DOWNLOAD PDF SENSORY SYSTEMS: GENERAL PRINCIPLES

Chapter 1 : Unit 9: Nervous System - General Principles and Sensory Physio Flashcards by Kim Wong | Br

Sensory Systems: General Principles and Somatic Sensation We have reached a significant juncture in Medical Neuroscience as we turn our attention to the organization and function of the sensory systems.

Unicellular Creatures[edit] The answer is, "No! Creatures existing of a single cell can be large, can respond to multiple stimuli, and can also be remarkably smart! Xenophyophores are the largest known unicellular organisms, and can get up to 20 cm in diameter! Paramecium, or "slipper animalcules", respond to light and touch. We often think of cells as really small things. And even with this single cell, those organisms can respond to a number of stimuli. For example look at a creature from the group Paramecium: The corresponding word in German is Pantoffeltierchen. Despite the fact that these creatures consist of only one cell, they are able to respond to different environmental stimuli, e. Physarum polycephalum left And such unicellular organisms can be amazingly smart: This single cell creature manages to connect sources finding the shortest connections Nakagaki et al. In addition, it has somehow developed the ability to read its tracks and tell if its been in a place before or not: On the one hand, the approach used by the paramecium cannot be too bad, as they have been around for a long time. On the other hand, a single cell mechanism cannot be as flexible and as accurate in its responses as a more refined version of creatures, which use a dedicated, specialized system just for the registration of the environment: A famous one is Caenorhabditis elegans, a nematode with a total of neurons. The sequence was published in And not only do we know its complete genome, we also know the connectivity between all of its neurons. In fact, the developmental fate of every single somatic cell in the adult hermaphrodite; in the adult male has been mapped out. Nevertheless, there is still a lot of research conductedâ€”also on its smellingâ€”in order to understand how its nervous system works. General principles of Sensory Systems[edit] Based on the example of the visual system, the general principle underlying our neuro-sensory system can be described as below: All sensory systems are based on a Signal, i. And the generation of a resulting Action. While the underlying physiology restricts the maximum frequency of our nerve-cells to about 1 kHz, more than one-million times slower than modern computers, our nervous system still manages to perform stunningly difficult tasks with apparent ease. Transduction[edit] The role of our "senses" is to transduce relevant information from the world surrounding us into a type of signal that is understood by the next cells receiving that signal: The sensory system is often regarded as part of the nervous system. Here I will try to keep these two apart, with the expression Sensory System referring to the stimulus transduction, and the Nervous System referring to the subsequent signal processing. Note here that only relevant information is to be transduced by the sensory system. The task of our senses is not to show us everything that is happening around us. Instead, their task is to filter out the important bits of the signals around us: Our Sensory Systems transduce those environmental variables that are probably important to us. And the Nervous System propagates them in such a way that the responses that we take help us to survive, and to pass on our genes. Types of sensory transducers[edit] Mechanical receptors.

Chapter 2 : Stimulus intensity

- Unit 3 Sensory systems (weeks). Here, you will learn the overall organization and function of the sensory systems that contribute to our sense of self relative to the world around us: somatic sensory systems, proprioception, vision, audition, and balance senses. - Unit 4 Motor systems (weeks).

General introduction[edit] Multimodal perception is a scientific term that describes how humans form coherent, valid, and robust perception by processing sensory stimuli from various modalities. Surrounded by multiple objects and receiving multiple sensory stimulations, the brain is faced with the decision of how to categorize the stimuli resulting from different objects or events in the physical world. The nervous system is thus responsible for whether to integrate or segregate certain groups of temporally coincident sensory signals based on the degree of spatial and structural congruence of those stimulations. Multimodal perception has been widely studied in cognitive science, behavioral science, and neuroscience. Stimuli and sensory modalities[edit] There are four attributes of stimulus: The neocortex in the mammalian brain has parcellations that primarily process sensory input from one modality. For example, primary visual area, V1, or primary somatosensory area, S1. These areas mostly deal with low-level stimulus features such as brightness, orientation, intensity, etc. These areas have extensive connections to each other as well as to higher association areas that further process the stimuli and are believed to integrate sensory input from various modalities. However, recently multisensory effects have been shown to occur in primary sensory areas as well. Binding problem The relationship between the binding problem and multisensory perception can be thought of as a question â€" the binding problem, and potential solution â€" multisensory perception. The binding problem stemmed from unanswered questions about how mammals particularly higher primates generate a unified, coherent perception of their surroundings from the cacophony of electromagnetic waves , chemical interactions, and pressure fluctuations that forms the physical basis of the world around us. It was investigated initially in the visual domain colour, motion, depth, and form , then in the auditory domain, and recently in the multisensory areas. It can be said therefore, that the binding problem is central to multisensory perception. It is obviously important for the senses to interact in order to maximize how efficiently people interact with the environment. For perceptual experience and behavior to benefit from the simultaneous stimulation of multiple sensory modalities, integration of the information from these modalities is necessary. Some of the mechanisms mediating this phenomenon and its subsequent effects on cognitive and behavioural processes will be examined hereafter. Perception is also defined and studied in terms of feature extraction, which is several hundred milliseconds away from conscious experience. Notwithstanding the existence of Gestalt psychology schools that advocate a holistic approach to the operation of the brain, [5] [6] the physiological processes underlying the formation of percepts and conscious experience have been vastly understudied. Nevertheless, burgeoning neuroscience research continues to enrich our understanding of the many details of the brain, including neural structures implicated in multisensory integration such as the superior colliculus SC [7] and various cortical structures such as the superior temporal gyrus GT and visual and auditory association areas. Although the structure and function of the SC are well known, the cortex and the relationship between its constituent parts are presently the subject of much investigation. Concurrently, the recent impetus on integration has enabled investigation into perceptual phenomena such as the ventriloquism effect, [8] rapid localization of stimuli and the McGurk effect ; [9] culminating in a more thorough understanding of the human brain and its functions. However, there is also a long and parallel history of multisensory research. They were reviewed by Hartmann [13] in a fundamental book where, among several references to different types of multisensory interactions, reference is made to the work of Urbantschitsch in [14] who reported on the improvement of visual acuity by auditive stimuli in subjects with damaged brain. This effect was also found latter in normals by Krakov [15] and Hartmann, [16] as well as the fact that the visual acuity could be improved by other type of stimuli. In this syndrome, all the sensory functions are affected, and with symmetric bilaterality, in spite of being a unilateral lesion where the primary areas were not involved. A feature of this syndrome is the great permeability to crossmodal effects between visual, tactile, auditive stimuli as well as muscular effort to improve the perception, also decreasing the reaction times. The improvement by crossmodal effect was found to be greater as the primary stimulus to be perceived was weaker, and as the cortical lesion was greater Vol I and II of reference [18]. This author interpreted these phenomena under a dynamic physiological concept, and from a model based on functional gradients through the cortex and scaling laws of dynamical systems, thus highlighting the functional unity of the cortex. According to the functional cortical gradients, the specificity of the cortex would be distributed in gradation, and the overlap of different specific gradients would be related to multisensory interactions. Example of spatial congruent and structural congruent[edit] When we hear a car honk , we would determine which car triggers the honk by which car we see is the spatially closest to the honk. On the other hand, the sound and the pictures of a TV program would be integrated as structural congruent by combining visual and auditory stimuli. However, if the sound and the pictures were not meaningfully fit, we would segregate the two stimuli. Therefore, whether spatial or structural congruent should not only combine the stimuli but also be determined by understanding. Theories and approaches[edit] Visual dominance[edit] Literature on spatial crossmodal biases suggests that visual modality often influences information from other senses. This is known as the ventriloquist effect. However, haptic dominance occurs when the factor to identify is object size. Thus, vision has a greater influence on integrated localization than hearing, and hearing and touch have a greater bearing on timing estimates than vision. The extent to which multisensory integration occurs may vary according to the ambiguity of the relevant stimuli. In support of this notion, a recent study shows that weak senses such as olfaction can even modulate the perception of visual information as long as the reliability of visual signals is adequately compromised. The Bayesian integration view is that the brain uses a form of Bayesian inference. However, depending on the discrepancies between modalities, there might be different forms of stimuli fusion: To fully understand the other two types, we have to use causal inference model without the assumption as cue combination model. However, hierarchical model is actually a special case of non-hierarchical model by setting joint prior as a weighted average of the prior to common and independent causes, each weighted by their prior probability. Based on the correspondence of these two models, we can also say that hierarchical is a mixture modal of non-hierarchical model. Independence of likelihoods and priors[edit] For Bayesian model , the prior and likelihood generally represent the statistics of the environment and the sensory representations. The independence of priors and likelihoods is not assured since the prior may vary with likelihood only by the representations. However, the independence has been proved by Shams with series of parameter control in multi sensory perception experiment. Through detailed long-term study of the neurophysiology of the superior colliculus, they distilled three general principles by which multisensory integration may best be described. The spatial rule [33] [34] states that multisensory integration is more likely or stronger when the constituent unisensory stimuli arise from approximately the same location. The temporal rule [34] [35] states that multisensory integration is more likely or stronger when the constituent unisensory stimuli arise at approximately the same time. The principle of inverse effectiveness [36] [37] states that multisensory integration is more likely or stronger when the constituent unisensory stimuli evoke relatively weak responses when presented in isolation. Perceptual and behavioral consequences[edit] A unimodal approach dominated scientific literature until the beginning of this century. Although this enabled rapid progression of neural mapping, and an improved understanding of neural structures, the investigation of perception remained relatively stagnant, with a few exceptions. The recent revitalized enthusiasm into perceptual research is indicative of a substantial shift away from reductionism and toward gestalt methodologies. Gestalt theory, dominant in the late 19th and early 20th centuries espoused two general principles: Just these ideas were already applied by Justo Gonzalo in his work of brain dynamics, where a sensory-cerebral correspondence is considered in the formulation of the "development of the sensory field due to a psychophysical isomorphism" pag. Decreasing sensory uncertainty[edit] It has been widely acknowledged that uncertainty in sensory domains results in an increased dependence of multisensory integration. It should be noted here that the integrative function only occurs to a point beyond which the subject can differentiate them as two opposing stimuli. Concurrently, a significant intermediate conclusion can be drawn from the research thus far. Multisensory stimuli that are bound into a single percept, are also bound on the same receptive fields of multisensory neurons in the SC and cortex. Hershenson presented a light and tone simultaneously and separately, and asked human participants to respond as rapidly as possible to them. As the asynchrony between the onsets of both stimuli was varied, it was observed that for certain degrees of asynchrony, reaction times were decreased. Further studies have analysed the reaction times of saccadic eye movements; [39] and more recently correlated these findings to neural phenomena. Redundant target effects[edit] The redundant target effect is the observation that people typically respond faster to double targets two targets presented simultaneously than to either of the targets presented alone. This difference in latency is termed the redundancy gain RG. RT to simultaneous visual and tactile stimuli was also faster than RT to simultaneous dual visual or tactile stimuli. The advantage for RT to combined visual-tactile stimuli over RT to the other types of stimulation could be accounted for by intersensory neural facilitation rather than by probability summation. These effects can be ascribed to the convergence of tactile and visual inputs onto neural centers which contain flexible multisensory representations of body parts. McGurk and MacDonald explained that phonemes such as ba, da, ka, ta, ga and pa can be divided into four groups, those that can be visually confused, i. Hence, when ba â€” voice and ga lips are processed together, the visual modality sees ga or da, and the auditory modality hears ba or da, combining to form the percept da. Ventriloquism describes the situation in which auditory location perception is shifted toward a visual cue. The original study describing this phenomenon was conducted by Howard and Templeton, after which several studies have replicated and built upon the conclusions they reached. Thus to test the influence of sound on perceived location, the visual stimulus must be progressively degraded. Some types of EVP â€” electronic voice phenomenon , mainly the ones using sound bubles are considered a kind of modern ventriloquism technique and is played by the use of sophisticated software, computers and sound equipment. Double-flash illusion[edit] The double flash illusion was reported as the first illusion to show that visual stimuli can be qualitatively altered by audio stimuli. They were then asked to say how many flashes they perceived. Participants perceived illusory flashes when there were more beeps than flashes. This suggests that the illusion reflects subjective perception of the extra flash. The RHI is an illusion of vision, touch, and posture proprioception , but a similar illusion can also be induced with touch and proprioception.

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Chapter 3 : Sensory Systems/Introduction - Wikibooks, open books for an open world

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The sensory perceptions are those of seeing, hearing, tasting, smelling, and touching. Humans also receive impressions of warmth, softness, pressure, and pain through the sensory system. By detecting environmental changes, the sensory system provides humans with protection and with mechanisms for experiencing the world. Structure and Function From the study of the nervous system,it is apparent that in order to be aware of information from the world, a person must have the following: The organs of the sensory system are the eyes, ears, tongue, nose, and skin. The activities of these organs are the senses of vision, hearing, taste, smell, and touch. These senses supply information to the brain and inner body. By providing information, they help the body to detect environmental changes. The body then responds, thereby maintaining homeostasis. Box outlines the functions of the sensory system. The senses of taste, smell, and touch are as interesting and as useful as the senses of sight and hearing. They are not as often involved in illness or disease as are the senses of sight and hearing; however, alterations in these other senses can pose safety hazards. For example, a person whose sense of taste is altered is at risk for ingesting spoiled food. A person whose sense of smell is compromised may not be able to smell smoke. Someone whose sense of touch is altered may not be able to detect hot water and is therefore at risk for burns. The nose is discussed, with the respiratory system. The sense of touch is related to the integumentary system. Key Concept Sight and hearing are most frequently involved in illness; however; alterations in taste, smell, and touch can present safety hazards. These senses also provide pleasurable sensations. It lies in a ball-shaped cavity of the skull called the orbit. Figure illustrates the major structures of the eye. The medical specialty related to the study of the eye and vision is ophthalmology. Key Concept The human eye has a degree viewing angle and can see 2. The medical prefix for eyelid is blephar[o]-. The oval opening between the upper and lower eyelids is called the palpebral fissure. Also covering the anterior eye, beneath and lining the eyelids the cornea and sclera , is a transparent mucous membrane called the conjunctiva, which is supplied with blood vessels and nerve endings. Normally, the body produces about 1 mL of lacrimal fluid each day. Tears drain out through a small opening, called the nasolacrimal duct, located in the inner corner of the eye or medial canthus. The nasolacrimal ducts drain these tears into the nose. Tears protect the eyes from infections and foreign objects. Chemical and mechanical irritants e. Humans are the only species that form tears in response to emotions. Eyeball The eyeball is a hollow sphere that consists of three layers of tissue known as tunics: The lens is another important part of the eyeball, which is illustrated in Figure The sclera helps to maintain the shape of the eyeball. To permit light rays to enter the front of the eye, the sclera is connected to a transparent, yet tough, section over the front of the eyeball called the cornea. The cornea is covered with stratified squamous epithelium, which is a transparent protective coating. It is one of the structures through which light rays pass. It influences visual acuity by refracting light rays. The cornea is very sensitive to touch and pain. Even minor irritations will stimulate a blinking reflex or a pain sensation. The eye is surrounded by the protective bony eye socket which includes a protective cushion of fat. The eyebrows, eyelids, and eyelashes also provide protection. The blink reflex protects the eye from foreign objects or blows. The protective function of tears is described above. Key Concept The cornea is often removed after death as a tissue for transplantation. Corneas were the first tissues used for transplantation. Transplants restore vision each year to thousands of people with defective or diseased corneas. The middle tunic, the choroid, contains the iris and the ciliary body. This layer, which is vascular, brings oxygen and nutrients to all the layers of the eyes. The colored iris controls the amount of light entering the eye. The anterior chamber is the space behind the cornea and in front of the iris. The posterior chamber begins behind the iris. The aqueous humor maintains intraocular within the eye pressure normal is about 24 mm Hg. It also provides nutrients and oxygen to the avascular without blood vessels lens and cornea. Over the front of the eyeball, the choroid develops into a pigmented section, the iris, which gives the eye its specific color. The amount of pigment in the iris determines eye color. The darker the eyes, the more pigment they contain. Lighter eyes, such as blue eyes, contain less pigment. Muscles in the iris control the size of the pupil. The pupil is the black center opening within the eye that allows light to enter the eye. When there is an abundance of light, the muscles of the iris constrict the pupil to allow less light to enter. The reverse occurs under low-light situations the Purkinje effect. Permanent eye color differentiates by age 6 to 9 months. The lens is elastic and is located immediately behind the iris. It has a major role in focusing light rays on the retina. The space behind the lens is filled with a transparent gelatin-like material called the vitreous humor. Loss of the vitreous humor causes blindness. The pigmented layer of the retina is composed of simple cuboidal epithelium and contains the receptors of the optic nerve. The retina also contains specialized neurons, called rods and cones, which permit the perception of light, dark, and color. Each retina contains between and million rods, which are dispersed throughout the retina. Because the pupil dilates in dim light, the light strikes all parts of the retina, thereby activating the rods. Because they are suited to dim light, rods are useful in night vision scotopic vision. The rods receive sensations of black and white and can register shapes, but not colors. Each retina also contains approximately 6 to 7 million cones, on which color vision depends. They consist of three individual classes and each receives either red, blue, or green light, which are combined to form colors. Cones also add to visual acuity visual sharpness , but require a significant amount of light. This explains why you see shades of gray, rather than color, in dim light, because only the rods are receiving stimuli Table Key Concept The adaptation to darkness the Purkinje effect depends on good blood flow to the eye. Blood flow is inhibited by vasoconstrictors, including tobacco and alcohol. It affects 1 in 30 people, most often men.

Chapter 4 : Multisensory integration - Wikipedia

Based on the example of the visual system, the general principle underlying our neuro-sensory system can be described as below: All sensory systems are based on a Signal, i.e. a physical stimulus, provides information about our surrounding.

Nociceptor Nociceptors respond to potentially damaging stimuli by sending signals to the spinal cord and brain. This process, called nociception , usually causes the perception of pain. Nociceptors detect different kinds of damaging stimuli or actual damage. Those that only respond when tissues are damaged are known as "sleeping" or "silent" nociceptors. Thermal nociceptors are activated by noxious heat or cold at various temperatures. Mechanical nociceptors respond to excess pressure or mechanical deformation. Chemical nociceptors respond to a wide variety of chemicals, some of which are signs of tissue damage. They are involved in the detection of some spices in food. Sensory cortex[edit] All stimuli received by the receptors listed above are transduced to an action potential , which is carried along one or more afferent neurons towards a specific area of the brain. While the term sensory cortex is often used informally to refer to the somatosensory cortex , the term more accurately refers to the multiple areas of the brain at which senses are received to be processed. For the five traditional senses in humans, this includes the primary and secondary cortexes of the different senses: This cortex is further divided into Brodmann areas 1, 2, and 3. Brodmann area 3 is considered the primary processing center of the somatosensory cortex as it receives significantly more input from the thalamus , has neurons highly responsive to somatosensory stimuli, and can evoke somatic sensations through electrical stimulation. Areas 1 and 2 receive most of their input from area 3. There are also pathways for proprioception via the cerebellum , and motor control via Brodmann area 4. S2 Secondary somatosensory cortex. The human eye is the first element of a sensory system: Visual cortex[edit] The visual cortex refers to the primary visual cortex, labeled V1 or Brodmann area 17 , as well as the extrastriate visual cortical areas V2-V5. The auditory cortex is composed of Brodmann areas 41 and 42, also known as the anterior transverse temporal area 41 and the posterior transverse temporal area 42 , respectively. Both areas act similarly and are integral in receiving and processing the signals transmitted from auditory receptors. Nose Primary olfactory cortex[edit] Located in the temporal lobe, the primary olfactory cortex is the primary receptive area for olfaction , or smell. Unique to the olfactory and gustatory systems, at least in mammals , is the implementation of both peripheral and central mechanisms of action. The peripheral mechanisms involve olfactory receptor neurons which transduce a chemical signal along the olfactory nerve , which terminates in the olfactory bulb. The chemo-receptors involved in olfactory nervous cascade involve using G-protein receptors to send their chemical signals down said cascade. The central mechanisms include the convergence of olfactory nerve axons into glomeruli in the olfactory bulb, where the signal is then transmitted to the anterior olfactory nucleus , the piriform cortex , the medial amygdala , and the entorhinal cortex , all of which make up the primary olfactory cortex. In contrast to vision and hearing, the olfactory bulbs are not cross-hemispheric; the right bulb connects to the right hemisphere and the left bulb connects to the left hemisphere. Gustatory cortex[edit] The gustatory cortex is the primary receptive area for taste. The word taste is used in a technical sense to refer specifically to sensations coming from taste buds on the tongue. The five qualities of taste detected by the tongue include sourness, bitterness, sweetness, saltiness, and the protein taste quality, called umami. In contrast, the term flavor refers to the experience generated through integration of taste with smell and tactile information. The gustatory cortex consists of two primary structures: Similarly to the olfactory cortex, the gustatory pathway operates through both peripheral and central mechanisms. Peripheral taste receptors , located on the tongue , soft palate , pharynx , and esophagus , transmit the received signal to primary sensory axons, where the signal is projected to the nucleus of the solitary tract in the medulla , or the gustatory nucleus of the solitary tract complex. The signal is then transmitted to the thalamus , which in turn projects the signal to several regions of the neocortex , including the gustatory cortex. Scent, in contrast, is not combined with taste to create flavor until higher cortical processing regions, such as the insula and orbitofrontal cortex.

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Chapter 5 : Mather: Foundations of Perception

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Chapter 6 : Coding theories

Principles of Cortical Organization & Specialization â€¢ Principles of Sensory System Function â€¢ Hierarchical Organization General Principles of Sensory System Function â€¢ Environmental energy (sensory stimulus) - Vision: Light Ã† chemical energy in the photoreceptors Ã† action potentials - Audition: Air pressure waves Ã† mechanical.

Chapter 7 : Sensory nervous system - Wikipedia

Principles of Organization of Sensory Systems All sensory systems have similar organization: All sensory systems are organized by the same general plan.

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Chapter 9 : The Sensory System (Structure and Function) (Nursing) Part 1

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