

Manipulating the Brain in Decision Making

Mary ET Boyle, Ph.D., Department of Cognitive Science, UCSD



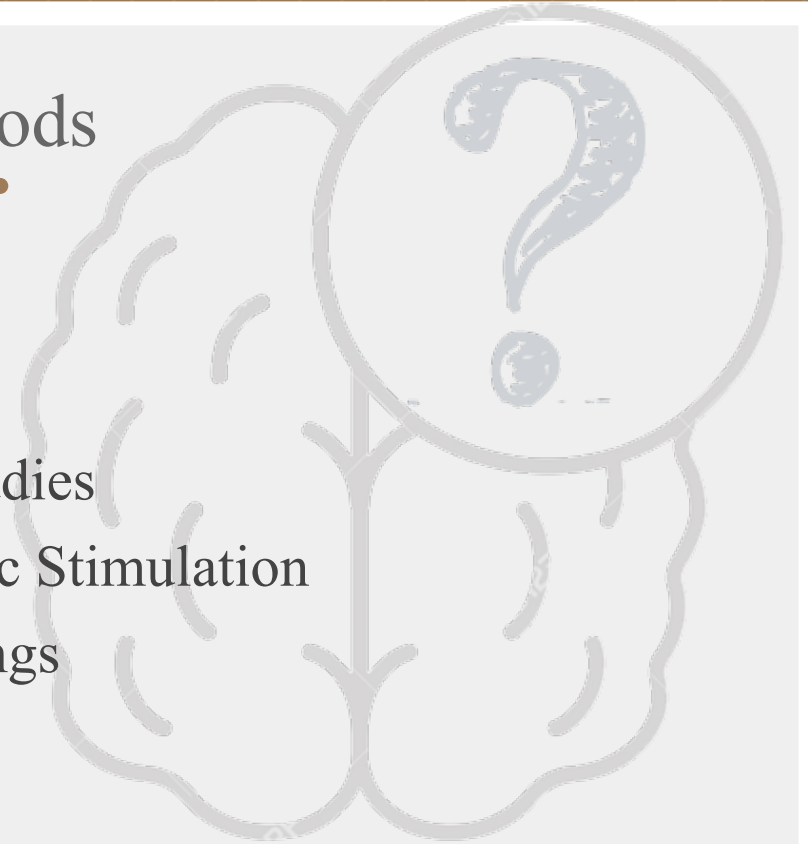
Damaged Brains

What lesion studies can tell us about decision-making

Methods

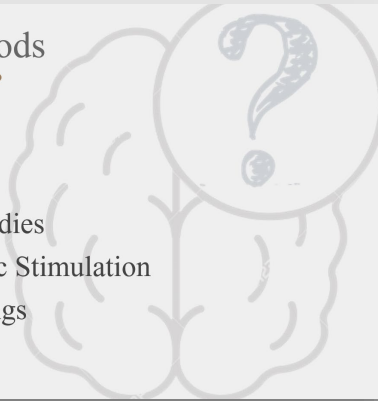


- ◆ fMRI
- ◆ EEG
- ◆ Damaged Brains– Lesion Studies
- ◆ TMS – Transcranial Magnetic Stimulation
- ◆ Electrophysiological recordings
- ◆ Electrical Stimulation



Methods

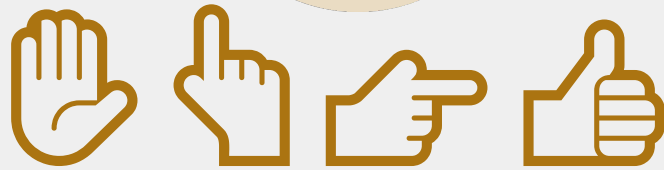
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All methods can
be categorized
by

- ① TEMPORAL
- ② SPATIAL

Resolutions



COMBINE METHODS

To understand the underlying dynamics and regions associated with decision making.

A **lesion** – any abnormal tissue damaged by disease or trauma.

1.
How do lesions
affect behavior?

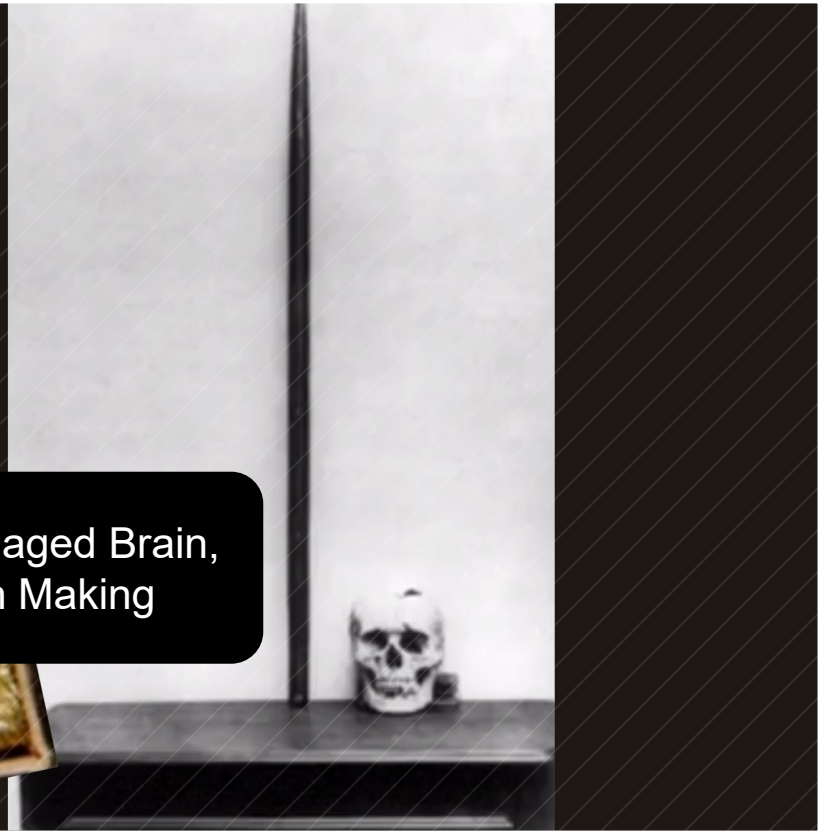


Phineas Gage, again!

Neuropsychology – the discipline that studies lesions (animals and humans) – and relates the structure to function, psychological processes, and behavior.

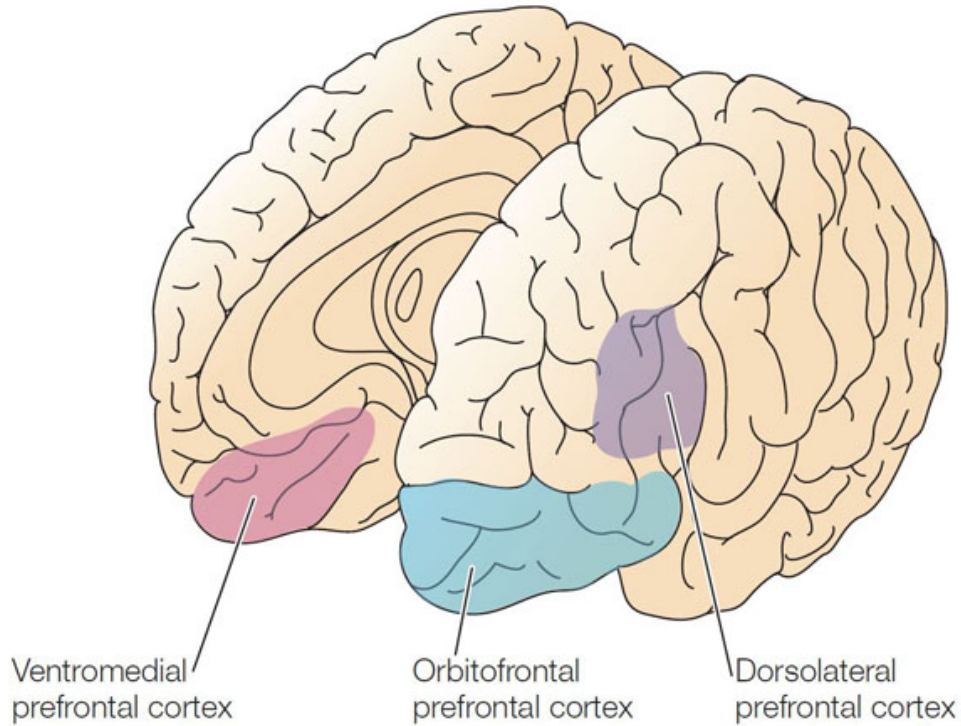


Phineas Gage – Damaged Brain,
Damaged Decision Making



1860's

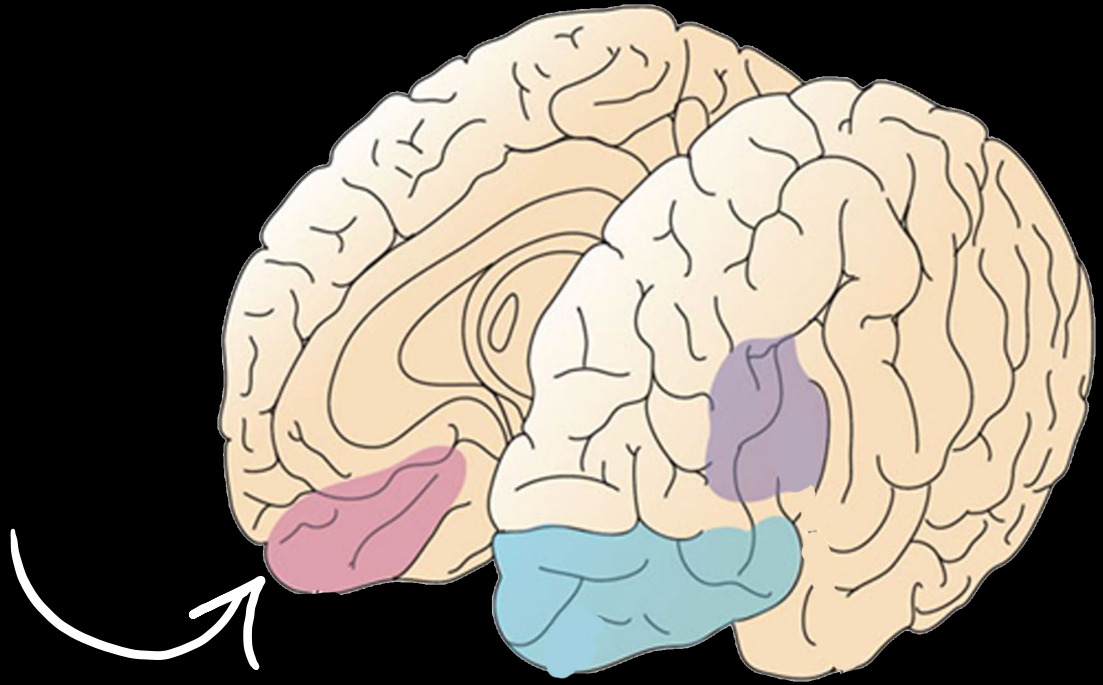
Decision-Making Regions



Ventro medial
prefrontal
cortex

decision
making

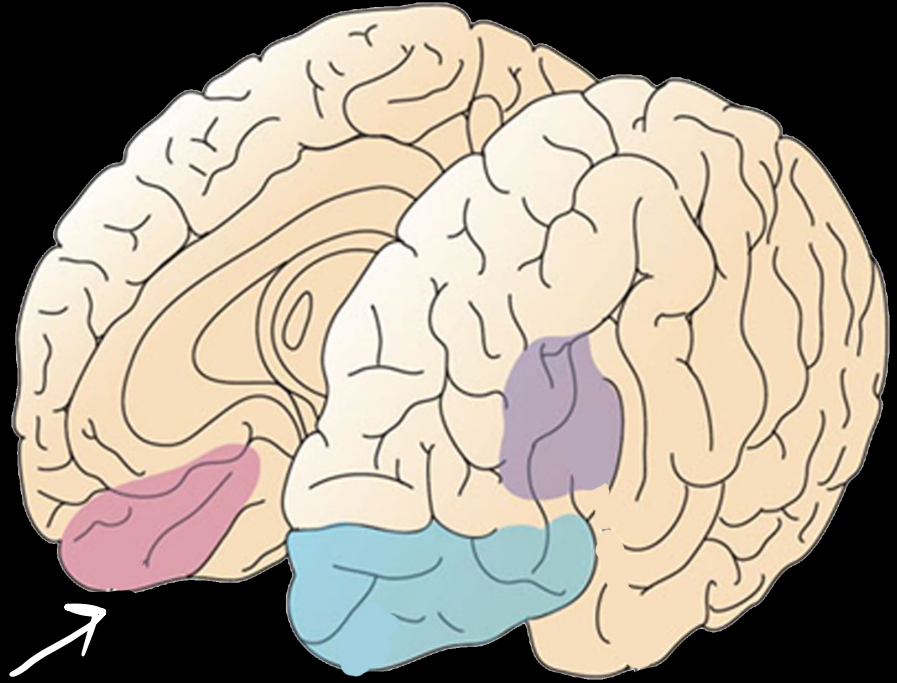
→ ambiguity, uncertainty, risky



VMPFC

THIS BRAIN AREA
REPRESENTS

BASIC INFORMATION
ABOUT THE "relative"
VALUE OF OPTIONS



*VALUE BASED DECISION MAKING



2.

Antonio Damasio



*Studied patients with VMPFC
damage.*

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Damage to ventromedial prefrontal cortex impairs judgment of harmful intent

Liane Young^{1,*}, Antoine Bechara², Daniel Tranel³, Hanna Damasio², Marc Hauser⁴, and Antonio Damasio²

¹ Department of Brain & Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

² Brain and Creativity Institute and Dornsife Center for Cognitive Neuroimaging, University of Southern California, Los Angeles, California 90089, USA

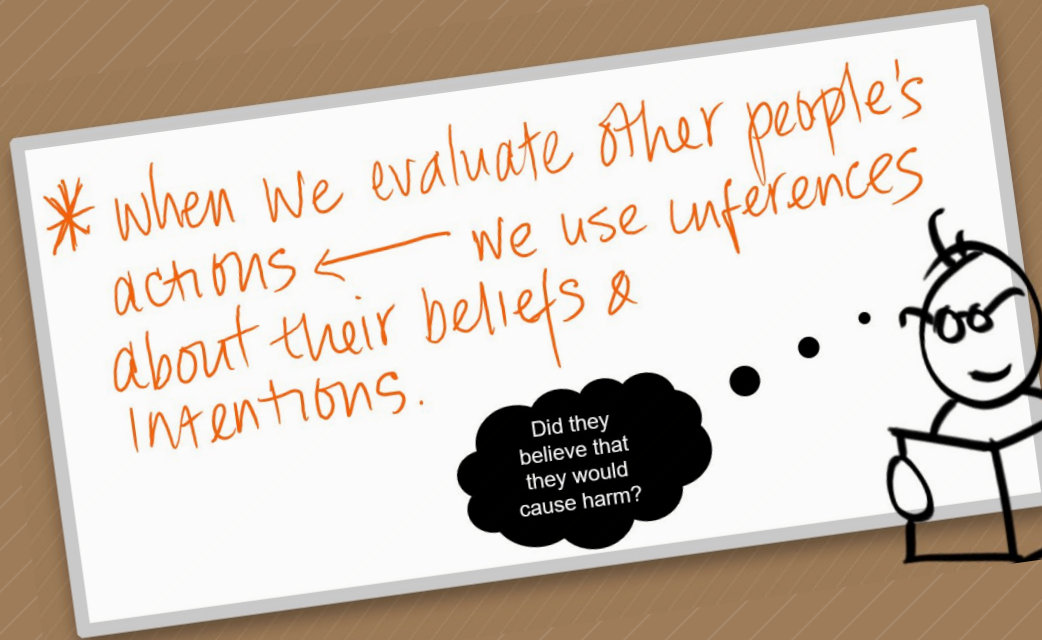
³ Departments of Neurology and Psychology, University of Iowa, Iowa City, Iowa 52242, USA

⁴ Departments of Psychology and Human Evolutionary Biology, Harvard University, Cambridge, Massachusetts 02138, USA

* When we evaluate other people's actions ← we use inferences about their beliefs & intentions.

Did they believe that they would cause harm?






Mismatches

- accidents

↳ when
intention
≠
action

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Did they believe that they would cause harm?


Mismatches

- accidents
↳ when intention ≠ action

Damasio asks:

What role does VMPFC have in moral judgments ← rely on intent

Summary



Moral judgments, whether delivered in ordinary experience or in the courtroom, depend on our ability to infer intentions. We forgive unintentional or accidental harms and condemn failed attempts to harm. Prior work demonstrates that patients with damage to the ventromedial prefrontal cortex (VMPC) deliver abnormal judgments in response to moral dilemmas, and that these patients are especially impaired in triggering emotional responses to inferred or abstract events (e.g., intentions), as opposed to real or actual outcomes. We therefore predicted that VMPC patients would deliver abnormal moral judgments of harmful intentions in the absence of harmful outcomes, as in failed attempts to harm. This prediction was confirmed in the current study: VMPC patients judged attempted harms including attempted murder as more morally permissible relative to controls. These results highlight the critical role of the VMPC in processing harmful intent for moral judgment.

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Damage to the prefrontal cortex increases utilitarian moral judgements

Michael Koenigs^{1,*†}, Liane Young^{2,*}, Ralph Adolphs^{1,3}, Daniel Tranel¹, Fiery Cushman², Marc Hauser², and Antonio Damasio^{1,4}

1 Department of Neurology, University of Iowa Hospitals and Clinics, Iowa City, Iowa 52242, USA

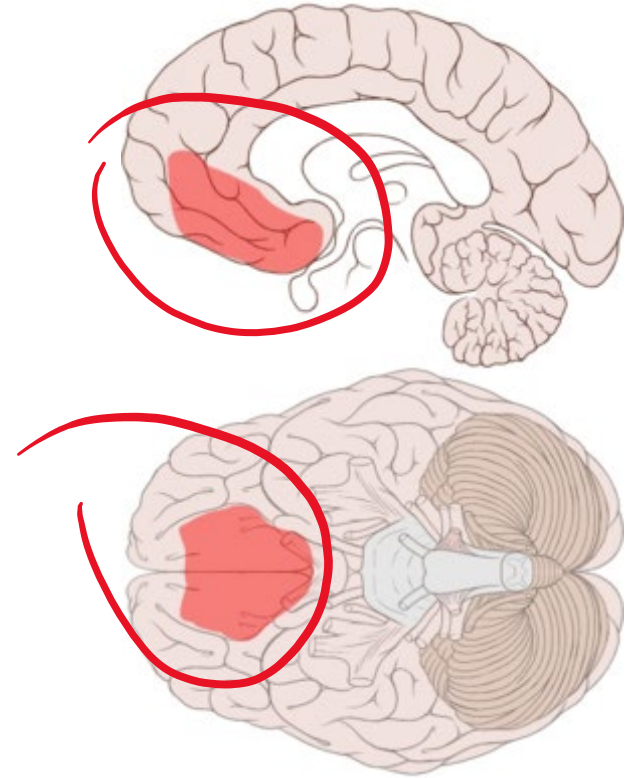
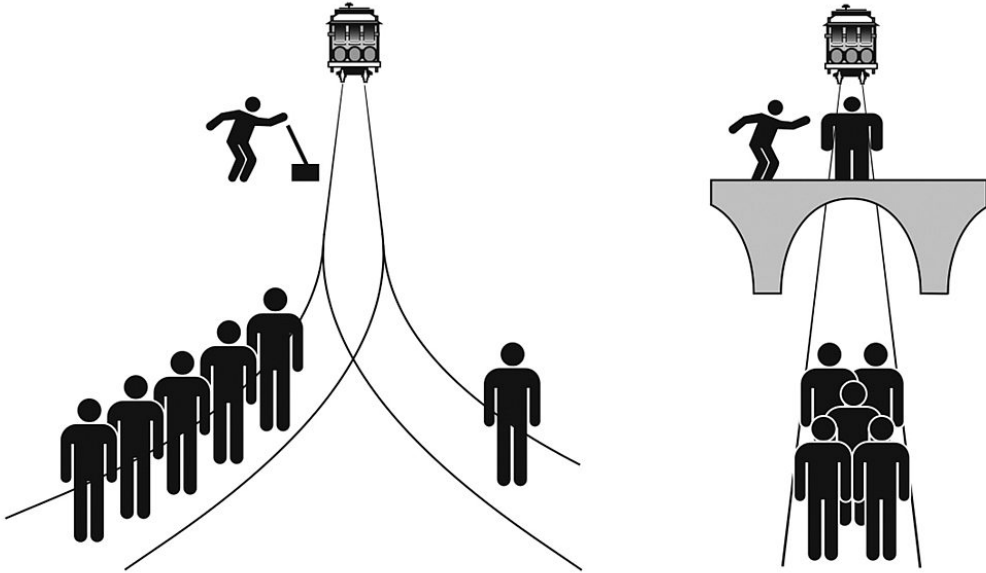
2 Department of Psychology, Harvard University, Cambridge, Massachusetts 02138, USA

3 Division of Humanities and Social Sciences and Division of Biology, California Institute of Technology, Pasadena, California 91125, USA

4 Brain and Creativity Institute and Dornsife Center for Cognitive Neuroimaging, University of Southern California, Los Angeles, California 90089, USA

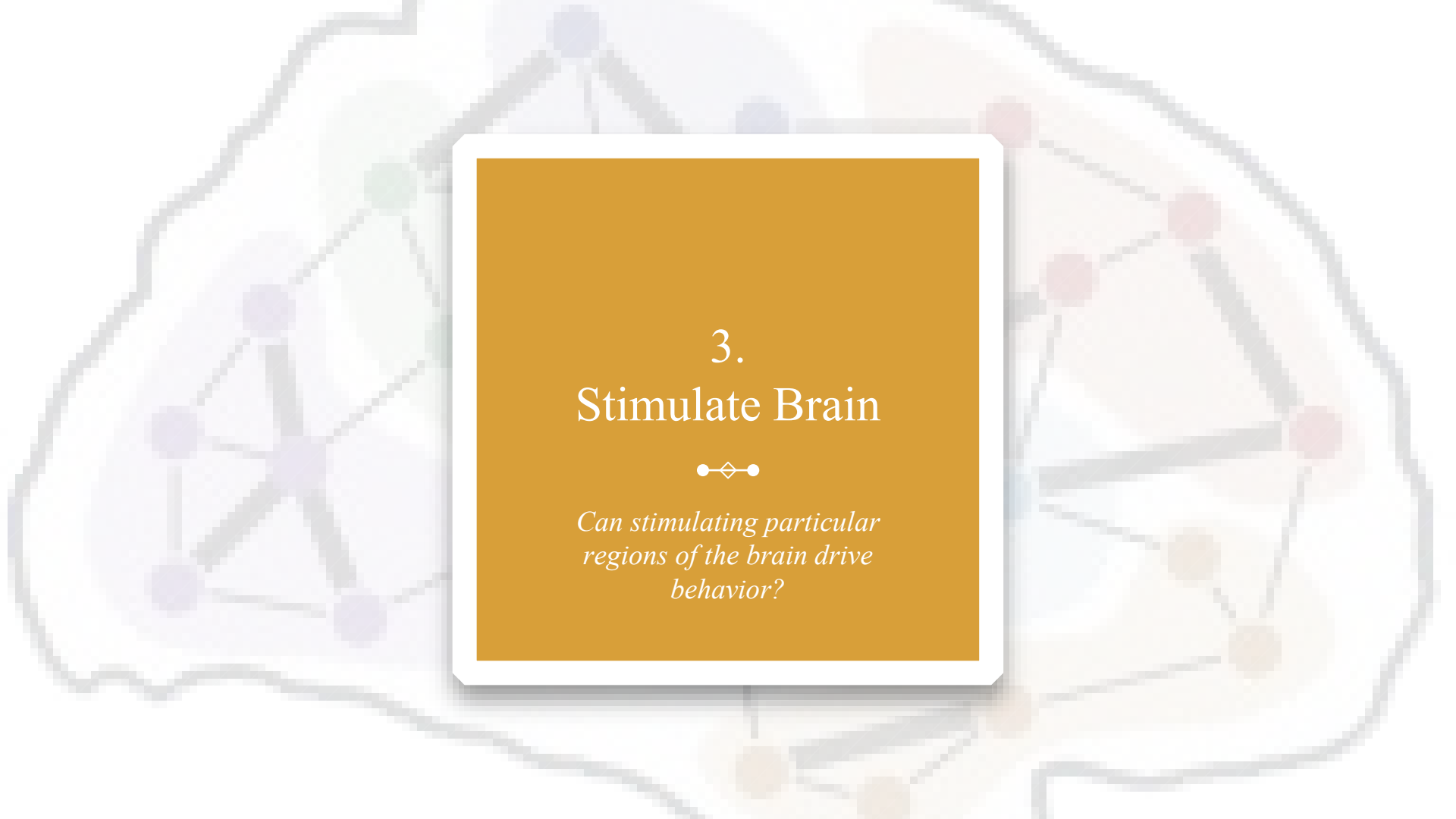
Trolley car moral dilemma:

VMPFC is active when subjects evaluate emotionally salient harms to an individual



Utilitarian maximization of aggregate welfare.

The psychological and neurobiological processes underlying moral judgement have been the focus of many recent empirical studies¹⁻¹¹. Of central interest is whether emotions play a causal role in moral judgement, and, in parallel, how emotion-related areas of the brain contribute to moral judgement. Here we show that six patients with focal bilateral damage to the ventromedial prefrontal cortex (VMPC), a brain region necessary for the normal generation of emotions and, in particular, social emotions¹²⁻¹⁴, produce an abnormally 'utilitarian' pattern of judgements on moral dilemmas that pit compelling considerations of aggregate welfare against highly emotionally aversive behaviours (for example, having to sacrifice one person's life to save a number of other lives)^{7,8}. In contrast, the VMPC patients' judgements were normal in other classes of moral dilemmas. These findings indicate that, for a selective set of moral dilemmas, the VMPC is critical for normal judgements of right and wrong. The findings support a necessary role for emotion in the generation of those judgements.



3. Stimulate Brain



*Can stimulating particular
regions of the brain drive
behavior?*

Anatomy: Hypothalamus



<https://www.youtube.com/watch?v=ErpxEWVvww4>

Exp. Brain Res. 8, 113—129 (1969)

Defence, Attack, and Flight Elicited by Electrical Stimulation of the Hypothalamus of the Cat

JERRAM L. BROWN, ROBERT W. HUNSPERGER and H. ENGER ROSVOLD

Department of Physiology, University of Zürich (Switzerland)

Received November 19, 1968

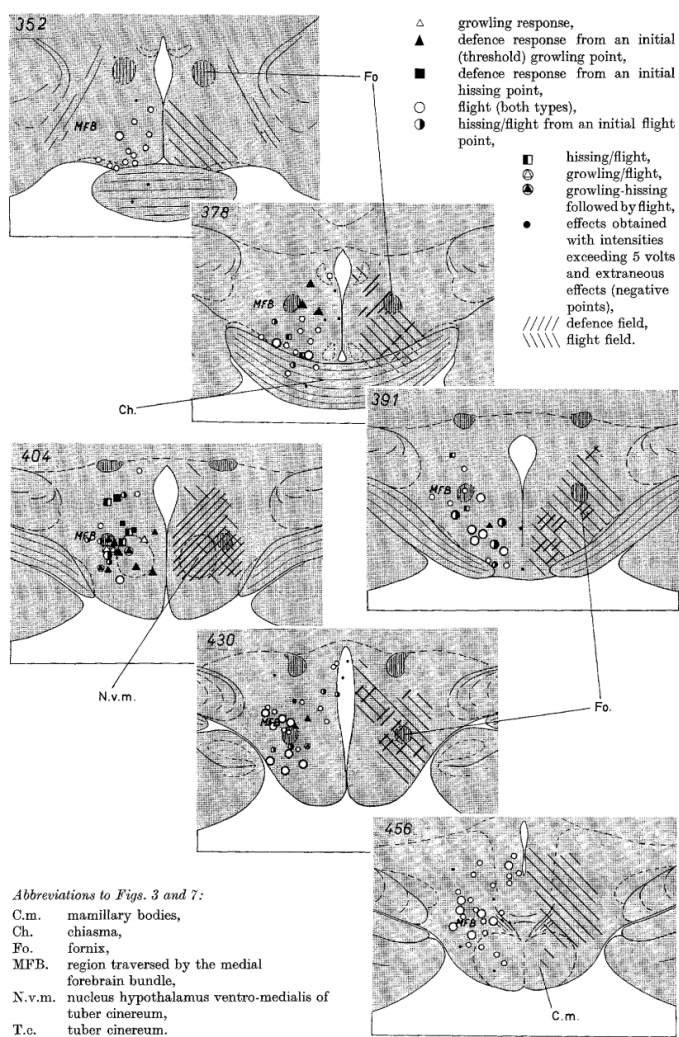
Summary. 1. Affective behaviour patterns produced by electrical stimulation of the hypothalamus were studied in unanaesthetized, freely-moving cats. Bipolar stimulation with coaxial electrodes and small cathode was used to elicit defence, attack or flight. The development of these responses was studied by varying stimulation strength. In some experiments a stuffed animal was introduced in order to study the reactions of the cat to changes in the environment during stimulation.

2. The following responses were evoked at threshold intensity: (i) growling reaction; (ii) hissing reaction; (iii) two types of flight — type *a* preceded by hastily looking to and fro as if in search of an exit, type *b* preceded by inspection of surroundings, in most cases associated with sniffing.

3. Increasing stimulation 1.5 times threshold often yielded combined patterns. At points yielding the growling reaction a defence response in which growls alternated with hisses was obtained. The points yielding flight type *a* sometimes yielded hissing followed by flight. Increasing stimulation at hissing points yielded either a defence reaction or the combined effect hissing-flight.

4. The growling reactions were obtained from the tuber region. The hissing responses were obtained from points above the tuber. The flight reactions, type *a*, were produced from the intermediate zone extending from the level of the preoptic area to the mamillary bodies and type *b* from the caudo-lateral hypothalamus.

5. The reactions of the cats to a dummy during stimulation varied depending on the type of response which had been evoked in the absence of the dummy. The defence reaction was converted into threatening and striking of the dummy, the combined effects into threatening, striking or biting, culminating in sudden flight. The dummy was ignored during stimulation of points yielding flight type *a*, but examined by sniffing during stimulation of points yielding flight type *b*.



Abbreviations to Figs. 3 and 7:

- C.m. mamillary bodies,
- Ch. chiasma,
- Fo. fornix,
- MFB. region traversed by the medial forebrain bundle,
- N.v.m. nucleus hypothalamus ventro-medialis of tuber cinereum,
- T.c. tuber cinereum.

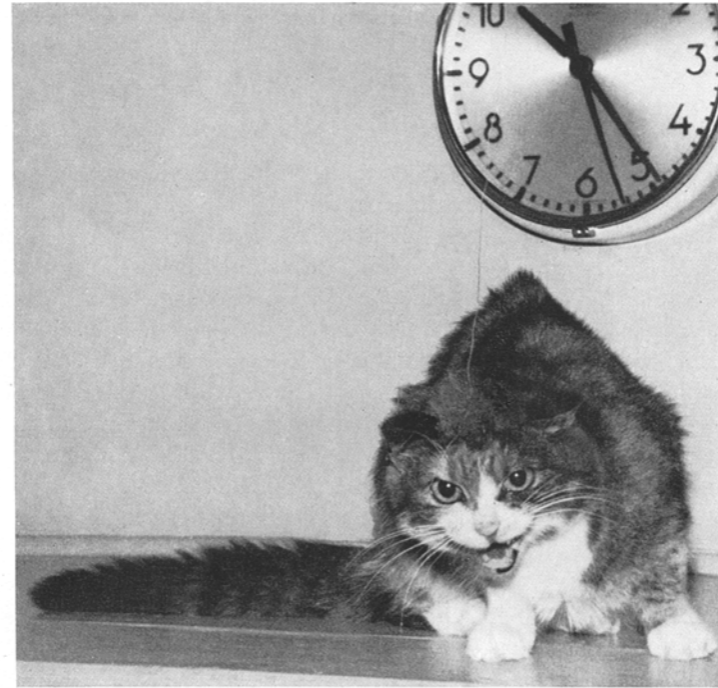


Fig. 2. Defence reaction. Hissing, pupil-dilatation, laying back of ears, piloerection, Stimulus intensity: 1.5 times threshold for growling (cat 44)

Fig. 4. *Development of behaviour patterns by increasing strength of stimulation.* Left: Growling reaction giving way to full defence response by progressively increasing stimulation strength (cat 45). a) growling (threshold), b) growling, which will be followed by hissing, ears slightly retracted (1.5 times threshold), c) full defence, hissing (alternating with growling), ears fully retracted (2.0 times threshold). Right: Full defence response culminating. d) in rushing forward as if to attack (cat 46), e) in vigorous flight; the flash-picture shows the moment before the cat jumped off the table (cat 44)

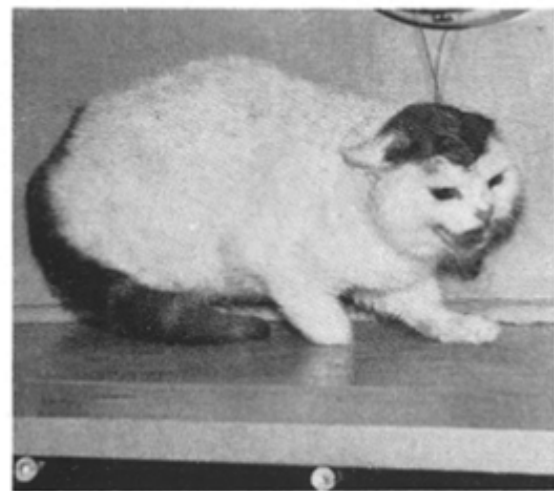
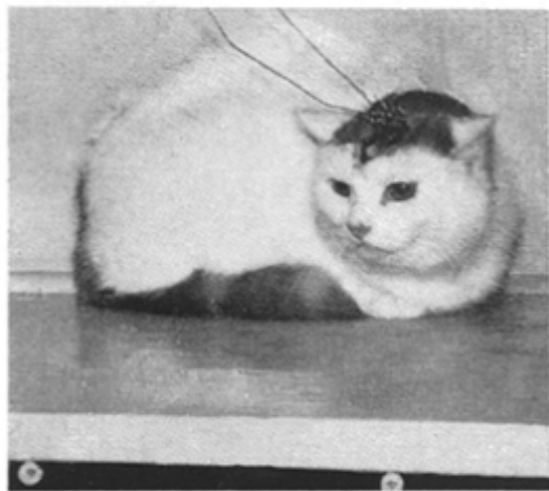
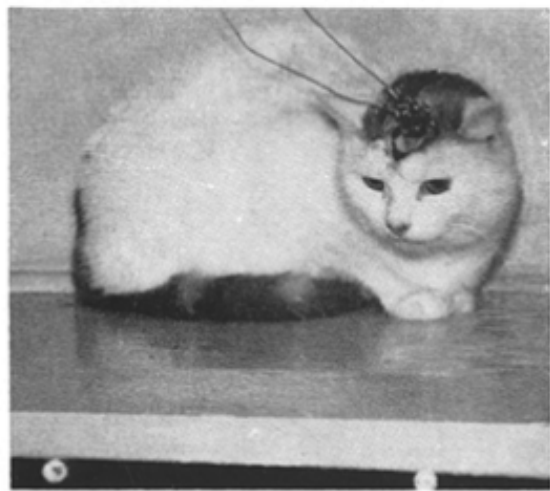


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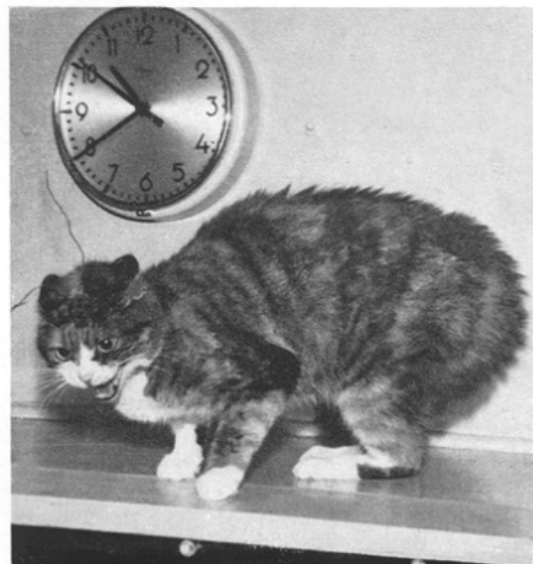
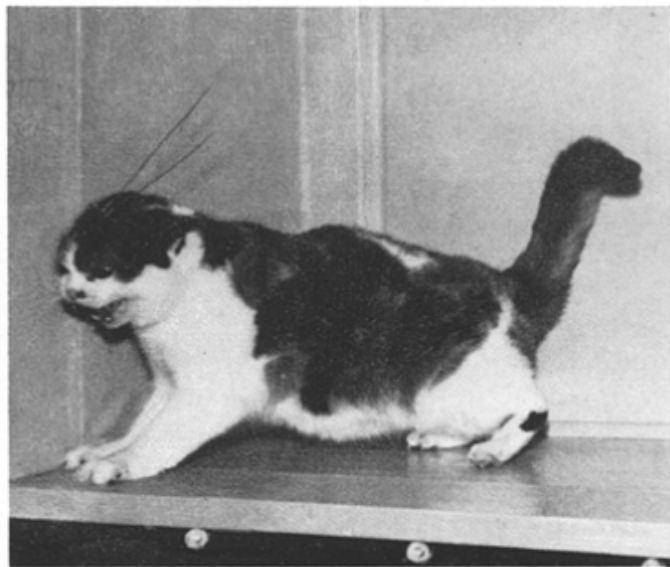
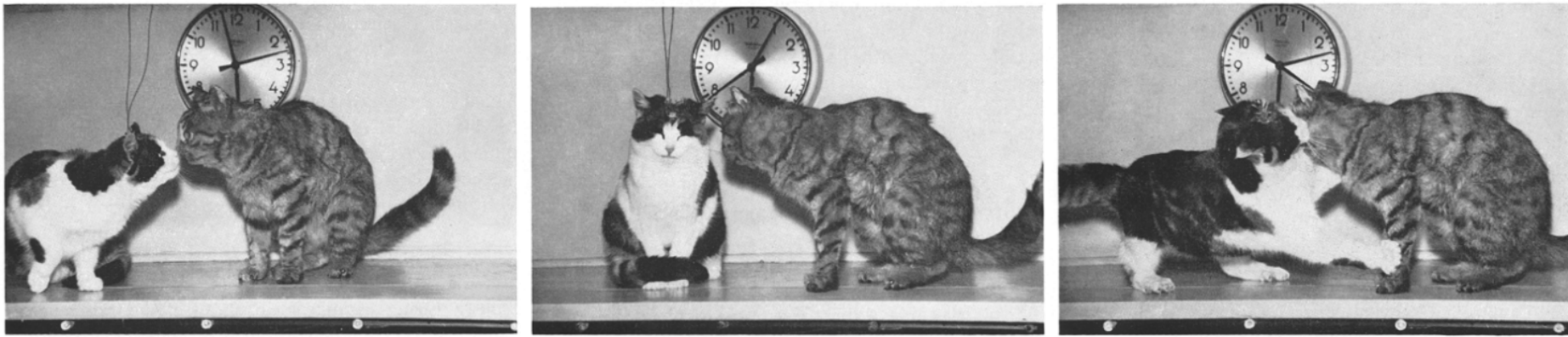


Fig. 6. *Reactions to dummy*: Friendly or aggressive behaviour of cat 48 (on left) depending on site of stimulation. a) Nose to nose sniffing obtained during stimulation of a flight point in the caudo-lateral hypothalamus; b) stimulation stopped, dummy is completely ignored; c) attack with teeth (biting) obtained from a threat/flight point alongside the tuber. The cat is hissing and will a moment later seize the nape of the dummy's neck





<https://www.youtube.com/watch?v=Kj2MqEMpj4U>