

Brain, Behaviour, and Cognition: General Examination Feedback (May 2018)

As part of this general feedback document I would like to address some general points that relate to the two examinations on the Brain, Behaviour, and Cognition module – the Cognitive exam and the Biological exam. I will then provide some comments on each of the specific exams, with indicative answers for all of the questions, and some statistics for the cohort.

So, to begin, overall these were an exceptionally good set of exams with many students providing good and clear descriptions of information required to answer the particular questions chosen. Furthermore, it was excellent to see so many of you going beyond simply providing basic descriptive answers and ensuring that you provided evidence from empirical research studies to back-up your arguments, critique of the theories and the research presented, and providing critical evaluative points – so well done! It was also clear to see in the biological exam that some of you had engaged with the core readings and had gone beyond the lecture notes to find other primary sources in order to strengthen the arguments being put forward – an aspect that is critical for obtaining higher marks. It was also good to see that many of you had taken on board the guidance provided in terms of ensuring that for the essay style questions to include an introductory paragraph setting-up what your answers were going to discuss and a concluding paragraph to wrap everything up.

Overall it seemed that the content of the biological exams was better than that of the cognitive exams, which to an extent can be understandable given that the weighting of the biological exam is double that of the cognitive exam. However, it seems that the cognitive exam produced a number of marks within a mid-range point, while there was greater dichotomy in marks for the biological exam with many students scoring in the lower ranges and others scoring in the very high ranges and little in-between. One aspect that was particularly disappointing in the cognitive exam was that hardly any of the scripts included reference to the core readings or the seminar readings provided on Moodle. Finally, another aspect that came through a number of the scripts for both exams was the incorrect use of the word “prove”. We do not say that the outcomes of a study for example “prove” something to be the case. At best we can say that findings “suggest” something to be the case.

Now to the feedback on each of the separate exams, indicative answers and some cohort statistics →

Cognitive Exam:

Overall the answers provided on this exam were generally good – clearly written and concepts were explained well. However, on the whole, the answers were rather basic, superficial, and descriptive in nature, with a substantial number of them simply repeating bits of information from the lecture slides. To obtain higher marks students needed to go beyond the lecture notes and make use of the readings provided on Moodle to help further back-up any points being made. Other issues included a lack of references, and errors or lack of detail in the reporting of specific studies.

Range of exam marks = 0-81; Cohort exam mark average = 54. Overall the average mark is suitable for this level of study and especially pleasing given that students find discussing cognitive concepts quite challenging. However, the lower range of marks is disappointing.

Indicative answers:

Q1. Critically discuss Marr's (1982) computational model of object recognition.

Indicative answer: This question would require students to have an understanding of Marr's computational model of object recognition. It is expected for answers to include a detailed and in-depth description of Marr's model, including the four key aspects: Multidisciplinary - Links neurophysiology with psychology and computational AI, based on an information processing view, describes perception in terms of a series of computations on sensory data, and suggests high level visual experience is the product of these computations. Include discussion of his levels of description: computational, algorithmic, hardware. Include specific details of his four distinct stages of processing: Raw primal sketch, complete primal sketch, 2 ½ D sketch, and full 3D representation, with details of any sub-categories discussed within each of these stages: proximity, similarity, continuation, and closure for the complete primal sketch stage, and the monocular cues of texture gradients, occlusion, convergence, and relative size for the 2 ½ D sketch stage. Stronger answers would include a discussion of evidence from neurophysiology – e.g., single cell recording of nerve cells show that different orientations of line and shades of light 'fire' different cells in the visual cortex of animals and humans (Hubel and Weisel), discuss the issue of viewpoint dependence vs. viewpoint invariance, and propose an alternative model (e.g., Biederman's RBC). Inclusion of reference to the work of Tarr and Bülthoff would have also been required.

Q2. Critically discuss the evidence for parallel-processing models of divided attention.

Indicative answer: Include a very brief introduction to the difference between focused and divided attention. Discuss what is meant by a parallel-processing model of attention and how this differs to serial processing. Explain how studies to examine divided attention are designed (e.g., dual-task technique, slit-span, etc.). Discuss how successful dual-task performance is constrained by 4 main factors: difficulty, skill, similarity, emergent properties. Discuss the various parallel-processing models – e.g., Kahneman's (1973) Central Resource

Model, Norman & Bobrow's (1975) central capacity interference theory, Wickens (1984) Multiple Resource Model. Stronger answer would include critical evaluation of these models and include empirical research studies to both demonstrate support for the theories put forward in the models and include evidence from empirical research studies to critique the models. Then to end, a discussion of automatic processing could have been included. The provided seminar reading (Pashler, 1990 and Hazeltine et al., 2006) would have been essential to answering this question well.

Q3. Critically discuss the evidence for a distinction between episodic and semantic memory.

Indicative answer: Brief account needed to begin describing Tulving's work/ideas on the distinctions between different LTM systems. Then a definition of episodic and semantic memory with examples should have been included. Answers should then have provided a detailed account of the various empirical literature and studies from brain-damaged patients, including those with amnesia (Spiers et al., 2001; Vargha-Khadem et al., 1997) and the evaluation of the Vargha-Khadem et al. study by Gardiner et al. (2008) and an explanation for the discrepancy. The evidence that episodic memory depends on the hippocampus whereas semantic memory depends on the entorhinal, perirhinal, and parahippocampal cortices (Vargha-Khadem et al., 1997; Bindschaedler et al., 2011). Evidence from patients with retrograde amnesia in particular (Bayley et al., 2006; Manns et al., 2003), the theory of consolidation to explain the difference, the evidence from the alcohol (Moulton et al., 2005) and sleep (Jenkins & Dallenback, 1924) studies to support the consolidation theory, and the critique of the sleep study regarding time of day (Hockey et al., 1972), and the alternative theory of semantisation. Evidence from patients with semantic dementia (Adlam et al., 2009) and that these patients show a double-dissociation with amnesic patients. An evaluation of using patients with brain damage in general (i.e., loss of other cognitive abilities, or strategies may be used to overcome issues). The essay could have also focused on patients with Korsakoff syndrome and the issues associated with basing evidence from this sample. Discussions on the distinction could have also focused on how different types of information can be forgotten and the influence of interference. Furthermore, an acknowledgment that perhaps the two systems are not so distinct and are instead interdependent was also required (e.g., Burianova et al., 2010 on similar brain regions of activation; Kan et al., 2009 on learning). Stronger answers would have included the seminar readings (Renoult et al., 2016; Kim, 2016; Takashima et al., 2017).

Q4. Critically discuss how heuristics influence human judgement and decision making.

Indicative answer: This question would require students to begin by explaining what is meant by judgement and decision making, then defining what is meant by heuristics, providing details of the sub-types with examples, and explaining how the various heuristics described can influence judgement and decision making. Empirical research studies to provide evidence for these ideas would also need to be included, which would have included the range of work by Kahneman and Tversky, along with an evaluation of these studies (e.g., Oppenheimer, 2004; Fiedler & von Sydow, 2015). Finally, an acknowledgement of other factors that can influence judgement and decision making could have been included.

Biological Exam:

Overall these scripts were very good – clearly a number of students had thoroughly prepared for this exam. However, some students threw away marks by not even attempting all of the questions required. Section A of the exam was answered very well by most. However, for Section B a number of students did not answer this to the extent required or did not answer the specific question being asked. Question 8 in particular on agonistic and antagonistic drugs was generally answered incorrectly. Finally, for Section C, this for many was a tale of two halves, with one of the questions being answered very well and the other not so well. Many answered Q17 on affective disorders. The main issue was people spent too much time discussing symptoms/explaining details of various forms instead of getting to the core of the argument for the question on evaluating the causal factors and the efficacy of treatments.

Range of exam mark totals = 19-94; Cohort exam mark average = 56. Very pleased with this as it is in line with the average mark expected for this level of study. Also, very pleased to see many higher range marks achieved.

Indicative answers:

SECTION A: Answer **TWO** questions from this section

Question 1: List five tests from the Common Neuropsychological Test Battery.

Any of the following: The Wechsler Adult Intelligence Scale (WAIS), or any of the WAIS sub tests, Digit span, Token test, Sodium Amytal test, dichotic listening. (5 marks)

Question 2: Briefly describe the difference between a contusion and a concussion

Contusion: closed-head injuries that involve damage to the cerebral circulatory system; damage produces internal haemorrhaging, which results in a hematoma (localized collection of clotted blood where a bruise forms).

Concussions – when there is disturbance of consciousness following a blow to the head and no evidence of structural damage. While there is no apparent brain damage with a single concussion, multiple concussions may result in a dementia referred to as “punch-drunk syndrome” (5 marks)

Question 3: Name five of the major internal features of a neuron.

Any of the following: Nucleus, Mitochondria, Endoplasmic reticulum, Cytoplasm, Ribosomes, Golgi complex, Microtubules, Synaptic vesicles, Neurotransmitters. (5 marks)

Question 4: List any five structures of the eye.

Any of the following: Ligament, eye muscle, Iris, Pupil, Lens, Cornea, Fovea, Blind spot, Ciliary muscles, Sclera, Retina, Optic nerve. (5 marks)

Question 5: Briefly describe the four main procedures involved in the delayed non-matching to sample task.

1. Monkey is presented with an object & under it is food,
2. After a delay screen is lowered,
3. Monkey is presented with 2 objects – one the same as before & new object
4. Monkey must remember old object to know to look under new object for food. (5 marks)

Question 6: List any five types of agnosia.

Any of the following: Prosopagnosia, Astereognosia, Asomatognosia, akinetopsia, any agnosia related to the senses (hearing, tactile, visual, smell, and taste), semantic agnosia, simultagnosia, visuo-spatial, etc. (5 marks)

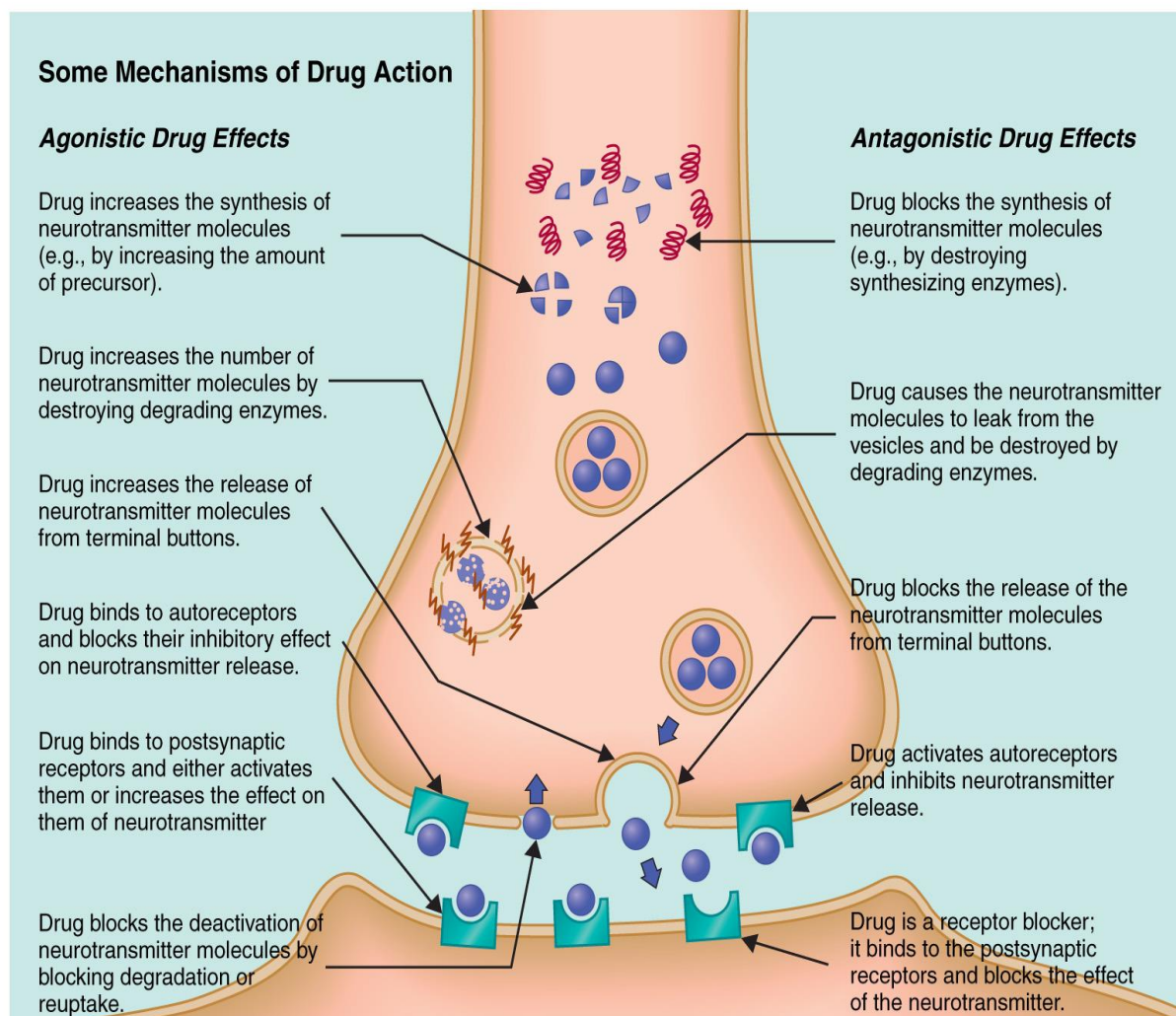
SECTION B: Answer **TWO** questions from this section

Question 7: Compare and contrast Functional Magnetic Resonance Imaging (fMRI) with Electroencephalography (EEG) as techniques for studying the brain.

fMRI provides images of brain structure and activity, uses strong magnetic field, two properties of oxygenated blood allow it to work. 1. Active areas of the brain take up more oxygenated blood than actually needed. 2. Oxygenated blood has magnetic properties through the iron. Structure is imaged using waves emitted by hydrogen ions, Function is imaged using signal created from interaction between oxygen and iron in the blood: Blood Oxygenated Level Dependent (BOLD) signal, Good spatial and temporal resolution, Produces 3D images of activity over the whole brain, But only provides indirect measure of neural activity through BOLD, Also, the 2 to 3 seconds to create image is too slow to capture neural responses e.g., action potentials that happen in milliseconds.

EEG measures gross electrical activity of brain with electrodes attached to scalp, including action potentials and postsynaptic potentials. Includes wave, ERP, & combined with MRI. Main difference = one shows image (structure and activity), the other informs about electrical activity. (10 marks)

Question 8: Describe the different ways agonistic and antagonistic drugs influence neurotransmitter action.



(10 marks)

Question 9: Describe how the brain is protected.

Physical Protection: Skull – CNS encased in bone & covered by: 3 Meninges – Dura mater – tough outer membrane – Arachnoid membrane – quite fine & web-like – Pia mater – inner & delicate membrane that adheres to CNS surface.

Cerebrospinal fluid (CSF) - serves as cushion by filling in space underneath arachnoid membrane, central canal of the spinal cord, and the cerebral ventricles of the brain. 4 large internal chambers of the brain: two lateral, third, and fourth.

Chemical protection: The blood-brain barrier: – Because blood can contain many toxins, the body needs to stop these toxins passing in to the brain. The cells of the blood vessel walls in the brain are so tightly packed together it forms a barrier which stops any molecules from passing through. (10 marks)

Question 10: Describe the cycle for a neuron at rest.

Ions move in & Out through ion-specific channels, Potassium & chloride pass readily, Little movement of Sodium, Proteins don't Move at all (they are trapped inside), Equilibrium Potential explains distribution of ions, Sodium is driven in by both electrostatic forces and its concentration gradient, Chloride is at equilibrium, Potassium is driven in by electrostatic forces and out by its concentration gradient, Sodium-potassium pump – active force that exchanges 3 Na⁺ inside for 2 K⁺ outside. (10 marks)

Question 11: Describe the difference between rod and cone vision.

Cones: Photopic (daytime) vision. High-acuity color information in good lighting.

Rods: Scotopic (night-time vision). High-sensitivity, allowing for low-acuity vision in dim light, but lacks detail and color information. More convergence than cone system, increase sensitivity, decrease acuity.

Difference comes from the way they are wired (convergence) Photopic system has few cones converging on each RGC Scotopic has several hundred rods converge on single RGC.

Rods and cones differ in numbers & distribution on the retina. ~125 million rods & 6 million cones. No rods in fovea only cones. (10 marks)

Question 12: Describe the four types of lesion methods used to examine animal behaviour following the destruction of that brain area.

1. Aspiration lesions: lesion to an area accessible to the eyes and instruments of the surgeon, cortical tissue is drawn off by suction through a glass pipette.
2. Radio-frequency lesions: place radio-frequency current through tissue from an electrode. Heat from the current destroys tissue, with the size & shape of lesion determined by duration & intensity of current.
3. Knife cuts: involves cutting nerves or tracts. Blade enters & swivels out to make the cut.
4. Cryogenic blockade: involves implanting cryoprobe in brain then pumping coolant through the system. Neurons are cooled to such a degree that they stop firing, but temperature is maintained above freezing to avoid structural damage. When tissue is allowed to warm back up, normal neural activity resumes. (10 marks)

SECTION C: Answer **TWO** questions from this section

Question 13: Critically evaluate the suitability of using evidence from animal research to understand the mechanisms of the human brain and human behaviour.

Answers to this question could have been drawn from a range of different angles and could have included a variety of evidence. Something regarding animal research was covered in nearly every lecture, therefore, many aspects could have been discussed. These could have included: studies of early experience and neurodevelopment in rats, visual deprivation, work by Hubel and Wiesel on receptive fields in animals and structure of the visual cortex, research on object recognition with monkeys, delayed non-matching to sample test with rats to examine memory, research on food-caching birds to understand hippocampus, research with rats to examine Hebb's theory of long-term potentiation, stereotaxic surgery to implant electrode in rat amygdala, invasive physiological research to examine cell recording in animals, measuring chemical activity in the brain of animals to examine impact of drugs, locating neurotransmitters receptors in the brain through Immunocytochemistry, gene knockout and gene replacement research to examine disorders such as schizophrenia, the various Biopsychological Paradigms of Animal Behaviour (open-field test, sexual behaviour, aggression and defensive behaviour), conditioning, Semi-natural Animal Learning Paradigms (taste aversion, radial arm maze, Morris water maze, conditioned defensive burying), the various Animal Models of Human Neuropsychological Diseases: Kindling model of epilepsy, Transgenic mouse model of Alzheimer's, MPTP model of Parkinson's, neural regeneration research, Promoting Recovery by Rehabilitative Training: Constraint induced therapy with monkeys, Rodents raised in enriched environments are resistant to induced neurological conditions (epilepsy, models of Alzheimer's, Huntington's, etc.), Physical activity promotes adult neurogenesis in rodent hippocampus, Conditioned Tolerance and Withdrawal of drugs in rats, research on Intracranial Self-Stimulation and Brain "Pleasure Centres" with rats, Measuring Drug-Produced Reinforcement in Laboratory Animals (drug self-administration and conditioned place preference), lesion studies to nucleus accumbens, animal model of anxiety (elevated-plus-maze test and risk assessment test), Clinical Trials: Development of New Psychotherapeutic Drugs with animals, etc. Most were able to describe some of this information. However, higher marks would have been achieved from actually answering the specifics of the question in regards to what this research with animals tells us about the mechanisms of the human brain and human behaviour. Also, whether these types of research are suitable or not, and if not then why not. Discussion regarding consideration of ethics also required. (35 marks)

Question 14: Critically evaluate two theories proposed to explain the functions of the ventral and dorsal pathways of visual processing.

Brief description of processing of information through V1 to various specialist areas of secondary and association cortex through dorsal and ventral pathways. Explain what neurons in the two streams respond to (Haxby, 2006). Present the "where" vs. "what" theory (Ungerleider and Mishkin, 1982) and what it suggests. Present evidence for the theory from effects of damage to the areas (Ungerleider & Haxby, 1994). Present alternative theory by Goodale & Milner (1992) on "Control of behavior" vs. "conscious perception" and explain the functions of the two streams under this theory, with research evidence from neurological findings. The inclusion of the two case studies in the Pinel book would have added to the argument. Finally, a discussion of how the two systems may not be as separate as once thought could be included (e.g., Konen & Kastner, 2008). (35 marks)

Question 15: Critically discuss the various methods used to promote Central Nervous System (CNS) regeneration.

So, this was quite a nasty question and a rather tricky one to answer, as neural regeneration is virtually non-existent in the CNS and considered hit and miss in the PNS of mammals. Therefore, careful thought and consideration would have been needed. Answers could have focused on explaining this issue and discuss how regeneration in the PNS occurs. However, a key point of discussion should have focused on how CNS regeneration is possible through transplantation in to the PNS. The work of Sperry's eye-rotation experiments could have also been discussed. The focus of the argument should then have moved on to the role of the Schwann cells and how they are key for promoting regeneration in the PNS and how the oligodendrocytes in the CNS actively block regeneration. The discussion could then move on to how regeneration in lower vertebrates is extremely accurate in both the PNS and CNS, with an explanation of how this happens (which is hopeful as a medical breakthrough in attempting to treat human brain disorders). Finally, a discussion of neural reorganisation and in particular neuroplasticity would have been required, which should have specifically covered reducing brain damage by blocking neural degeneration, transplanting sections of myelinated PNS across a transection of the spinal cord of rats (Cheng et al., 1996), transplanting olfactory ensheathing cells across lesions of corticospinal tracts of rats (Raisman & Li, 2007), neural transplantation of fetal tissue (e.g., in to substantia nigra for treating MPTP monkey model of Parkinson's disease: Sladek et al., 1987) – this was then tested in human patients who appeared to improve (e.g., Sawle & Myers, 1993), but severe side effects ensued (Greene et al., 1999). Also, a discussion of transplanting stem cells (e.g., through injection) would be required (e.g., McDonald et al., 1999), along with the discussion of potential issues and aspects that still require extensive consideration (e.g., Lanza & Rosenthal, 2004). Finally, a discussion of rehabilitative training to promote recovery from CNS damage was required: Strokes – hand training in monkeys (constraint-induced therapy in humans), and outcomes from cognitive and physical exercise. (35 marks)

Question 16: Evaluate the evidence to suggest that different regions of the brain are involved in the processing and storage of different memories.

Evidence to answer this question could have come from discussing patient H.M. A clear explanation of the areas removed and the effect this had on the various forms of memory through the range of assessments he was given could have included. Then an acknowledgment that not all patients with this form of amnesia are unable to form new explicit long-term memories could be included: Effects of Cerebral Ischemia on the Hippocampus and Memory – patient R.B. Then information on the following: Amnesia of Korsakoff's Syndrome, Amnesia of Alzheimer's Disease (AD), Amnesia after Concussion, Hebb's theory of consolidation, role of hippocampus in storing memories, lesion studies with animals to assess memory performance (temporal lobes/hippocampus), hippocampus (spatial memory), perirhinal cortex (object memory), mediodorsal nucleus, basal forebrain, IT cortex (sensory memory), amygdala (emotional significance), PF cortex (episodic & working memory), cerebellum (learned sensorimotor skills), striatum (SR). Storage linked to immediate areas of usefulness, diffusion across brain prevents catastrophic damage to all at one site. (35 marks)

Question 17: Evaluate the causal factors of affective disorders and discuss the efficacy of treatments.

Answers to this question should have briefly introduced affective disorders, then swiftly moved on to discuss the role of genetics, with evidence from specific research studies on twins. Also, stressful experiences, with a link to PTSD; Seasonal affective disorder, with evidence from incidence rates in N. America vs. Florida and the light therapy used to help alleviate symptoms. Postpartum depression and incidence rates, plus any specialist treatments

offered to new mothers. Then a highly detailed account of the four major classes of drugs to help treat affective disorders should have been discussed – including their structure, efficacy and any side effects. The effectiveness of these drugs needed to include the research by Hollon et al. (2002) on drug vs. control group improvement and Hirsch et al. (2008) on placebo effect. Answers to this question should have also included a discussion on brain pathology and how brain structures in those with affective disorders differs to those who do not - amygdala, cingulate cortex, and prefrontal cortex. Evaluation of this then also needed to show that pattern of results is inconclusive because certain brain structures found to be of reduced size in one study is of normal size in other studies. Importantly, a discussion of the Monoamine theory and diathesis-stress model of depression should have been covered in detail. The strengths and weakness of each should be provided with reference to relevant empirical studies to support discussion. Finally, other treatments such as brain stimulation (Lozano et al., 2008), sleep deprivation, and exercise should have been evaluated. (35 marks)

Question 18: Critically discuss the impact of early visual deprivation on neurodevelopment. Answers to this question could have begun by discussing the critical and sensitive period of neurodevelopment. Then a discussion of research to examine the effects of sensory deprivation on animals reared in the dark and the resulting amounts of dendritic spines in the visual cortex leading to issues with depth and pattern perception as adults. Then a discussion of how research has now moved on to examine the competitive nature of experience on development in regards to ocular dominance and the studies depriving only one eye. A discussion of research on sensory topographic maps (and inclusion of research for example on barn owls with vision-displacing prisms placed over their eyes). (35 marks)