NTNU
Kunnskap for en bedre verden

Institutt for psykologi

Eksamensoppgave i PSY3111 – Individuell utvikling, gener, nervesystem og atferd

Faglig kontakt under eksamen: Dawn Behne

Tlf.: 73 59 19 60

Eksamensdato: 30. november 2018

Eksamenstid (fra-til): 09:00-13:00

Hjelpemiddelkode/Tillatte hjelpemidler: Ingen

Målform/språk: Bokmål

Antall sider (uten forside): 1

Informasjon om trykking av eksamensoppgave
Originalen er:
1-sidig ☐ **2-sidig** ☐
sort/hvit ☐ **farger** ☐
skal ha flervalgskjema ☐

Kontrollert av:

Dato Sign

Merk! Studenter finner sensur i Studentweb. Har du spørsmål om din sensur må du kontakte instituttet ditt. Eksamenskontoret vil ikke kunne svare på slike spørsmål.

Studenten skal ***besvare 4*** av de følgende 6 spørsmål:

1. Definer kort hva et gen er og forklar med bakgrunn i strukturen på DNA-molekylet hva som er essensen i den universelle genetiske kode.

2. Under læring ser det ut til at erfaringer og minner nedfelles som endringer i synaptiske strukturer. Forklar hvordan man tror dette skjer og hvor stabilt det ser ut til å være?

3. Forklar begrepet "arvbarhet" og grei ut om begrensninger ved begrepet.

4. Forklar hvordan det motoriske systemet forbinder talepersepsjon og taleproduksjon.

5. Beskriv og diskuter tre grunnleggende motoriske kontrollfunksjoner som er nødvendig for musikalsk ytelse.

6. Gjør rede for hvordan C. Frith forklarer hallusinasjoner og vrangforestillinger knyttet til schizofreni.

SENSORVEILEDNING

Oppgave

Bokmål**:** Definer kort hva et gen er og forklar med bakgrunn i strukturen på DNA-molekylet hva som er essensen i den universelle genetiske kode.

English: Briefly define what a gene is and explain, based on the structure of the DNA molecule, what the essence of the universal genetic code is.

Sensorveiledning

Det forventes at studenten er kjent med at et gen er en sekvens av DNA-molekylet som koder for en kjede av aminosyrer, dvs. et polypeptid/protein (eller evt. et RNA). Det forventes videre at studenten kan forklare strukturen på DNA-molekylet, dvs. en dobbel helix bestående av nukleotider, der hvert nukleotid inneholder et sukker, et fosfat og en nitrogenbase. Studenten bør kunne gjøre rede for innholdet i den universelle genetiske kode som går ut på at tripletter av nitrogenbaser, kalt kodon, koder for spesifikke aminosyrer.

2

Oppgave

Bokmål**:** Under læring ser det ut til at erfaringer og minner nedfelles som endringer i synaptiske strukturer. Hvordan tror man dette skjer og hvor stabilt ser det ut til å være?

English: During learning experiences and memories seem to be expressed in synaptic structures. Explain how this process is thought to occur and how stable it appears to be.

Sensorveiledning

Spørsmålet er åpent, noe som gir frihetsgrader mht svar. Men pensumkapitlet omhandler minneprosesser i hippocampus og svaret bør reflektere det. Oppgaven bør inneholde at innkoding av nye minner er trolig synonymt med oppstart av proteinsyntese og strukturelle endringer av synapser. NMDA-reseptoren bør være med, indikert som utløsende faktor, samt at influx av kalsium utløser en kaskade som nettopp endrer med proteinsyntese. En meget god besvarelse benevner hvert vesentlige ledd i denne kaskaden, samt samspillet mellom CREB-1 og CREB-2. Å bruke LTP som et eksempel er bra, men ikke påkrevd. Det er et pluss om man nevner forskjellige typer initiering (assosiativ/ ikke-assosiativ), og om man skiller tidligfase fra senfase. En meget god besvarelse tar også med teorien om synaptisk merking (tagging), at den endelige proteinsyntese finner sted i de synapser der kaskaden startet. Det er et pluss om man drøfter gammaoscillasjoner sin mulige rolle. Med hensyn til stabilitet bør man komme inn på begrepet rekonsolidering og hvordan nyere studier indikerer at det er mulig å avlære fryktminner under spesielle betingelser.

3

Oppgave

Bokmål: Forklar begrepet "arvbarhet" og grei ut om begrensninger ved begrepet.

English: Explain the term "heritability" and clarify the term´s limitations.

Sensorveiledning

Arvbarhet er et mål på hvor stor grad av fenotypisk varians som skyldes genotypisk varians. Begrepet anvendes bare på populasjonen i studiet, og er kun et estimat av den genetiske delen av variasjonen i en populasjon. Arvbarhet kan endres over tid dersom andre påvirk- ninger endres, og estimater kan være ulike i ulike populasjoner, selv for samme trekk (f.eks. Dersom miljøvarians øker, avtar arvbarhet; dersom miljøvarians minker, øker arvbarhet).

Begrensninger: Arvbarhetsestimater sier noe om forklart varians på gruppe nivå, og ikke noe om individer (arvbarhet på for eksempel .4 forteller oss at 40 % av individuelle forskjel- ler vi observerer for trekket kan tilskrives genetiske individuelle forskjeller i gruppen).

Arvbarhetsestimater er påvirket av både populasjonens genetikk og miljø. Dersom noe er genetisk betinget kan det fremdeles være lav arvbarhet (evolusjonære tilpasninger – to bein er arvelig, men har tilnærmet null arvbarhet da det ikke er varians i trekket).

Arvbarhetsestimatet vil øke jo mer populasjonen blir utsatt for et likt miljø: Eks. 1: PTSD – dersom alle har vært utsatt for krig så vil ikke variansen skyldes miljøfaktorer. Eks. 2: Høyde – dersom man generelt har god ernæring så vil gener forklare mer av variansen.

Arvbarhetsestimatet gjelder derfor kun for den studerte populasjonen.

Det viktigste poenget med arvbarhetsestimater har vært å slå fast at gener faktisk påvirker, og i mange tilfeller er avgjørende for, utviklingen av psykologiske trekk og evner.

4

Oppgave

Bokmål**:** Forklar hvordan motorisk systemmet forbinder talepersepsjon og taleproduksjon.

English: Describe how the motor system connects speech production and speech perception.

Sensorveiledning

Studenten bør ha kjennskap til at persepsjon av tale er knyttet til en spesifikk opplevelse av en auditiv stimulus, der tale-signalet aktiverer motoriske mekanismer knyttet til artikulering – noe som fremmer oppfattelsen av tale-signalet. Nærmere bestemt, bør studenten være kjent med oppdagelsen av såkalte speilnevroner. Om studenten kan forklare at det er kartlagt spesifikke speilnevroner knyttet til talepersepsjon (audiovisuelle speilnevroner), samt hvilke egenskaper som kjennetegner disse, er det et pluss. Studenten bør videre kjenne til at studier som omfatter stimulering av spesifikke områder i motorisk korteks har bidratt til kunnskapen om prosessering av tale-informasjon; disse studiene har vist at motoriske responser som omfatter aktivering av leppene, har en spesifikk kapasitet i og med at responsen øker når en forsøksperson – samtidig med en stimulus som aktiverer det relevante området av motorisk korteks – får høre tale eller får se en annens lepper bevege seg.

5

Oppgave

Bokmål**:** Beskriv og diskuter tre grunnlegende motoriske kontrollfunksjoner som er nødvendig for musikalsk ytelse.

English: Describe and discuss three basic motor control functions which are required for musical performance.

Sensorveiledning

When a musician performs, at least three basic motor control functions are required: timing, sequencing and spatial organization of movement. The accurate timing of movements is related to the organization of musical rhythm, whereas sequencing and spatial aspects of movement relate to playing individual notes on a musical instrument. Although a large number of studies have examined the neural systems underlying these functions separately, little is known about how they work together to produce a complex musical performance. In addition, there is considerable debate regarding both the definition of these motor parameters and the specific contributions of particular brain regions to their control. The study of music production requires these systems to be studied in an integrated fashion, thus making it both a challenging and fruitful model system for research into sensory–motor integration.

Timing. The neural mechanisms that underlie the timing of movement have been intensively studied over the past 20 years, but currently there is more controversy than consensus in this field. The ability to time movement precisely has been attributed to a neural clock or counter mechanism in which time is represented through pulses or oscillations, but it has also been hypothesized to be an emergent property of the kinematics of movement itself. Functional neuroimaging studies, as well as studies of brain-damaged patients, have linked movement timing to several cortical and sub-cortical regions, including the cerebellum, basal ganglia and supplementary motor area (SMA). It has been

proposed that the basal ganglia and possibly the SMA may be more important for interval timing at longer timescales (1 second and above), whereas the cerebellum may be more important for controlling motor timing at shorter timescales (millisecond).

Studies have shown that patients with cerebellar lesions have an impaired ability to complete perceptual and motor timing tasks, and neuroimaging studies have shown cerebellar activity in relation to movement timing. Although some studies have failed to sup- port a direct contribution of the cerebellum to timing, current theories of cerebellar function suggest it may have a role in feedforward control or error correction — both of these functions would be relevant for timing. Several researchers have proposed that the cerebellum computes predictive models of movement that would include movement timing, whereas others suggest that it is most important for online error correction based on feedback, which would also contribute to optimization of timing. The cerebellum may contribute to the precise control of movement trajectories, which are related to accurate timing, and it has been shown to have a role in the acquisition and integration of sensory information. When subjects perform purely auditory perceptual tasks, neuroimaging studies consistently show cerebellar activity.

Studies have suggested that the basal ganglia are also directly involved in movement timing. Patients with Parkinson's disease, who have damage in the basal ganglia system, show impaired movement timing. Furthermore, neuroimaging studies have shown that the basal ganglia are active in tasks that require timed finger tapping. It has also been suggested that the basal ganglia may be involved in controlling specific motor parameters, such as force, which contribute to accurate timing.

Many of these studies have examined very simple rhythms, usually requiring participants to tap a single finger to a constant beat. Although such tasks reveal important basic properties of perceptual and motor timing, it is not clear whether neural models based on these simple tasks are adequate for complex tasks like musical performance. Several recent experiments have examined perception and reproduction of more com- plex musical rhythms. These studies have shown greater involvement of the dorsal premotor cortex (dPMC), lateral cerebellar hemispheres and the prefrontal cor- tex. It is not known whether these changes in brain activity are directly related to the temporal complexity of the rhythms or to other parameters such as sequence complexity, or the degree to which rhythmic structure allows subjects to predict and organize their motor performance. These results indicate that motor timing is not controlled by a single brain region, but by a network of regions that control specific parameters of movement and that depend on the relevant timescale of the rhythmic sequence. High-level control of sequence execution appears to involve the basal ganglia, PMC and SMA, whereas fine-grain correction of individual movements may be controlled by the cerebellum.

Sequencing. Motor sequencing has been explored in terms of either the ordering of individual movements, such as finger sequences for key presses, or the coordination of subcomponents of complex multi-joint movements. Several cortical and sub-cortical regions, including the basal ganglia, the SMA and the pre- SMA, the cerebellum, and the premotor and prefrontal cortices, have been implicated in the production and learning of motor sequences, but their specific contribu- tions and the way they work together are not yet clear. Neurophysiological studies in animals have demonstrated an interaction between the frontal cortex and basal ganglia during the learning of movement sequences. Human neuroimaging studies have also emphasized the contribution of the basal ganglia for well-learned sequences. It has been argued that the cerebellum is important for sequence learning and for the integration of individual movements into unified sequences, whereas the pre-SMA and SMA have been shown to be involved in organizing or chunking of more complex movement sequences. Finally, the premotor cortex has been shown to be involved in tasks that require the production of relatively complex sequences, and it may contribute to motor prediction. Sequencing has also been studied in a more musical context in an experiment that examined neural activity during the execution of sequences of key-presses that differed either in temporal or sequential complexity.

This study showed that more complex sequences required activity from the basal ganglia, dPMC and cerebellum.

Spatial organization. Expert musical performance requires precise spatial organization of movements. Few studies of complex motor control have distinguished between the spatial and sequential components of a series of movements. Studies in animals and humans have established the involvement of parietal, sensory–motor and premotor cortices in the control of movements when the integration of spatial, sensory and motor information is required. More recent work has suggested that separate neural systems may underlie the ability to learn and produce the spatial and sequential components of a complex task. Surprisingly, few studies have explicitly examined the role of spatial processing in the context of musical tasks. A behavioural study of spatial accuracy in trained cellists found that they do not show the typical distance/accuracy trade-off for finger movements while playing. A recent neuroimaging study contrasting sequential and temporal sequence learning suggested that the dPMC may have a role in the learning of spatial trajectories. Overall, however, the contribution of spatial processing to music-related motor tasks remains an area in which future work could make an important contribution.

6

Oppgave

Bokmål: Gjør rede for hvordan C. Frith forklarer hallusinasjoner og vrangforestillinger knyttet til schizophrenia.

English**:** Discuss how C. Frith explains hallucinations and delusions connected to schizophrenia

Sensorveiledning

Frith builds on the basic principle that in order to act in the world, it is necessary to distinguish between the effects of one's own actions and the effects of external causes. One fundamental way of doing so is to compare the predicted effects of one's own actions with the observed outcomes. A large enough deviation can then be attributed to an external cause. (In this paper, Frith does not discuss what "large enough" means. A more statistical approach dealing with that question is presented in a later paper that is not in the *pensum*.) Events attributed to one's own actions receive less attention and are perceived as less intense. That is one reason why it is not possible to tickle oneself. One possible cause of hallucinations is then to overestimate the deviation between predicted and observed outcome, and therefore to attribute the outcomes of one's own actions to external causes. Frith presents several experimental results supporting that view. For example, subjects are asked to draw a circle on a touchpad that is out of sight, the result being shown on a computer screen. They are warned that the relative magnitude of movements on touchpad and screen will change at some random moment (analogous to changing the sensitivity of a computer mouse), and that they should both adjust their movements to keep the circle on the screen at a constant size and also indicate when the scale changes. People with hallucinations and delusions find it more difficult to detect the change, although they adjust their movements as well as controls. It is the conscious assessment of deviation that is impaired, giving an impression that deliberate acts are not under the subject's own control.

Frith points out that this feeling of actions not being under one's own control would be a false perception and therefore a hallucination, but as the anarchic hand phenomenon shows, not all people with such a problem then believe that that their actions are controlled by an external entity. However,

Frith then presents evidence that schizophrenics are also more prone to attribute intention as the cause of events. It is the combination of faulty estimates of deviations with exaggerated attribution of intent that can explain delusions of control.