PSYPRO4412

Long questions (Choose two of three, each counts as 40% of the final grade)

Question 1: What is computational psychiatry, and what is the point, if any?

Hva er beregningspsykiatri,(computational psychiatry) og hva er poenget, hvis noen?

Question 2: Provide an example each of a pure deficit model of delusions, a purely motivational model, and a combined model. McKay et al. argue that at least some delusions can only be explained by a combination of deficit and motivation. Can you judge whether that is always true, or whether there might be some delusions that require only a deficit or only motivation?

Gi et eksempel av underskuddsmodell for vrangforestillinger, et for motivasjonsmodellen og et eksempel for kombinasjonsmodellen. McKay et al. argumenterer for at enkelte vrangforestillingen kun kan forklares gjennom en kombinasjon av underskudd og motivasjonsmodellen. Kan du bedømme hvorvidt dette er alltid tilfellet eller hvorvidt noen vrangforestillinger kan forklares utelukkende ved bruk av underskudds eller motivasjonsmodellen?

Question 3: What kinds of impulsivity are there? Do the distinctions have real world implications?

Hva slags impulsivitet er det? Har skillene virkelige verdensimplikasjoner?

Short questions (Choose one of two, each answer counts as 20% of the final grade)

Question 1: What is the difference between actor-critic or habit learning and Q-learning, and why does that matter?

Hva er forskjellen mellom "actor-critic" eller vanelæring og Q-læring, og hvorfor betyr det noe?

Question 2: What are the consequences of different learning being context specific to different degrees? How do you define degree of context specificity?

SENSURVEILEDNING

Emnekode og navn: PSYPRO4412	**Semester / År / Eksamenstype:** Semester/ Skriftlig eksamen, x timer

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Hva er konsekvensene av at ulik læring er kontekstspesifikk i forskjellige grader? Hvordan definerer du grad av kontekstspesifisitet?

Relevant pensumlitteratur:

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12p

Bouton, M. E. (2014). Why behaviour change is difficult to sustain. *Preventive Medicine, 68*, 29-36. doi: 10.1016/j.ypmed2014.06.010

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Craske, M. G., Treanor, M., Conway, C. C. and Zbozinek, T. (2014). Maximizing exposure therapy: an inhibitory learning approach. *Behavior Research and Therapy, 58*, 10-23.

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Everitt, B. J. and T. W. Robbins (2016). Drug Addiction: Updating Actions to Habits to Compulsions Ten Years On. *Annual Review of Psychology*, 67(1), 23-50.

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Geraerts, E., Schooler, J. W., Merckelbach, H., Jelicie, M., Hauer, B. J. A. and Ambadar, Z. (2007). The reality of recovered memories. *Psychological Science*, **18(7)**, 564-568.

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Adams, R. A., Huys, Q. J. M. and Roiser, J. P. (2015). Computational psychiatry: towards a mathematically informed understanding of mental illness. *Journal of Neurology, Neurosurgery and Psychiatry, ?*, 1-11. doi: 10.1136/jnnp-2015-310737.

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Anderson, N. D. (2015). Teaching signal detection theory with pseudoscience. *Frontiers in Psychology*, **6**(762).

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Computational psychiatry, delusions, hallucinations, and rationality

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Waller, H., et al. (2015). Thinking Well: A randomised controlled feasibility study of a new CBT therapy targeting reasoning biases in people with distressing persecutory delusional beliefs. *Journal of Behavior Therapy and Experimental Psychiatry*, 48, 82-89.

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Computational psychiatry, impulsivity

Barrenoa, E. M., et al. (2019). Specific aspects of cognitive impulsivity are longitudinally associated with lower treatment retention and greater relapse in therapeutic community treatment. *Journal of Substance Abuse Treatment,* 96, 33-38.

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Caswell, A. J., et al. (2015). "Further evidence of the heterogeneous nature of impulsivity." Personality and Individual Differences **76**: 68-74.

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Chamberlain, S. R., et al. (2006). "Motor inhibition and cognitive flexibility in obsessive-compulsive disorder and trichotillomania." American Journal of Psychiatry **163**(7): 1282-1284. **3p**

Dalley, J. W., et al. (2011). "Impulsivity, Compulsivity, and Top-Down Cognitive Control." Neuron **69**(4): 680-694. **10p**

Mulder, M. J., et al. (2010). Basic Impairments in Regulating the Speed-Accuracy Tradeoff Predict Symptoms of Attention-Deficit/Hyperactivity Disorder. *Biological Psychiatry*, **68**(12): 1114-1119. **6p**

Taylor, M. R., et al. (2017). The Function of Reward Sensitivity and Temporal Discounting in the relationship between Risk and ADHD in Adults." *New Zealand Journal of Psychology*, **46**(1), 36-47. **9p**

Eksamenskrav:

Long questions (Choose two of three, each counts as 40% of the final grade)

Question 1: What is computational psychiatry, and what is the point, if any?

Hva er beregningspsykiatri,(computational psychiatry) og hva er poenget, hvis noen?

Computational psychiatry is a cognitive approach to mental health. Cognitive psychology is concerned with how minds do what they do, at the algorithmic level. The aim is to find a description of the rules and equations that can generate observed behaviour, ideally precisely enough to be able to reproduce that behaviour. Such rules and equations have quantitative parameters, and these differ between individuals. Examples of such parameters would be working memory capacity, or in the dot motion task non-decision time, drift rate, decision boundaries, and bias, or in Frith's theory, how much prediction error is overestimated. For contrast, the five personality dimensions are too vague to be considered computational parameters. Computational psychiatry assumes that there will be problems when computational parameters deviate enough from the average, and different patterns of deviations correspond to different mental health problems. The hope is that computational psychiatry will be able to achieve the following goals:

1) Revise diagnostic criteria. For example, Fair et al found that normally developing children showed six different multidimensional profiles in children diagnosed with ADHD, four of which were also found in normally developing children, and two more were subtypes of those four. That indicates that ADHD is not a single condition. Another example is that there are four different kinds of impulsivity. Gold et al.'s picture discrimination task can distinguish impairments in stimulus-response (model

free or actor-critic) learning from impairments in representing either positive or negative outcomes in response-outcome (model based or Q) learning. Problems with representing positive outcomes are associated with negative symptoms in schizophrenia, problems with representing negative outcomes are associated with pathological gambling.

2) Identify underlying mechanisms (at the algorithmic level) through measurement of computational parameters: for example, learning from positive or negative prediction errors; changes in bias, drift rate or decision threshold in the drift-diffusion model, depth of recursion in the stag-hunt game, sensitivity to fairness in the trust game; four kinds of impulsivity. Again, a contrast may help. Schizophrenia has been described as a disorder of dopamine. Yet there is nothing inherent to the molecule dopamine that makes it so. If an animal could be genetically engineered so that all dopaminergic signalling were replaced by cholinergic signalling, and vice versa, the engineered animal should behave exactly as the original wild type. What matters is what role dopamine plays, not that is is dopamine which plays this role. And the role, the function, is the concern of an algorithmic level or functional description. Likewise, it does not matter what the underlying physiological basis of, for example, temporal discounting is. Changing the temporal discounting rate has the same consequence no matter what the hardware is.

3) Assess specific effects of treatment on those more precisely identified mechanisms. We have no specific examples in the pensum. A student may bring in information from the biological psychology course, on there being multiple kinds of ADHD, and they do not respond in the same way to Ritalin. It should not matter whether kinds of ADHD are identified by EEG markers or by behavioural tests. If they can be distinguished, that can be used to find out whether a treatment that seems to have a modest success rate for a broadly defined condition might be very successful in treating a more precisely diagnosed condition.

4) Perhaps use such assessments to design new treatments (not done yet as far as I know). For example, reduced ability to represent positive outcomes is found in schizophrenia patients with negative symptoms. Reduced ability to represent negative outcomes is found in gamblers. If behavioural treatments can be found that selectively changes these parameters, patients could be brought back closer to the normal range. If the parameters at the algorithmic level can be linked to specific aspects of physiology, that could lead research into more precisely targeted drugs, or neurofeedback treatments.

Question 2: Provide an example each of a pure deficit model of delusions, a purely motivational model, and a combined model. McKay et al. argue that at least some delusions can only be explained by a combination of deficit and motivation. Can you judge whether

that is always true, or whether there might be some delusions that require only a deficit or only motivation?

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Sensorveiledning: An example of a purely motivational account of a delusion is the proposal that the Fregoli delusion, mistaking a stranger for a familiar person, such as the patient's dead father, is the result only of a strong wish that the father were still alive. Signal detection theory can be used to illustrate that a change in the subjective evaluations of the consequences of true and false positives and negatives also changes the where the optimal decision criterion is. Extreme evaluations lead to extreme biases, which may be dysfunctional enough to be called delusions. Higher incidence of persecutory delusions in members of disadvantaged groups is a plausible candidate for that kind of motivational factor, seeing that these people are more likely to be discriminated against, and missing a plot against them may have more severe consequences.

However, McKay et al. first propose that that there may also be cognitive deficits. For example, if people's voices seem to be fainter than they used to be, it could be that one's hearing is failing, or that people are whispering because they are conspiring. Someone may wish to believe that their faculties are not failing. That could be a motivational factor. If the patient needs to turn up the volume on media, if bird song seems fainter, and rainfall, and all sorts of other sounds that can be expected to have remained as loud as they used to be, then believing in the conspiracy is implausible, and evidence for a cognitive deficit as well.

Second, McKay et al. propose that the existence of a second factor can be inferred if there are people who have a deficit that is associated with a delusion, but they lack that delusion. If the people who suffer from the delusion share both the first and a second factor, and the second factor alone is not enough to produce the delusion, then both factors are needed. (This translates to an interaction between first and second factor.)

Two factor accounts of the Fregoli and the Capgras delusion can differ in what kinds of factors they depend on. For the Fregoli delusion a first deficit in face processing leads to exaggerated feelings of familiarity and affect, and in the Capgras delusion a lack of familiarity and affect. The second factor in both is a deficit in belief evaluation, allowing bizarre beliefs to gain credence. These would be examples of two cognitive deficits.

Frith's explanation of delusions of control depends on one clearly cognitive deficit, the overestimation of prediction error, and a second factor, the overattribution of agency that could be argued to be either a cognitive deficit or a motivational factor. Deciding that would need more information on attribution of agency.

McKay et al. say that persecutory delusions are associated with two factors, namely high overt and low covert self esteem, and high need for closure (some facets only). They describe both as motivational factors.

In summary, McKay et al. list two factor accounts of several delusions. Adding in McKay's account of persecutory delusions following from deafness, and one interpretation of Frith's account of delusions of control, the proposals include accounts proposing two cognitive impairments, one cognitive and one motivational factor, or two cognitive factors.

Although McKay et al. only discuss theories with up to two factors, there is no guarantee that this is universal. There may well be delusions that are caused by a single factor, and others that only occur when more than two factors coincide.

Question 3: What kinds of impulsivity are there? Do the distinctions have real world implications?

Hva slags impulsivitet er det? Har skillene virkelige verdensimplikasjoner?

Sensorveiledning: Wiecki et al. list four kinds of impulsivity. The better students may notice something Wiecki et al did not mention: temporal or delay discounting, reward sensitivity and speed accuracy trade-offs apply to decisions with outcomes that are delayed over a wide range of time intervals, from less than a second to centuries. Failures of inhibition apply to responses typically less than a second delayed.

Caswell et al. initially describe three kinds of impulsivity, and their factor analysis indicates there are four. Two of these are also in Wiecki et al.'s list, a further two are different, but not precisely specified. The pensum thus describes six kinds of impulsivity, of which four are clearly explained:

1) Temporal discounting (what Caswell et al. call temporal impulsivity) is treating events as less important the more they are delayed. The standard procedure to estimate temporal discounting is to offer a choice between one fixed and once variable amounts, at one fixed and one variable delay. For example, offered a choice between two new 100 kr bank notes right now, one should be indifferent between the two. Next, offer 100kr tomorrow, and vary the alternative amount offered right now until finding the indifference point, say 90 kr. Then offer 100 kr in two days, and again find what amount is subjectively worth the same if paid immediately, say 82 kr. That variable amount indicates how much the 100 kr are worth at the delay that has been specified. The steeper that temporal discounting is (the more subjective value declines with delay), the greater the preference for an immediate over a delayed reward. Steep temporal discounting is one of the kinds of impulsivity associated with ADHD, and with nicotine use.
2) Reward sensitivity refers to how much people are motivated by positive as opposed to negative outcomes. It can be measured by learning tasks involving gains and

losses, and checking to what extent choices are explained by memory for either gains or losses. Greater sensitivity for losses is associated with the negative symptoms of schizophrenia, greater sensitivity for gains with pathological gambling, and with ADHD. Reward sensitivity is not one of the four factors identified by Caswell et al.

3) Speed accuracy trade-offs occur in sequential sampling tasks in which people can choose how much data they sample before making a decision. Because the rate at which data become available is not, or not entirely, available under one's own control, gathering more data takes more time. That forces a trade-off between speed, a fast decision relying on les data, and accuracy. Examples of sequential sampling tasks in the laboratory would be the random dot motion task, the beads task, or the box task. Examples of real life sequential sampling problems would be deciding where to go on holiday, or whether to propose marriage. People with ADHD adjust speed, and consequently the amount of data gathered, less than controls in response to task demands. Impaired speed accuracy trade-off is associated with greater risk of being a perpetrator or victim of violence

4) Motor impulsivity corresponds to failure of inhibition, as measured by the stop signal task or the Stroop task. Real life examples would be inability to stop oneself from making inappropriate remarks. This is factor 1 of Caswell et al.'s analysis. Motor impulsivity does occur in ADHD. Chamberlain et al. found reduced motor inhibition, as measured by the stop signal task, in both OCD and trichotillomania (compulsive hair pulling). The conditions differ in that OCD sufferers also show less cognitive flexibility.

5) Caswell et al. describe reflection impulsivity as involving a general preference for speed. The task they use to measure it does have speed and an accuracy version, but their analysis seems to be not sensitive to speed accuracy trade-offs. Reflection impulsivity seems to correspond to the jumping to conclusions bias in the beads task shown by schizophrenia patients, not an impaired speed accuracy trade-off. However, the link between reflection impulsivity and jumping to conclusions is not confirmed by empirical data, and therefore students are not expected to go into detail.

6) Caswell et al.'s third factor is measured by the immediate memory task, which does not seem to measure and it is not even clear why it is considered a measure of impulsivity. Therefore students are again not expected to go into detail.

Dalley et al. found that drug taking in humans is associated with a questionnaire-based measure of impulsivity, and with one aspect of sensation seeking. Rats bred for impulsivity consume more cocaine than rats bred to be less impulsive, and worked harder for nicotine and sugar.

There is some evidence that different kinds of impulsivity are selectively associated with different real world problems. It is less clear, from the material in the pensum, how impulsivity is associated with mental health conditions. Wiecki et al. mention some kind of impulsivity being associated with ADHD, OCD, Tourette's syndrome, substance abuse, gambling, and eating disorders. It is less clear how specific those associations are, because patients with a particular condition may not have been tested for all kinds of impulsivity. ADHD is associated with all four kinds of impulsivity mentioned by Wiecki et al. Gambling, OCD and trichotillomania are mentioned in connection with only one kind of impulsivity each, but either patients were only tested for one kind, or it is not clear whether there were other tests.

Short questions (Choose one of two, each answer counts as 20% of the final grade)

Question 1: What is the difference between actor-critic or habit learning and Q-learning, and why does that matter?

Hva er forskjellen mellom "actor-critic" eller vanelæring og Q-læring, og hvorfor betyr det noe?

Sensorveiledning: In actor-critic (model-free, stimulus-response, habitual) cognition, you choose whatever response has been best rewarded in the past in this situation, while this stimulus was present.

For example, if you learn to find your way around by actor-critic learning, you just know that in the presence of *this* stimulus (this place), you choose the response of going in *this* direction, without knowing where that will take you, what you will find at the end of this chain of stimulus-response associations, or how long it takes to get there. Or you might habitually prepare a food that you don't like any longer because the last time you ate it, you became violently ill. Stimulus-response learning does not represent the outcome, and so it is not immediately sensitive to changes in the value of the outcome. Only new (and slow) learning can change the response.

In Q learning (model-based, response-outcome or stimulus-(response-outcome) or goal-directed cognition), experience is compiled into a (possibly hierarchical) generative model of the world—a mechanistic, causal understanding of the causes and consequences of actions and events. When faced with a particular situation, this model can be searched, and the quality of various behaviours deduced—even if they have never been tried or experienced. As this involves somehow simulating or inferring future possibilities, it can have high computational costs.

For example, if you learn to find your way around by associating a stimulus with a response-outcome association, meaning you represent the *value* or *quality* of the outcome, you can

plan your path. If you are in the presence of *this* stimulus (you are *here*), you can say that if you perform *this* response (go in *this* direction) you will experience *this* outcome (end up in *this* place). Then you can take this imagined outcome as the stimulus for a new stimulus-(response-outcome) association, and so simulate a whole chain of actions.

One reason why the difference matters is that Q-learning, which represents the outcome, is immediately sensitive to changes in the value of the outcome. Therefore persuading client that an outcome is not desirable should quickly change behavior. The actor-critic learning system, however, will need to be retrained by actively monitoring habits (mindfulness) and substituting good new habits for the old, bad habits until the new habits stick.

Further, specific impairments have distinct outcomes. Impairment in representing positive outcomes in Q-learning is associated with negative symptoms in schizophrenia, while giving excessive weight to positive outcomes is associated with one form of impulsivity.

Question 2: What are the consequences of different learning being context specific to different degrees? How do you define degree of context specificity?

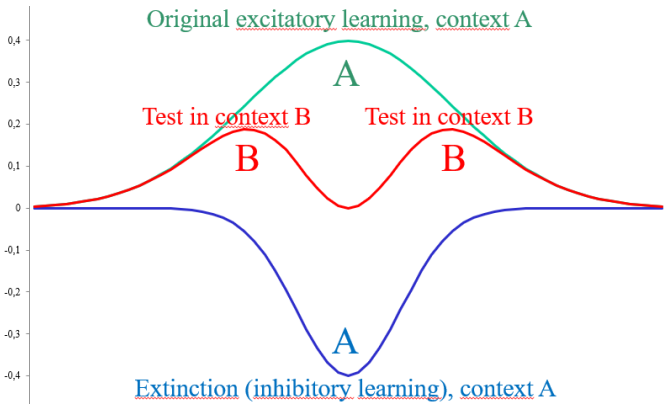
Hva er konsekvensene av at ulik læring er kontekstspesifikk i forskjellige grader? Hvordan definerer du grad av kontekstspesifisitet?

Sensorveiledning: Learning is context specific to the extent that behavior differs between the context in which behavior was learned and the context in which it occurs, or fails to occur, later. For example, if an association between a stimulus and outcome is learned in context A, then context specificity means that the relationship between stimulus and outcome is treated as valid in context A, but as uncertain in other contexts.

Extinction training (reducing the probability of the stimulus being followed by the outcome) can lead to the learning of new inhibitory associations. That means a new association between the stimulus and the *absence* of a relevant outcome. When the new inhibitory association is combined with the old excitatory association, the net outcome is reduced or zero expectation of the outcome.

Renewal after extinction training is the recovery of a response after a change of context. ABA renewal can be explained purely qualitatively: there is less confidence that the outcome expected in the learning context A will also occur in B, and so even if extinction training creates an inhibitory association that there is no response (and presumably no expectation), the inhibitory association does not need to be as strong as the original excitatory association in context A. On return to the context A for testing, the already weaker inhibitory learning also generalizes only to a limited extent, so the original excitatory learning is stronger. A similar argument can be made for ABC renewal.

Explaining AAB renewal requires the additional assumption that inhibitory associations are more strictly context specific than excitatory associations. If context is treated as continuously variable, meaning it is possible to say *how* different two contexts are, then greater context specificity means a narrower generalisation gradient, that responding declines faster for inhibitory associations as context changes. Then the inhibitory learning needed to counter the original excitatory learning needs to be as strong as that excitatory learning, but because it generalises less than the excitatory learning, more of the excitatory is left in somewhat different contexts.



Betegnelse	Generell kvalitativ beskrivelse av vurderingskriterier	Fagspesifikk beskrivelse med relevans for vurdering av besvarelser/arbeider med bestått/ikke bestått
Bestått	Kunnskapsmengde (teoretisk/empirisk) Innsikt (oversikt/forståelse) Fremstilling (struktur/begrepsapparat) Bruk (selvstendighet/originalitet)	Besvarelsen/arbeidet reflekterer tilstrekkelig relevant kunnskapsmengde og oversikt/forståelse av fagområdet. Besvarelsen/arbeidet er strukturert og har et noenlunde konsist begrepsapparat. Besvarelsen/arbeidet dokumenterer en viss grad av selvstendighet og evne til å trekke egne konklusjoner.
Ikke bestått	Mangler vesentlige kunnskaper. Utilfredsstillende fremstilling med klare feil og mangler	Besvarelsen/arbeidet reflekterer dårlig generell kunnskap og/eller faller på siden av oppgaven. Fremstillingen er ustrukturert, mangler oversikt over fagområdet og inneholder mange direkte feil.

Faglærer / oppgavegiver:

Navn: Robert Biegler
Sted / dato: Trondheim, 19.05.2021