Depression & Anxiety
Clinical features, treatment, neurobiology & theory
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Description: Depression and anxiety disorders are amongst the most prominent psychiatric disorders in the world, and account for a disproportionally large fraction of the burden of psychiatric disease. The aim of the course is to give students a contemporary overview over anxiety and depression. The course will start by describing the clinical features, epidemiology and treatments. Substantial time will be devoted to animal models, human cognitive and neurobiological features and computational approaches.

Where & when: The course takes place on Friday afternoons from 14.00-16.00 in room ETZ F 91 (on Gloriastrasse) during the winter semester 2013/2014. Each session will contain a lecture followed by a journal club.

Please read both the background reading and the journal club paper, as these will be discussed in depth during the lecture.

Credit: To receive credit points, you must

• either give a 45min presentation in one of the seminar sessions covering all but the 'additional reading' papers. You may choose to either moderate the journal club, or to discuss the journal club paper in your talk. Moderating a journal club alone is insufficient.
• or program your own simulation addressing one of the topics discussed in the seminar and give a short presentation (5-10 min) of your code and results in the final session of the seminar. Papers marked in red might be most interesting for modelling projects.

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27.9 Topic & paper distribution

Please have a look at the course requirements and choose which, if any, sessions you would like to present.
Anxiety (4.10. - 18.10.)

4.10. Background reading and treatments

**Presenter** Background + JC: Eduardo Aponte

**Background reading**
- Shorter Oxford Textbook of Psychiatry, chapter 9 Anxiety disorders

**Journal club**

**Additional reading**
- Stahl's Essential Psychopharmacology. Chapter 9: Anxiety disorders and anxiolytics
- Kaplan & Sadock: Synopsis of psychiatry, chapter 16 Anxiety disorders
- Clark et al. (2006): Cognitive therapy versus exposure and applied relaxation in social phobia: a randomized controlled trial.
- Oler et al. (2010): Amygdalar and hippocampal substrates of anxious temperament differ in their heritability

11.10. Fear conditioning and extinction

**Presenter** Background + JC: Valance Wang

**Background reading**
- Schiller et al. (2010): Preventing the return of fear in humans using reconsolidation update mechanisms.

**Journal club**

**Additional reading**
- Rogan et al. (1997): Fear conditioning induces associative long-term potentiation in the amygdala.
- Robinson et al. (2012): Acute tryptophan depletion increases translational indices of anxiety but not fear: serotonergic modulation of the bed nucleus of the stria terminalis?

18.10. Obsessive-compulsive disorder

**Presenter**
- Background: Dr. Frederike Petzschner
- JC: Saee Paliwal?

**Background reading**
- Shorter Oxford Textbook of Psychiatry, chapter 9 Anxiety disorders (part on OCD)
Journal club
- Gillan et al. (2011): Disruption in the balance between goal-directed behavior and habit learning in obsessive-compulsive disorder

Additional reading
- Kaplan & Sadock: Synopsis of psychiatry, chapter 16 Anxiety disorders (part on OCD)
- Gillan et al. (2013): Enhanced Avoidance Habits in Obsessive-Compulsive Disorder
- Rotge et al. (2012): Forgetting what you have checked: a link between working memory impairment and checking behaviors in obsessive-compulsive disorder.
Depression (25.10. and 15.11.)

25.10. Symptoms, signs, epidemiology & biology

**Presenter**
Background: Dr. Helene Haker
JC: Tina Wentz

**Background reading**
- Shorter Oxford Textbook of Psychiatry, chapter 11 Mood disorders
- Brown (1993): Life events and affective disorder: replications and limitations

**Journal club**
- Kendler et al. (1999): Causal Relationship Between Stressful Life Events and the Onset of Major Depression

**Additional reading**
- Kaplan & Sadock: Synopsis of psychiatry, chapter 15 Mood disorders
- Wittchen et al. (2003): Depressive episodes–evidence for a causal role of primary anxiety disorders?

1.11. Neurobiology of depression

**Presenter**
Background + JC: Laura Bohleber

**Background reading**
- Krishnan and Nestler (2008): The molecular neurobiology of depression.

**Journal club**
- Drevets et al. (1997): Subgenual prefrontal cortex abnormalities in mood disorders

**Additional reading**
- Heim et al. (2000): Pituitary-adrenal and autonomic responses to stress in women after sexual and physical abuse in childhood.

8.11. Anhedonia and reward

**Presenter**
Background + JC: Suraj Honnuraiah

**Background reading**
- Eshel and Roiser (2010): Reward and punishment processing in depression.

**Journal club**
- Tye et al. (2013): Dopamine neurons modulate neural encoding and expression of depression-related behaviour.

**Additional reading**
- Pizzagalli et al. (2005): Toward an objective characterization of an anhedonic phenotype: a signal-detection approach.
- Rottenberg et al. (2005): Emotion context insensitivity in major depressive disorder.
15.11. THE TREATMENT OF DEPRESSION

Presenter
Background: Prof. Dr. Heinz Böker
JC: Quentin Huys

Background reading
- Pharmacological: Stahl's essential psychopharmacology, chapter 11
- Neurosurgical: Andrade et al. (2010): Neurostimulatory and ablative treatment options in major depressive disorder: a systematic review

Journal club
- Rush et al. (2006): Acute and longer-term outcomes in depressed outpatients requiring one or several treatment steps: a STAR*D report.

Additional reading
- Mayberg et al. (2005): Deep Brain Stimulation for Treatment-Resistant Depression
Cognition & Neurobiology of Depression & Anxiety (22.11. - 13.12.)

22.11: Attention, Emotion and Memory in Depression & Anxiety

Presenter  Background + JC: Konstantinos Zeimpekis

Background reading

- Mathews and MacLeod (2005): Cognitive vulnerability to emotional disorders.
- Williams et al. (2007): Autobiographical Memory Specificity and Emotional Disorder

Journal club

- Harlé et al. (2013): The influence of emotions on cognitive control: Feelings and beliefs – where do they meet?

Additional reading

- MacLeod et al. (1986): Attentional bias in emotional disorders.
- Gotlib et al. (2004): Attentional Biases for Negative Interpersonal Stimuli in Clinical Depression

29.11. Serotonin in Depression & Anxiety

Presenter  Background + JC: Caroline Jahn

Background reading

- Ruhé et al. (2007): Mood is indirectly related to serotonin, norepinephrine and dopamine levels in humans: a meta-analysis of monoamine depletion studies.

Journal club

- Caspi et al. (2003): Influence of life stress on depression: moderation by a polymorphism in the 5-HTT gene

Additional reading

- Parsey et al. (2006): Lower serotonin transporter binding potential in the human brain during major depressive episodes.
- Lanzenberger et al. (2012): Prediction of SSRI treatment response in major depression based on serotonin transporter interplay between median raphe nucleus and projection areas.
- Harmer et al. (2004): Increased positive versus negative affective perception and memory in healthy volunteers following selective serotonin and norepinephrine reuptake inhibition.
- Smith et al. (1997): Relapse of depression after rapid depletion of tryptophan

6.12. Helplessness

Presenter  Background + JC: Kate Lomakina

Background reading

- Maier et al. (2006): Behavioral control, the medial prefrontal cortex, and resilience.
- Alloy et al. (1999): Depressogenic cognitive styles: predictive validity, information processing and personality characteristics, and developmental origins.
Journal club

- Amat et al. (2005): Medial prefrontal cortex determines how stressor controllability affects behavior and dorsal raphe nucleus.

Additional reading

- Warden et al. (2012): A prefrontal cortex-brainstem neuronal projection that controls response to behavioural challenge.

13.12. COGNITIVE CONTROL

Presenter Background + JC: Daniel Renz

Background reading


Journal club

- Lee et al. (2012): Amygdala-prefrontal coupling underlies individual differences in emotion regulation.

Additional reading

- Erk et al. (2010): Acute and sustained effects of cognitive emotion regulation in major depression.
- Johnstone et al. (2007): Failure to regulate: counterproductive recruitment of top-down prefrontal-subcortical circuitry in major depression.

20.12. FINAL EXAMINATION SESSION

10-min slots will be reserved for all those who programmed their own simulation addressing one of the topics discussed in the seminar. They will give a short presentation (5-10 min) of their code and results in the final session of the seminar.
EXERCISE: OPTION 1

In this exercise, you will be asked to code up a simple reinforcement-learning agent, and then to infer from observed behaviour what its learning parameters were. A reference book is Sutton and Barto (1998), and a brief overview set of slides is at http://quentinhuys.com/pub/Huys13-ACCN-RL-Theory.pdf.

GENERATING DATA

Consider a simple experiment like that in Pizzagalli et al. (2005), in which subjects are faced with a set of stimuli \( s \in S \), and for each stimulus have to choose one of a set of actions \( a \in A \). For each stimulus, a different action \( a \) is rewarded, i.e., if the subject chooses that action, then they receive a reward of size \( \rho \) with probability \( p(\rho; s, a) \), and otherwise no reward.

Consider now a simple Rescorla-Wagner-like learning model (Rescorla and Wagner, 1972). Agents are presented with a known sequence of stimuli, with stimulus \( s_t \), being presented on trial \( t \). On each trial \( t \), an agent chooses between one of two actions \( a_t \in \{0, 1\} \) according to a probability

\[
p(a_t) = \frac{e^{Q_t(a_t, s_t)}}{\sum_{a'} e^{Q_t(a', s_t)}}
\]

where \( Q_t(a_t, s_t) \) is the expected value of emitting action \( a_t \) in the presence of \( s_t \). It is an exponentially weighted average of past rewards which is updated, on each trial \( t \) on which action \( a_t \) is taken in the presence of stimulus \( s_t \) as

\[
Q_t(a_t, s_t) = Q_{t-1}(a_t, s_t) + \alpha(p r_t - Q_{t-1}(a_t, s_t))
\]

where \( r_t \) equals unity on trials on which a reward (of size \( \rho \)) was obtained, and 0 on other trials. The parameter \( \alpha \) is the so-called 'learning rate'.

First, assume there is only one stimulus and one action.

**Part 1:** Show analytically that for small \( \alpha \), \( Q \) tends asymptotically towards \( p(\rho; s) \).

**Part 2:** Derive analytically to the mean and variance of the distribution of \( Q_t \), given known values of \( \alpha, \rho \) and \( p(\rho; s) \). Assume \( Q_0 = 0 \). Note that the moment generating function for a Bernoulli random variable with probability \( p \) is \( p + (1 - p)e^t \).

**Part 3:** Generate a random sequence of length 300 by flipping a coin with probability 0.5. Let 0 indicate that stimulus 1 was presented, and 1 indicate stimulus 2. Generate a sequence of choices \( a_t \) with \( \rho = 2, \alpha = 0.2 \) and \( p(\rho = 1; s_1, a_1) = 0.8, p(\rho = 1; s_1, a_2) = 0.2, p(\rho = 1; s_2, a_1) = 0.2 \) and \( p(\rho = 1; s_2, a_2) = 0.8 \). Generate a plot of showing how the distribution of \( Q \) for the two actions, and the choice behaviour itself evolves.

INFERRING THE PARAMETERS

From the choice data you just generated, you will now infer the parameters \( \rho \) and \( \alpha \). Assume the outcome probabilities \( p(\rho; s, a) \) are known and \( Q_0 = 0 \).

**Part 4:** Given the probability of choices in equation 1, write down the total log likelihood of the entire sequence of choices.

**Part 5:** Maximise this log likelihood with respect to the parameters \( \alpha \) and \( \rho \). You may choose gradient ascent, or any other method of your liking. Show that you are able to recover the true parameters used to generate the data.

ANHEDONIA AND LEARNING IMPAIRMENTS

A key component of depression is anhedonia, a subjective sense that what used to be pleasurable no longer is. Tasks like that by Pizzagalli et al. (2005) have been used to try to measure anhedonia directly without having to rely on conscious verbal reports.
Also read Schultz et al. (1997). This paper argues that dopaminergic neurons in the ventral tegmental areal of the midbrain report the learning signal $\delta_t = r_t \rho - Q(a_t, s_t)$.

**Part 6:** Generate some more datasets of choices and run the inference again. What do you notice about your inference of $\alpha$ and $\rho$?

**Part 7:** Would anhedonia best be captured by $\alpha$ or $\rho$? Explain your reasoning. If dopamine reports the prediction error as suggested by Schultz et al. (1997), which parameter would a dysfunction of the dopaminergic system most likely affect?

**Part 8 - not compulsory:** design a task to optimize the ability of distinguishing between $\alpha$ and $\rho$.

**Submission option 1**

Please submit one archive containing:

- one pdf file with the answers to the questions and with graphs showing the results of the simulations.
- The code in matlab. It should be ready to run and produce all relevant figures without further input.

**Exercise: option 2**

Alternatively, you can develop your own model of one of the papers highlighted in red. This should be a mathematical model, with simulations in matlab.

**Submission option 2**

Please submit one archive containing:

- one pdf file with the description of your question, the model, and the results.
- The code in matlab. It should be ready to run and produce all relevant figures without further input.
REFERENCES


Mayberg, H., Lozano, A., Voon, V., McNeely, H., Seminowicz, D., Hamani, C., Schwalb, J.,


