Bokmål: Studenten skal jobbe individuelt og besvare 3 av de følgende 5 oppgavene:
English. The student should work individually and answer 3 of the following 5 tasks:

OPPGAVE/ TASK 1

Bokmål

Narrativ presenteres som ett av de fire systemene som Rubin inkluderer i det atferdsmessige grunnlaget for selvbiografisk hukommelse (Rubin, 2006). Hva er betydningen av narrativ i selvbiografisk hukommelse? Hva er funksjonene som gjør narrativ viktig for selvbiografisk hukommelse og sin utvikling?

English

Narrative is presented as one of the four systems that Rubin includes in the behavioral basis of autobiographical memory (Rubin, 2006). What is the importance of narrative in autobiographical memory? What are the features that make narrative important for autobiographical memory and for the its development?

Sensorveiledning: Narrative establishes a major form of organization in autobiographical memory, providing temporal and goal structure. Autobiographical memories are usually recoded as narrative. Narratives are told to another person and to oneself. Inclusions and exclusions depend in part on the narrative structures used. Information that is not central to the narrative structure of the schema being used is less likely to be remembered than information that is more central. Flashbulb memories tend to include canonical categories of information, such as the place, the ongoing event that was interrupted by the news, the source of the news, affect in others, affect in self, and the aftermath. These categories may be properties of the narrative genre used to report any news, rather than properties of flashbulb memories per se. There has been considerable research on the role of narrative in autobiographical memory. Research has been focused on autobiographical reasoning, narrative structure and development, narrative coherence, and visual imaginary. These are all important factors in the formation of autobiographical memories. Autobiographical reasoning is the process by which autobiographical memories are combined into a coherent life story and related to the current self. The content of story memories depends on whether and how they are told to others, and these reconstituted memories form the basis of the individual's remembered self. Children must have the ability to create narrative structure in recollection before they develop autobiographical memory. Narrative may be especially important for the development of autobiographical memory, and thus is a limiting factor. Narrative structure is also central to recollection in groups and to the shared memories that define them. Narrative coherence is often claimed to be reduced in individuals with schizophrenia and posttraumatic stress disorder, but more evidence is needed to support this claim for PTSD. Narrative is often important because it is used to communicate to other people the information that is in other systems, such as visual imagery, rather than because of its intrinsic value. The experience of having an image is linguistically marked in narrative. For example, the linguistic dimension of involvement is marked by the use of first person and dialogue, and we use these same properties to infer that other people are reliving an experience.

OPPGAVE/ TASK 2

Bokmål

Gjør rede for utviklingen av den menneskelige hjernebarken fra gastrulasjon og neurulasjon til apoptose og beskjæring. Hvilke, om noen, kliniske tilstander skyldes avvikende kortikal utvikling? Skyldes noen kliniske tilstander avvikende kortikal utvikling, i så fall hvilke?

English

Describe the development of the human cerebral cortex from gastrulation and neurulation to apoptosis and pruning. What, if any, clinical conditions result from aberrant cortical development?

Sensorveiledning: The candidate should cover most of the following topics: gastrulation, neurulation, neural proliferation (incl. asymmetric vs. asymmetric mitosis), neuronal migration, cortical organization/ specialization, cortical arealization, synaptogenesis, cell death (apoptosis), pruning, and myelination. The candidate should know what the primary and secondary vesicles are, and how the different parts of the CNS develop from the neural tube.

[E1 = embryonic day 1; GW1 = gestational week 1]

There are nine months (40 weeks) of human gestation, commonly divided into three *trimesters*. First comes the embryonic stage, and some define the first two weeks as pre-embryonic. As we enter the last third of the first trimester, in Week 9 the fetal stage begins; now the brain starts to take shape and it grows until birth, when all its various parts are in place. The brain continues to grow after birth, and the first 2-3 years it increases dramatically in size. Thereafter, it grows steadily but less dramatically until approx. 11-12 years of age, when it has reached adult size even though the rest of the body keeps growing. Myelination likely continues into young adulthood.

Gastrulation: Takes place in Week 2 – this is cellular differentiation. Three cellular layers are created from Embryonic stem cells: Ecto-, Meso-, Endoderm. Mesoderm turns into skeleton, muscles, cardiovascular system; Endoderm becomes the inside of the respiratory system and gastrointestinal tract ; Ectoderm becomes the nervous system- and the skin. The neural plate is formed on the back of the embryo (dorsally), where neural stem cells begin to grow.

Neurulation: The neural tube closes on E22-E27 (i.e., during the fourth week of gestation). Thus, the central nervous system is initially a tube, but at the rostral end the primary vesicles take shape, which is what becomes the brain stem, midbrain and cerebrum. At the caudal end, the tube remains more evenly shaped, this is what will be the spinal cord. At the same time as neurulation is happening, neurogenesis starts on the inner linings of the tube, i.e., the formation and proliferation of neurons.

Neural proliferation is the formation of neurons, neurogenesis. This takes place in the "ventricular zone" (VZ) in the hollow insides of the neural tube (what will become the walls of the cerebral ventricles). The VZ is so named because it lines the the inside of the developing ventricles, which contain cerebrospinal fluid (CSF). The embryonic ventricular system contains growth factors and other nutrients needed for the proper function of neural stem cells. The primary neural stem cells of the brain and spinal cord, termed radial glial cells, reside in the VZ. A secondary proliferative zone, the subventricular zone (SVZ), lies adjacent to

the VZ. In the embryonic CNS, the SVZ contains intermediate neuronal progenitors that continue to divide into post-mitotic neurons. Through the process of neurogenesis, the parent neural stem cell pool is depleted and the VZ disappears.
Glial cells are also formed roughly in the same period, only a little later. Radial glial cells have important roles as neural progenitors and also have an important guiding function in neuronal cortical migration. Neurogenesis/proliferation starts with symmetric cell division on day E21 (week4), and asymmetric begins on day E42 (week 7) and is completed around the middle of the second trimester (ca. E108 or GW 15 ½).
At this time, the primary vesicles start to appear (E28, GW5) and in GW8, the secondary vesicles become visible.
Symmetric/asymmetric mitosis: Radial glia are now recognized as key progenitor cells in the developing nervous system. During the late stages of neurogenesis, radial glial cells divide asymmetrically in the ventricular zone, generating a new radial glial cell, as well as a postmitotic neuron or an intermediate progenitor (IPC) daughter cell. Intermediate progenitor cells then divide symmetrically in the subventricular zone to generate neurons.
So: First, cell division is *symmetrical*, that is, a radical glial cell/neural progenitor cells becomes two new progenitor cells. After the switch to *asymmetrical division* (which begins on E42), the progenitor cell produces one new progenitor cell and one postmitotic neuron in the subventricular zone (or an intermediate progenitor, which continues symmetrical cell division in the subventricular zone). In asymmetric cell division, the daughter cell lies "on top" of the mother cell so the column grows vertically. More rounds of symmetrical cell division lead to horizontal growth, and thus more cortical columns, which means increased surface area, whereas more rounds of asymmetric division will result in thicker cortex. The timing of this transition is therefore important, since a delayed transition will yield a large cortical surface area. The timing is genetically controlled, and it varies across species, which probably affects the surface area of the cerebral cortex. The genes in mice have been manipulated so that the transition switch is delayed, and that leads to a doubling of the surface of the cortex in those mice. It is first and foremost the surface of the cerebral cortex that has increased dramatically in human evolution; we primarily have a large surface not thicker cerebral cortex than other large mammals.
Neuronal migration: Newborn neurons in the VZ must migrate substantial distances to their final destination in the developing brain or spinal cord where they will establish neural circuits. Migration occurs between the fourth and fifth months (GW 13-20) of pregnancy. It must be timed right, and the neurons must reach the correct destination. The migration takes place inside-out, the deepest cortical layers first (except lamina 1, which is the preplate), then 5, 4, 3 etc. Some students may mention: There are roughly speaking two modes of cortical migration; somal translocation and glia-guided locomotion (by far the most common, 75-90%).
Organization/specialization: After having reached their destination in the developing cerebral cortex, the neurons specialize. There is a certain degree of plasticity here, so neurons that have arrived at the wrong location, can be reprogrammed and adapt. How the nerve cells group, and emit axons, is mainly genetically determined. The size of the neuron, the shape of the dendritic tree and the expression of transmitter substances and receptors are determined

by the genome of the cell. However, final specification of the neuron also depends on the influence of other neurons and the appropriate use of the neuron The nervous system is plastic, structure and performance may change in response to changing requirements (i.e., use).

Synaptogenesis: The neurons start forming connections with other neurons and synaptogenesis begins. This is how the brain's networks are built.

Apoptosis: Most neurodevelopmental events involve the proliferation of neural elements, but two important processes involve substantial loss of neural elements (apoptosis and pruning). Apoptosis is naturally occurring (programmed) cell death, affects both the neural stem cells in the ventricular zone, and unused cortical neurons. Neural progenitors have a time-limited function and are supposed to die. The neurons that survive are those that are functional, i.e., , the ones that have active connections (synapses), these are protected by trophic factors. More precisely, the neurotrophic hypothesis is that neurotrophic factors are produced by efferent neurons at the level of the synapse, and are taken up by the afferent neuron's receptors, which this leads to the neuron's survival.

Apoptosis involves the normal loss of 50% or more of the neurons within a brain region up to 70% in some cortical regions. It is a well-understood cell-intrinsic process that involves a cascade of gene expression that ultimately results in the breakdown of nuclear chromatin (DNA and support proteins) and the fragmenting of the cell. All neurons and neural progenitor cells (as well as many other types of cells) have this intrinsic "suicide" program. The set of genes involved in the apoptotic cascade is large, but very specific, and each molecular signal triggers the next step in the cascade.

Apoptosis is mainly a prenatal process for neurons, but it is a postnatal process for glia cells. Glia cells both differentiate and specialize later and die later.

Pruning: There is a reduction in synaptic connections by mid-adolescence, which is experience-dependent in that unused synapses are eliminated. It varies from region to region when it happens, and not all regions have been surveyed. But in the human frontal lobes, there is a lot of elimination just before and during puberty. Much is completed by the end of puberty, or adolescence, but in the prefrontal cortex it has been found to be ongoing in the late twenties (see Petanjek et al., 2011).

The student may also speculate on why we produce that many synapses in the first place? Large excess of synapses is assumed to be favorable during periods of high plasticity. Humans are only to a very limited extent born with ready-made behavioral programs, We are characterized by enormous behavioral flexibility and learning ability. In our case, evolution has favored that over "secure" pre-programming of synaptic links. Overproduction of synapses is hardly found in animals with less developed cerebral cortex. However, also within the same species there is variation between wild and domestic animals, which shows experience affects the process; then wild animals have larger brains and dendritic branches than domesticated animals of the same species; probably because life in the wild places greater demands on learning.

Myelination: Myelination begins in the second trimester (18 weeks), is mostly completed at the age of 2-3, especially in the motor and sensory pathways and spinal cord. All parts of the

brain are myelinated by age 2-3, but successive rounds of myelination continue in the brain beyond that age. Especially in the association regions of the cerebral cortex, in the frontal lobe and in the front of the temporal lobe, myelination may continue into the 20s. The association cortex is myelinated during the first 4 months after birth, but there is *further* myelination after that, of already myelinated not new (unmyelinated) pathways. The pyramidal tracts are not fully myelinated until the age of two, which explains the uncontrolled nature of infant movement.

- Myelination order:
    - Vital functions first
        - Swallowing reflexes, pain, emptying reflexes for bladder and rectum
    - Around 6 months: Sensory and motor pathways in the spinal cord and cranial nerves
        - The spine: superior -> inferior
    - Cerebral cortex: starts just prior to birth (incl. nervus opticus); continues into the 20s – at least in the frontal lobes
        - Primary sensory / motor bark areas first: posterior -> anterior

Cortical arealization: The candidate should be rewarded for discussing the protomap hypothesis (including the radial unit hypothesis) vs. the protocortex hypothesis.

Among the clinical conditions that can be mentioned are:

Anencephaly: If the neural tube does not close rostrally, a very serious condition arises where the fetus does not develop a brain. Anencephaly is a lethal condition; death occurs either before or shortly after birth. This is why pregnant women are recommended to take Folic acid every day (which is a B -vitamin).

Spina bifida: If the neural tube does not close caudally, a condition arises which in the most severe cases leads to paralysis. Spina bifida might cause physical and intellectual disabilities that range from mild to severe.

Primary microcephaly: Is caused by mutations in 5-6 genes critical for normal cell division of neural progenitors, leading to reduced cortical area. Inbreeding increases the risk.

Lissencephaly: The brain has a smooth surface; results from disturbed migration.

Other disorders of neuronal migration include undermigration, overmigration or ectopic migration (wrong placement) of the neurons.

OPPGAVE/ TASK 3

Bokmål

«Zoom fatigue» refererer til opplevelsen av å være utslitt med videokonferanser. En artikkel i The New York Times inkluderte følgende sitat om audiovisuell synkronitet og Zoom fatigue.

> "Hjernen vår genererer prediksjoner og når det er forsinkelser, eller ansiktsuttrykkene er frossne eller ikke synkroniserte, som kan skje på Zoom og Skype, oppfatter vi det som en prediksjonsfeil som må løses," ... "...aspekter ved våre prediksjoner blir ikke bekreftet, og det kan bli utmattende." (april 2020)

Forklar hvordan Bayesiansk teori kan redegjøre for den ekstra perseptuelle anstrengelsen når audio-video synkroniseringen er variabel i video-konferanser. Med dette som grunnlag, forklar

hvordan du ville forvente at Zoom fatigue ville bli påvirket om variasjon i audiovisuell synkronisering kunne fjernes i videokonferanser.

English

"Zoom fatigue" refers to the experience of being exhausted with video conferencing. An article in The New York Times included the following quote about audio-visual synchrony and Zoom fatigue.

> "Our brains are prediction generators, and when there are delays or the facial expressions are frozen or out of sync, as happens on Zoom and Skype, we perceive it as a prediction error that needs to be fixed,"… "… aspects of our predictions are not being confirmed and that can get exhausting." (April 2020)

Explain how Bayesian theory can account for the extra perceptual effort when audio-video alignment is variable in video conferencing. With this as a basis, explain how you would expect Zoom fatigue to be affected if variation in audiovisual synchrony could be eliminated in video conferencing?

Sensorveiledning: The task has two parts, where a good response in Part 2 is dependent on being able to respond to Part 1. Being able to respond to only Part 1 is not an adequate response for the task.

Part 1

A Bayesian approach offers insight into extra effort with variable audio-video alignment in two ways: in the development of the expectations, and the extra effort with accommodating variable challenges to those expectations.

First, Bayes offers a basis for understanding how a perceiver develops expectations for audio-video alignment. The student should explain that with experience with the co-occurrence of audio and video sensory information, probabilities are dynamically developed, and form the basis for expectations (priors). These probabilities can be used to represent the degree of belief in different propositions and therefore the rules of probability can be used to update beliefs based on new information. Extensive experience with audio-visual synchrony perception fine-tunes and strengthens these expectations.

With audio and video temporal misalignment, the stimulus would be highly inconsistent with the strong pre-established expectation. Nevertheless, if audio-video misalignment would continue consistently, audio-visual expectations would adjust to gradually approach accommodating that misalignment. However, if audio-visual alignment is variable, as in video conferencing, the temporal expectations become weakened with inconsistent timing and cannot be relied on, which in turn leads to more effort used in perception.

Part 2

With a basis solely in a Bayesian approach, if variation in audio-visual alignment could be eliminated in video conferencing, we would expect Zoom fatigue to be reduced or eliminated. This is because, with each incoming experience with audio-visual alignment would consistently be synchronous, such that expectations for audio-visual alignment would be dynamically reinforced, rather than weakened. This predictability would reduce the cognitive effort associated with audio-visual alignment, and thereby potentially reduce Zoom fatigue.

A strong answer could take different forms, including, for example, an especially rich description, or a response going into depth in Bayesian theory.

OPPGAVE/ TASK 4

Bokmål: Forklar begrepet "arvbarhet" og grei ut om begrensninger ved begrepet. Gjør rede for hvordan læring er, og er, ikke arvbart.

English: Explain the term "heritability" and clarify the term´s limitations. Discuss how learning is, and is not, heritable.

Sensorveiledning: Heritability is a measure of the degree of phenotypic variance that is due to genotypic variance. The term is only applied to the population in the study and is only an estimate of the genetic part of the variation in a population. Heritability can change over time if other influences change, and estimates can be different in different populations, even for the same trait (e.g., if environmental variance increases, heritability decreases; if environmental variance decreases, heritability increases).

Limitations

Heritability estimates say something about explained variance at group level, and not something about individuals (heritability of, for example .4 tells us that 40% of individual differences we observe for the trait can be attributed to genetic individual differences in the group).

Heritability estimates are influenced by both the population's genetics and the environment. If something is genetically determined, there may still be low heritability (evolutionary adaptations - two bones are hereditary but have almost zero heritability as there is no variance in the trait).

The heritability estimate will increase the more the population is exposed to an equal environment: Ex. 1: PTSD - if everyone has been exposed to war then the variance will not be due to environmental factors. Ex. 2: Height - if you generally have good nutrition, genes will explain more of the variance.

The heritability estimate therefore only applies to the studied population.

Learning and heritability

The discussion may take various perspectives. As s starting point the response should include that research using DeFries-Fulker (DF) extremes analysis, which assesses genetic links between extremes and the normal variation, shows linearly increasing heritability of intelligence from infancy (20%) through adulthood (60%). Furthere points may discuss that research indicates substantial heritability of cognitive disabilities (e.g., language, mathematical, general learning disability, reading disability). However, based on DF extremes, severe intellectual disabilities appear to be etiologically distinct from the normal distribution of intelligence. Other issues and examples can be brought into a good response.

The most important point of heredity estimates has been to establish that genes actually influence, and in many cases are crucial to, the development of psychological traits and abilities.

OPPGAVE/ TASK 5

Bokmål Gjør rede for Ioannidis argument om at det meste av forskning som publiseres er feilaktig. Betyr dette at vi skal forkaste forskning og bli postmodernister?

English

Discuss Ioannidis' argument that most published science is wrong. Does it mean we should all abandon research and become postmodernists?

Sensorveiledning: It is not satisfactory if a student just lists Ioannidis' conclusions, without explaining how he or she arrived at those conclusions. Such an explanation will have to involve application of Bayes' theorem. However, it is not necessary to use Ioannidis' nomenclature. A specific example using Gigerenzer's approach will be just fine. The crucial numbers are the prior odds of a hypothesis being true, the detection rate (statistical power, or 1 – Type II error rate) and the false alarm rate (the level of statistical significance, conventionally $p \leq 0.05$).

If we then assume prior odds of 1:1, adopt the conventional significance level of 0.05, and assume a detection rate of 0.7, we can calculate the posterior probability of the hypothesis being true. Think of 1000 tests of experimental hypotheses with those prior odds. If they distribute exactly according to probabilities, 500 of those hypotheses will turn out to be true, and 500 wrong. With statistical power or detection rate being 0.7, 350 tests of true hypotheses will have a statistically significant result. However, 5% of the 500 false hypothesis will also produce a statistically significant result. That means 350 out of 375 significant results come from true hypotheses. The probability of a hypothesis being true, given a positive result, is 350/375 = 0.9333. Ioannidis calls that the positive predictive value. Here is the same calculation in Gigerenzer's table format.

If the prior odds are lower, for example 1:9, fewer true hypotheses can contribute to the positive results, while there will be more false hypotheses producing false alarms. The second calculation shows that if 70% of the now only 100 true hypotheses give positive results, and 5% of the now 900 false hypotheses, positive predictive value of a statistically significant result is only 0.609. Then nearly 40% of positive results would be false.

Ioannidis doesn't discuss whether demanding a more rigorous level of statistical significance could improve the situation. The better students may examine this question anyway. The table on the right shows the consequence of asking for $p < 0.01$. This must reduce detection rate, because shifting the decision criterion only trades the two types of error against each other. The students don't have a principled way of determining what the new detection rate might be, so any arbitrary value will do, though recognizing that it should be a lower value would be a good thing. Anyway, if we assume that the 1% false alarm rate comes with a 44% detection rate, the positive predictive value for prior odds of 1:9 turns out to be 0.83. There is a price for increasing the probability that a hypothesis claimed to be true really is true: more than half of true hypotheses are being rejected.

Odds of true hypothesis = R = 1:9, base rate = $\frac{R}{R+1}$ = 10%
Detection rate = statistical power = 1 – β = 43.8% if β = 0.562
False alarm rate = α = 1%

True Relationship?	*Positive result*	*Negative result*	*sum*
Yes	**44**	**56**	**100**
No	**9**	**891**	**900**
	53	**947**	**1000**

Positive Predictive Value (PPV) = 44/53 = 0.83

Odds of true hypothesis = R = 1:1, base rate = $\frac{R}{R+1}$ = 50%
Detection rate = statistical power = 1 – β = 70% if β = 0.3
False alarm rate = α = 5%

True Relationship?	*Positive result*	*Negative result*	*sum*
Yes	**350**	**150**	**500**
No	**25**	**475**	**500**
	375	**625**	**1000**

Positive Predictive Value (PPV) = posterior probability statistically significant result is true = 350/375 = 0.93333

Odds of true hypothesis = R = 1:9, base rate = $\frac{R}{R+1}$ = 10%
Detection rate = statistical power = 1 – β = 70% if β = 0.3
False alarm rate = α = 5%

True Relationship?	*Positive result*	*Negative result*	*sum*
Yes	**70**	**30**	**100**
No	**45**	**855**	**900**
	115	**885**	**1000**

Positive Predictive Value (PPV) = 70/115 = 0.609

To see the effects of bias, return to the second example calculation. Ioannidis defines bias generally as the conversion of negative into positive results, for example by cherry picking data, redefining hypotheses, or whatever. Mathematically, he assumes that the probability of a negative finding being converted into a positive is the same for true and false hypotheses. Assume that Bias is 0.2: one fifth of negative results are turned into positive results. Of the 30 true hypotheses that had been rejected, 6 would be moved from the negative results column into the positive results column, for a total of 76. Likewise, one fifth of the 855 false hypotheses that had been rejected will now be accepted. 171 negative results are moved into the positive results column, for a total of 216. The positive predictive value then is no longer 70/115 = 0.609, but instead 76/216 = 0.35.

I did not take the students through the calculations for multiple research teams testing the same hypothesis, because that is more difficult to make intuitive. I am content if a student understands that this offers multiple chances for a false hypothesis to produce a statistically significant result.

Ioannidis' six corollaries or conclusions about the probability of a positive research finding being true can then be linked to the three fundamental numbers required to calculate posterior probability in Bayes' theorem. Small studies (corollary 1) and small effect sizes (corollary 2) mean less statistical power, meaning a lower detection rate. The more hypotheses are tested and the less those hypotheses are selected (corollary 3), the lower the prior odds. Greater flexibility in designs, definitions and outcomes (corollary 4) means more room for bias to creep in, even unintentionally, while greater financial incentives and greater prejudice will also increase bias (corollary 5). Finally, the hotter a field, meaning the more research teams chase the same hypotheses, the less likely a positive result is to be true, because there are more chances for a false hypothesis to produce a positive result (corollary 6), and it is positive results that get attention, and they are more likely to be published.

I would like to see at least a brief discussion of possible solutions to the problems that Ioannidis has identified. Merely applying a more stringent criterion for statistical significance, for example, would have the further consequence of increasing the contribution that publication bias makes to the phenomenon that effect sizes often decrease as a new finding is more thoroughly investigated. Briefly, initial studies are likely to employ few subjects, because it is hard to get funding for large studies searching for an effect that may not exist. If you run multiple identical studies, then small studies have more variable effect sizes. If mostly positive

results get published, then even for a real effect the small studies that happen to find modest effect sizes will fail to reach significance and therefore they will be less likely to get published. Only those studies that find large effects, either because the effect really is large or because random fluctuation makes it look large, will get published. So the initial small studies of modest or small effect sizes can only reach statistical significance through noise. The published sample is heavily skewed, and it will get more skewed the more demanding your criterion for statistical significance is. Then follow-up studies use larger samples. The larger samples reduce variation in effect size, reducing the scope for published data to be skewed, and the larger studies can reach significance level more easily. So if the real effect size is modest or small, then early and small studies can only get published if they overestimate effect sizes, later and larger studies show smaller effect sizes. And it looks like effects disappear the longer they are studied.

Ioannidis proposes that large studies that have a higher detection rate, but are also expensive, should be aimed at major theoretical concepts, rather than narrow, specific questions. Then a negative finding can refute not just a very specific claim, but a wider range of claims. Second, replication is especially important in hot fields. Bias can be reduced by prior registration of studies (reduces publication bias) including definition of hypotheses and relevant outcomes (reduces opportunity to redefine hypotheses and outcomes). Third, it would be useful to establish prior odds.