusers.
Cross-fostering in animals consistently emphasises parental influences

- **Control white-footed mice**
- **Cross-fostered white-footed mice**
- **Cross-fostered California mice**
- **Control California mice**

### Attack latency (s)

- **resident/intruder**
- **neutral**

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What effects does experience have on levels of aggression?
What effects does experience have on levels of aggression?

Key external factors:

Rule of law: perceived risk of punishment associated with aggressive acts
What effects does experience have on levels of aggression?

Key external factors:

Rule of law:
perceived risk of punishment associated with aggressive acts

Cultural moral values concerning aggression
Why engage in group-based aggression to kill neighbours?

Access to food and appropriate conditions to conceive and rear young
Why engage in group-based aggression to kill neighbours?

Access to food and appropriate conditions to conceive and rear young

Hunter-gatherer vs. territorial societies
Why engage in group-based aggression to kill neighbours?

Love thy neighbour vs. the neighbours from hell!

[Image of the cover of the Neighbours soundtrack album]
Why engage in group-based aggression to kill neighbours?

Use safe guerrilla tactics to weaken opposition
Why engage in group-based aggression to kill neighbours?

Use safe guerrilla tactics to weaken opposition

Kill males and abduct females
Why engage in group-based aggression to kill neighbours?

Use safe guerrilla tactics to weaken opposition

Kill males and abduct females

The creation of no-go areas
Why engage in group-based aggression to kill neighbours?

Nation states and organised vs. opportunistic warfare
Do other species engage in warfare?

Chimpanzees – Jane Goodall
Do other species engage in warfare?

Chimpanzees – Jane Goodall

Wolves – David Mech

Denali Wolves Adopt New Alpha

The Toklat pack's alpha male killed during a research project.

DENALI, ALASKA—A wolf that was moved from its home range east of Fairbanks six months ago as part of a caribou recovery plan has joined the Toklat wolfpack in Denali National Park and Preserve. The wolf roamed nearly 200 miles to join the pack whose alpha male died in March after being darted for research.

The pack is the best known of Alaska's approximately 1,000 wolf packs, and an estimated 20,000
Do other species engage in warfare?

Chimpanzees – Jane Goodall

Wolves – David Mech

Death rates from violence are low and very similar
Humans: 0.1-0.3%
Chimpanzees: 0.2-0.5%
Do other species engage in warfare?

This can increase to 50% with intense competition for resources

Logging Sets Off an Apparent Chimp War

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The New York Times

May 13, 1997
Can we learn from other species in order to live peacefully?

Few other species have a developed moral sense to suppress physical aggression and yet most seem able to control it.
Can we learn from other species in order to live peacefully?

Few other species have a developed moral sense to suppress physical aggression and yet most seem able to control it.

Aggression is controlled by social perception skills and submissive or threat postures.
Can we learn from other species in order to live peacefully?

Animals use rough and tumble play and group activities such as foraging and hunting both to maintain social relationships and burn off pent-up aggression.

The more social you are, in terms of bonds, the more potential you have for aggression.
Can we learn from other species in order to live peacefully?

Avoidance of warfare may require no territorial borders and access to the same level of resources!
Make love not war – The Bonobo story
Make love not war – The Bonobo story

This could not work in a monogamous culture
Make love not war – The Bonobo story

This could not work in a monogamous culture

Being peaceful may not promote species survival
Could we completely prevent aggression?

Yes but aggression is linked to other beneficial behaviours

Our aggressive nature aids survival by motivating problem-solving

Ambition, dedication and commitment

Physical aggression is triggered by boredom, and inability to express skills and ambitions
Some final conclusions

Aggression, dominance and impulsivity are related

For males aggression is about social dominance and competition

For females it is about protection and acquisition of resources

Affective and predatory aggression are distinctive

Female brains have more cortical aggression control
Some final conclusions

Testosterone makes an aggressive male brain but not necessarily aggression itself

Females find high T males more attractive for reproduction but not parenting!

Reduced brain serotonin is linked to increased aggression

Alcohol reduces brakes on aggression and obscures perception of social signals
Some final conclusions

Control of male but not female bond formation is linked to aggression

Experience can blunt or accentuate aggression but is not responsible

Warfare is not an exclusive human invention

Make love not war may be an option for some species but not for us
Some final conclusions

We need creative outlets for aggression