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Plasticity of the Auditory System **Plasticity and Signal Representation in the Auditory System** **Plasticity in auditory cortex on the grounds of learning discrimination** **Rapid Adaptive Plasticity in Auditory Cortex** Auditory System Plasticity and Regeneration Long Term Plasticity Induced by Intracellular Tetanization in the Rat Auditory Cortex **Short-Term Plasticity in Auditory Cortical Circuit Evoked by Monetary Incentive Delay Task** *Plasticity and Signal Representation in the Auditory System* **Auditory Development and Plasticity** *Inhibitory Regulation of Plasticity Across the Lifespan in the Rat Primary Auditory Cortex* **The Oxford Handbook of the Auditory Brainstem** *Modulation of Short- and Long-term Plasticity in the Rat Auditory Cortex* **Short-Term Plasticity in the Auditory System** **Plasticity of Auditory Responses in the Guinea Pig Central Nervous System During Development and Ageing** **Distinct Temporal and Special Components of Developmental Plasticity in Rat Auditory Cortex** Hearing and Hormones **Issues of Development and Plasticity of the Auditory System** **Auditory Plasticity - Listening with the Brain** Micro-electrode Investigation of Neural Coding and Learning-induced Plasticity in Auditory Cortex *Plasticity and Perception in Primary Auditory Cortex* *Organization and Plasticity of Auditory Spatial Representations* **Plasticity in the Auditory Cortex and Changes in Perceptual Discrimination After Nucleus Basalis Stimulation in Rats** **Cochlear Implantation, Synaptic Plasticity and Auditory Function** **Plasticity in the Central Auditory System** **Brain Oscillations, Synchrony and Plasticity** **Auditory Perception and Cortical Plasticity After Long-term Blindness** *Environmental and Training-induced Plasticity in Primary Auditory Cortex* **Plasticity in the Chick Auditory Central Nervous System** **Targeting Auditory Cortex Plasticity Using Vagus Nerve Stimulation** *Functional Organisation and Plasticity of the Auditory Cortex* *The Auditory Cortex* **Crossmodally Induced Plasticity of Auditory Spatial Perception** **Nucleus Basalis Activity Enables Spatial and Temporal Plasticity in Rat Auditory Cortex** **Deafness Noise and the Brain** Tonotopy and Plasticity at Multiple Levels of the Auditory Pathway **Brain Plasticity Shown by the Processing of Auditory and Somatosensory Information in Blind Humans** *Neural Correlates of Auditory Cognition* **The Brain and Sensory Plasticity** **Reprogramming the Cerebral Cortex**

Doctoral Thesis / Dissertation from the year 2002 in the subject Psychology - Biological Psychology, grade: magna cum laude, University of Münster (Institute for Experimental Audiology), 233 entries in the bibliography, language: English, abstract: The motivation for this thesis came from the intriguing idea that we continuously restructure our brain through everyday learning. How can this highly complex, highly adaptive “learning device” change and reorganize itself all the time while keeping the illusion that we are constantly “ourselves”? The question is, whether learning has the power to trigger functional and structural changes in the brain. Several levels of thinking are involved in an interdisciplinary way. Thus, on a psychological level, 3 major topics enter this work: learning, memory and preconscious or pre-attentive perception and processing of information. Pre-attentive perception means that the subjects' attention and awareness is not mirrored in the neuronal response at a great deal. Learning is involved in this study as an improving discrimination of fine frequency and word duration differences; the latter was examined in a group of native and non-native speakers. Memory is referred to as sensory memory, a short-time memory trace that is established through the repetition of the same “standard” stimulus. In the auditory modality this has been termed “echoic memory”. A long, repetitive training engraves deep “traces” into the memory. The lifelong training of one’s native language results in a very fast and highly automated long-term memory access. On a neurophysiological level the main topics are plasticity and the reorganization of the underlying representational brain areas. Plastic changes on a molecular, synaptic and neuronal level and reorganization of cortical “maps” have been demonstrated abundantly in animal studies. On a physical level the measured magnetic fields and the calculation of the source parameters of their underlying neural generators are discussed in the light of the neurophysiological and psychological phenomena. Therefore, the aim of this dissertation thesis was, to transfer the insights of animal plasticity research onto the human brain and to draw a connection line between discrimination learning and the underlying neurophysiological changes. In a second step, these effects of discrimination learning are tested on speech perception. During an early epoch of development, the brain is highly adaptive to the stimulus environment.

Repeatedly exposing young animals to a particular tone, for example, leads to an enlarged representation of that tone in primary auditory cortex. While the neural effects of simple, single-frequency tonal environments are well characterized, the principles that guide plasticity in complex tone environments, as well as the perceptual consequences of cortical plasticity, remain unclear. To address these questions, this dissertation documents the neural and perceptual effects of simple and complex manipulations to the early acoustic environment. First, I show that rearing rat pups in a multi-tone environment leads to complex primary cortical representational changes that are related to the statistical relationships between experienced sounds. Specifically, tones that occur together within short temporal sequences tend to be represented by the same groups of neurons, whereas tones that occur separately are represented separately. This suggests that the development of primary auditory cortical response properties is sensitive to higher-order statistical relationships between sounds. The observed neural changes are accompanied by perceptual changes. Discrimination ability for sounds that never occur together within temporal sequences is improved. Heightened perceptual sensitivity is correlated with heightened neuronal response contrasts. These results suggest that early experience-dependent neural changes can mediate perceptual changes that may be related to statistical learning. Finally, I develop and experimentally test a model of the relationship between cortical sensory representations and perception. The model suggests that cortical stimulus representations may function as the neural representation of previously encountered stimulus probabilities, and makes predictions about how changes in these representations should affect perception within a statistical inference framework. Preliminary behavioral results support the model predictions, suggesting that one function of early experience-dependent plasticity may be to internalize stimulus distributions to shape future perception and behavior. Contributions from leading international specialists critically document the rapid and substantive progress achieved in understanding plasticity and regeneration of the adult auditory system. Articles synthesize what is currently known about the principles and mechanisms of hair cell regeneration and identify future research directions in this challenging area of hearing science. The symposium that has provided the basis for this book, "Plasticity of the Central Auditory System and Processing of Complex Acoustic Signals" was held in Prague on July 7-10, 2003. This is the fourth in a series of seminal meetings summarizing the state of development of auditory system neuroscience that has been organized in that great world city. Books that have resulted from these meetings represent important benchmarks for auditory neuroscience over the past 25 years. A 1980 meeting, "Neuronal Mechanisms of Hearing" hosted the most distinguished hearing researchers focusing on underlying brain processes from this era. It resulted in a highly influential and widely subscribed and cited proceedings co-edited by professor Lindsay Aitkin. The subject of the 1987 meeting was the "Auditory Pathway - Structure and Function". It again resulted in another important update of hearing science research in a widely referenced book - edited by the late Bruce Masterton. While the original plan was to hold a meeting summarizing the state of auditory system neuroscience every 7 years, historical events connected with the disintegration of the Soviet Empire and return of freedom to Czechoslovakia resulted in an unavoidable delay of what was planned to be a 1994 meeting. It wasn't until 1996 that we were able to meet for the third time in Prague, at that time to review "Acoustical Signal Processing in the Central Auditory System". (Cont.) These changes included an expanded pattern of labeling and a large increase in the density of labeling. Changes were seen not only in primary auditory cortex, but also in other cortical fields that have not been studied before. In contrast, there was little change in brainstem (inferior colliculus, dorsal and anteroventral cochlear nucleus) labeling. Second, the effect of past sound exposure on brain response to sound was examined. After daily exposure to a sound, labeling evoked by that sound was markedly decreased in cortex, but not in brainstem. In two very different conditions, hearing loss and prior sound exposure, we found the same answer: cortical Fos labeling was highly changed, whereas brainstem labeling was more stable. The results suggest that the effects observed in cortex do not reflect subcortical changes and that the multiple fields of auditory cortex are malleable in ways that brainstem auditory nuclei are not. There has been substantial progress in understanding the contributions of the auditory forebrain to hearing, sound localization, communication, emotive behavior, and cognition. The Auditory Cortex covers the latest knowledge about the auditory forebrain, including the auditory cortex as well as the medial geniculate body in the thalamus. This book will cover all important aspects of the auditory forebrain organization and function, integrating the auditory thalamus and cortex into a smooth, coherent whole. Volume One covers basic auditory neuroscience. It complements The Auditory Cortex, Volume 2: Integrative Neuroscience, which takes a more applied/clinical perspective. Brain Oscillations, Synchrony and Plasticity: Basic Principles and Application to Auditory-Related Disorders discusses the role of brain oscillations, especially with respect to the auditory system and how those oscillations are measured, change over the lifespan, and falter leading to a variety of psychiatric and neurological disorders. The book begins with a description of these cortical rhythm oscillations and how they function in both the normal and pathological brain. It explains how these oscillations are important to auditory, executive and attention brain networks and how they relate to the development, production and deterioration of speech and language. In addition, treatment of malfunctioning cortical rhythms are reviewed using neuromodulation, such as transcranial magnetic, direct current, random noise, and alternating current stimulation, as well as focused ultrasound. The book concludes by describing the potential role of oscillations in dyslexia, autism, schizophrenia and Alzheimer's disease. Introduces readers to brain imaging methods such as structural and functional magnetic resonance imaging, EEG and magnetoencephalography, in the study of brain oscillations, synchrony and networks of the normal and pathological brain Highlights the role of brain oscillations in perception and cognition, in particular with respect to the auditory system, speech and language Describes lifespan changes, from preterm to senescence, of brain oscillations, brain networks and how they relate to the development and deterioration of speech and language Explains the effects of hearing loss on neural network change in the auditory and non-auditory networks such as the default mode-, the salience-, the executive- and attention networks Illustrates the breakdown of network connections in auditory-related disorders such as tinnitus and in psychiatric disorders with a strong auditory, speech and language component This book reviews the growing literature that is consistent with the hypothesis that hormones can regulate auditory physiology and perception across a broad range of animal taxa, including humans. Understanding how hormones modulate auditory function has far reaching implications for advancing our knowledge in the basic biomedical sciences and in understanding the evolution of acoustic communication systems. A fundamental goal of neuroscience is to understand how hormones modulate neural circuits and behavior. For example, steroids such as estrogens and androgens are well-known regulators of vocal motor behaviors used during social acoustic communication. Recent studies have shown that these same hormones can also greatly influence the reception of social acoustic signals, leading to the more efficient exchange of acoustic information. The auditory system has a remarkable ability to adjust to an ever-changing environment. The six review chapters that comprise Plasticity of the Central Auditory System cover a spectrum of issues concerning this ability to adapt, defined by the widely applicable term "plasticity". With chapters focusing on the development of the cochlear nucleus, the mammalian superior olivary complex, plasticity in binaural hearing, plasticity in the auditory cortex, neural plasticity in bird songs, and plasticity in the insect auditory system, this volume represents much of the most current research in this field. The volume is thorough enough to stand alone, but is closely related a previous SHAR volume, Development of the Auditory System (Volume 9) by Rubel, Popper, and Fay. The book fully addresses the difficulties, challenges, and complexities of this topic as it applies to the auditory development of a wide variety of species. Thèse. Biologie. Médecine. 2013 The study of blindness provides a context for examining neural plasticity in the adult and developing brain, and for asking basic questions about the principles that guide neural computation in sensory cortex. By noting how a system operates when its inputs are altered, we gain insight into the rules that govern its function. The experiments described in this dissertation combine functional magnetic resonance imaging (fMRI) with behavioral methods and computational modeling to examine three issues: (1) Does longstanding blindness affect the cortical representation of auditory frequency? (2) Can we relate cortical representations of auditory frequency to behavioral discrimination, and/or to higher-order phenomena like auditory motion processing? (3) How do visual and auditory responses in adult sight-recovery subjects compare to responses observed in individuals without a history of blindness, and in those with sustained blindness? Humans and many other species have the capacity to learn and change their behavioral responses when they repeatedly practice a discrimination task. This change in behavior must be caused by changes in response properties of the nervous system. Understanding the relationship between learning and changes in neural responses has been an important field of study for the past twenty years. Numerous papers have observed correlations between plasticity in primary cortical areas and improved perceptual discrimination abilities, implying that this plasticity is the underlying cause of improved performance. However, a causal relationship cannot be proven unless plasticity is induced outside of a behavioral context. In the following dissertation I document the perceptual consequences of plasticity induced using stimulation of the nucleus basalis paired with auditory stimuli. The nucleus basalis is a deep-brain structure which releases acetylcholine onto the neocortex during behaviorally important events. Damage to this structure has been shown to impair both learning and plasticity, and stimulation during presentation of sensory stimuli produces plasticity which mimics the effects observed after behavioral training. We demonstrate for the first time that pairing nucleus basailis stimulation with a tone can alter learning and performance of a frequency discrimination task. We also document a pattern of plasticity after discrimination training and nucleus basalis stimulation which indicates that cortical plasticity in primary sensory areas may be important for learning but not performance of a discrimination task. Finally, we report a further possible source of cortical plasticity and behavioral improvement by showing that nucleus basalis-stimulation pairing can cause stimulus-specific plasticity in both primary and secondary cortical areas. The results of these studies reveal that cortical plasticity contributes to sensory discrimination and perceptual learning, and provide new insights about the relationship between cortical plasticity and continued performance of well-learned behavioral tasks. Hearing and communication present a variety of challenges to the nervous system. To be heard and understood, a communication signal must be transformed from a time-varying acoustic waveform to a perceptual representation to an even more abstract representation that integrates memory stores with semantic/referential information. Finally, this complex, abstract representation must be interpreted to form categorical decisions that guide behavior. Did I hear the stimulus? From where and whom did it come? What does it tell me? How can I use this information to plan an action? All of these issues and questions underlie auditory cognition. Since the early 1990s, there has been a re-birth of studies that test the neural correlates of auditory cognition with a unique emphasis on the use of awake, behaving animals as model. Continuing today, how and where in the brain neural correlates of auditory cognition are formed is an intensive and active area of research. Importantly, our understanding of the role that the cortex plays in hearing has the potential to impact the next generation of cochlear- and brainstem-auditory implants and consequently help those with hearing impairments. Thus, it is timely to produce a volume that brings together this exciting literature on the neural correlates of auditory cognition. This volume compliments and extends many recent SHAR volumes such as Sound Source Localization (2005) Auditory Perception of Sound Sources (2007), and Human Auditory Cortex (2010). For example, in many of these volumes, similar issues are discussed such as auditory-object identification and perception with different emphases: in Auditory Perception of Sound Sources, authors discuss the underlying psychophysics/behavior, whereas in the Human Auditory Cortex, fMRI data are presented. The unique contribution of the proposed volume is that the authors will integrate both of these factors to highlight the neural correlates of cognition/behavior. Moreover, unlike other these other volumes, the neurophysiological data will emphasize the exquisite spatial and temporal resolution of single-neuron [as opposed to more coarse fMRI or MEG data] responses in order to reveal the elegant representations and computations used by the nervous system. In our industrialized world, we are surrounded by occupational, recreational, and environmental noise. Very loud noise damages the inner-ear receptors and results in hearing loss, subsequent problems with communication in the presence of background noise, and, potentially, social isolation. There is much less public knowledge about the noise exposure that produces only temporary hearing loss but that in the long term results in hearing problems due to the damage of high-threshold auditory nerve fibers. Early exposures of this kind, such as in neonatal intensive care units, manifest themselves at a later age, sometimes as hearing loss but more often as an auditory processing disorder. There is even less awareness about changes in the auditory brain caused by repetitive daily exposure to the same type of low-level occupational or musical sound. This low-level, but continuous, environmental noise exposure is well known to affect speech understanding, produce non-auditory problems ranging from annoyance and depression to hypertension, and to cause cognitive difficulties. Additionally, internal noise, such as tinnitus, has effects on the brain similar to low-level external noise. Noise and the Brain discusses and provides a synthesis of hte underlying brain mechanisms as well as potential ways to prvent or alleviate these aberrant brain changes caused by noise exposure. Authored by one of the preeminent leaders in the field of hearing research Emphasizes direct and indirect changes in brain function as a result of noise exposure Provides a comprehensive and evidence-based approach Addresses both developmental and adult plasticity Includes coverage of epidemiology, etiology, and genetics of hearing problems; effects of non-damaging sound on both the developing and adult brain; non-auditory effects of noise; noise and the aging brain; and more To choose optimally, people must consider both the potential value and the probability of a desired outcome. This idea is reflected in the expected value theory, which considers both the potential value of different courses of action and the probability that each action will lead to a desired outcome. Accordingly, during decision-making people choose an alternative with the highest expected value. The dominant neurobiological models of decision-making assume that the sensory inputs to the decision-making neural networks are stationary. However, many cognitive studies have demonstrated experience-induced plasticity in the primary sensory cortex, suggesting that repeated decisions could modulate the sensory processing. We investigated experience-induced plastic changes in the neural representation of the acoustic cues coding different expected values using a repeated monetary incentive delay task (MID-task; Knutson et al., 2005). Subjects participated in two extensive sessions of an audio-version of the MID-task. Next, we investigated electrophysiological correlates of the experience-induced plasticity of the primary auditory cortex by comparing the mismatch negativity (MMN) component before and after the MID-task sessions. We found that after extensive MID-task training, the stimuli with largest expected value evoked larger MMN responses (as compared to the baseline oddball session) that probably reflects a more fine-grained stimulus discrimination of highly valued stimuli. After extensive MID-task training acoustic cues coding intermediate expected values evoked larger P3a component (as compared to the baseline oddball session), that can indicate a stronger involuntary attention switching toward moderately valued stimuli. Overall, our results show that continuing valuation during the MID-task evokes a short-term plastic changes in the auditory cortices associated with the improved stimulus discrimination and the involuntary attention towards auditory cues with the high expected value. The symposium that has provided the basis for this book, "Plasticity of the Central Auditory System and Processing of Complex Acoustic Signals" was held in Prague on July 7-10, 2003. This is the fourth in a series of seminal meetings summarizing the state of development of auditory system neuroscience that has been organized in that great world city. Books that have resulted from these meetings represent important benchmarks for auditory neuroscience over the past 25 years. A 1980 meeting, "Neuronal Mechanisms of Hearing" hosted the most distinguished hearing researchers focusing on underlying brain processes from this era. It resulted in a highly influential and widely subscribed and cited proceedings co-edited by professor Lindsay Aitkin. The subject of the 1987 meeting was the "Auditory Pathway - Structure and Function". It again resulted in another important update of hearing science research in a widely referenced book - edited by the late Bruce Masterton. While the original plan was to hold a meeting summarizing the state of auditory system neuroscience every 7 years, historical events connected with the disintegration of the Soviet Empire and return of freedom to Czechoslovakia resulted in an unavoidable delay of what was planned to be a 1994 meeting. It wasn't until 1996 that we were able to meet for the third time in Prague, at that time to review "Acoustical Signal Processing in the Central Auditory System". The brain has a remarkable ability to adapt in the event of damage - in many cases shifting responsibility for specific cognitive functions to other non-damaged brain regions. This 'plasticity' can be crucial in aiding recovery from stroke, trauma, and peripheral damage such as eye or ear damage. Over the past thirty years our view of cortical plasticity has evolved greatly. Early studies suggested that changes to cortical function due to peripheral lesions could only occur during development and that these plastic changes were specific to a particular temporal window or "critical period". Over time, it has been demonstrated that cortical modifications as a consequence of either peripheral or central lesions can induce adaptive, or beneficial, changes in cortical function in an effort to preserve or enhance function. More recently, studies have identified that many of these adaptive changes, once thought only possible in the developing brain, are also possible in the mature or developed brain. At present, many laboratories are defining the beneficial capabilities of cerebral cortex plasticity, upon which many proactive and therapeutic strategies may be developed in order to maximiSe the "reprogramming" capabilities of the cerebrum. 'Reprogramming the Cerebral Cortex' describes these exciting studies and examines adaptive cortical plasticity in a variety of systems (visual, auditory, somatomotor, cross-modal, language and cognition). The book leads the reader through the complexities and promise of neuroplasticity, and presents insights into current and future research and clinical practice. It is unique in looking at the beneficial capabilities of cerebral cortex plasticity, upon which many proactive and therapeutic strategies may be developed. The book will be a valuable resource for behavioural, systems, computational and cognitive neuroscientists, as well as clinicians and neuropsychologists. The Oxford Handbook of The Auditory Brainstem provides an introduction as well as an in-depth reference to the organization and function of ascending and descending auditory pathways in the mammalian brainstem. Individual chapters are organized along the auditory pathway beginning with the cochlea and ending with the auditory midbrain. Each chapter provides an introduction to the respective area, and summarizes our current knowledge before discussing disputes and challenges the field currently faces. A major emphasis throughout this book is on the numerous forms of plasticity that are increasingly observed in many areas of the auditory brainstem. Several chapters focus on neuronal modulation of function and synaptic, neuronal, and circuit plasticity, especially under circumstances when they occur most prominently: during development, aging, and following peripheral hearing loss. In addition, the book addresses the role of trauma-induced maladaptive plasticity with respect to its contribution in generating central hearing dysfunction such as hyperacusis and tinnitus. The book is intended for students and postdocs starting in the auditory field, and researchers of related fields who wish to get an authoritative and up-to-date summary of the current state of auditory brainstem research. For clinical practitioners in audiology, otolaryngology, and neurology, the book is a valuable resource of information about the neuronal mechanisms that are major candidates for the generation of central hearing dysfunction. The Brain and Sensory Plasticity: Language Acquisition and Hearing is the eighth volume honoring the annual Kresge-Mirmelstein award for excellence. This volume celebrates Masakazu Koniski, who has led the field in neuroethology since the 1960's. This book contains a collection of seven research articles presented by prominent contributors in the field of neuroethology. This volume presents a set of essays that discuss the development and plasticity of the vertebrate auditory system. The topic is one that has been considered before in the Springer Handbook of Auditory Research (volume 9 in 1998, and volume 23 in 2004) but the field has grown substantially and it is appropriate to bring previous material up to date to reflect the wealth of new data and to raise some entirely new topics. At the same time, this volume is also unique in that it is the outgrowth of a symposium honoring two-time SHAR co-editor Professor Edwin W Rubel on his retirement. The focus of this volume, though, is an integrated set of papers that reflect the immense contributions that Dr. Rubel has made to the field over his career. Thus, the volume concurrently presents a topic that is timely for SHAR, but which also honors the pioneer in the field. Each chapter explores development with consideration of plasticity and how it becomes limited over time. The editors have selected authors with professional, and often personal, connections to Dr. Rubel, though all are, in their own rights, outstanding scholars and leaders in their fields. The specific audience will be graduate students, postdoctoral fellows, and established psychologists and neuroscientists who are interested in auditory function, development, and plasticity. This volume will also be of interest to hearing scientists and to the broad neuroscience community because many of the ideas and principles associate with the auditory system are applicable to most sensory systems. The volume is organized to appeal to psychophysicists, neurophysiologists, anatomists, and systems neuroscientists who attend meetings such as those held by the Association for Research in Otolaryngology, the Acoustical Society of America, and the Society for Neuroscience. Cochlear Implantation, Synaptic Plasticity and Auditory Function. This book considers deafness as a medical condition, exploring the neuronal consequences on the peripheral and the central nervous system as well as on cognition and learning, viewed from the standpoint of genetics, neuroanatomy and neurophysiology, molecular biology, systems neuroscience, and cognitive neuroscience. "Neuroplasticity refers to the brain's ability to modify its connections and function in response to experience. This experience-dependent plasticity is necessary for the acquisition of new abilities during early development or in adult life, and plays a crucial role in recovery after a neurological injury. During early developmental epochs known as critical periods (CPs), passive experience alone can have profound and long-lasting effects in cortical sensory representations. In contrast, plasticity in the adult brain occurs almost exclusively in the context of perceptual learning (PL); i.e., the process whereby attention and repetition lead to long-lasting improvements in stimulus detection or sensory discrimination.Whether it occurs as a result of passive experience, PL, or other experimental interventions, cortical plasticity ultimately entails a change in activity patterns driven by a shift in the local levels of excitation and inhibition. And although cortical inhibitory interneurons constitute a clear minority compared to the number of excitatory neurons, they are instrumental in regulating both juvenile and adult experience-dependent plasticity. This thesis consists of three experimental studies that addressed critical and interrelated knowledge gaps regarding the inhibitory regulating mechanisms of experience-dependent plasticity, both in the context of changes in the environment and during PL. Using the rat primary auditory cortex (A1) as a model, we combined electrophysiological, anatomical, chemogenetic, and behavioral methodologies to address each study's main hypotheses. In the first study we examined the role of inhibition in A1 plasticity across the lifespan. We found that reduced cortical inhibition in older adults was associated with an increased but poorly regulated plasticity when compared to younger adults. In older brains, however, changes elicited by auditory stimulation and training were rapidly lost, suggesting that such increased plasticity might be detrimental, as the older brains were unable to consolidate these changes. Importantly, increasing inhibition artificially with clinically available drugs restored the stability of sensory representations and improved the retention of plastic changes associated with PL.In the second study, we turned our attention to parvalbumin-positive (PV+) cells, the most common type of inhibitory neurons in the brain. Bidirectional manipulation of PV+ cell activity affected neuronal spectral and sound intensity selectivity, and, in the case of PV+ interneuron inactivation, was mirrored by anatomical changes in PV and associated perineuronal net expression. In addition, we showed that the inactivation of PV+ interneurons is sufficient to reinstate CP plasticity in the adult auditory cortex. In the third study, we investigated the role of PV+ cells in auditory PL. As previously reported in other cortical areas, training was associated with a transient downregulation of PV expression during early stages of training. We then examined the effects of prolonged PV+ cell manipulation throughout the training period. Our results suggest that, although reduced PV+ cell function may facilitate early training-related modifications in cortical circuits, a subsequent increase in PV+ cell activity is needed to prevent further plastic changes and consolidate learning. Taken together, our findings underscore the importance of sustained inhibitory neurotransmission in ensuring high fidelity discrimination of sensory inputs and in maintaining the stability of sensory representations. Our behavioral studies further suggest that such stability is necessary for the consolidation of complex skills that are built on basic sensory representations. Finally, the experimental work presented in this thesis also highlights the potential of pharmacological and chemogenetic approaches for harnessing cortical plasticity with the ultimate goal of aiding recovery from brain injury or disease"-- One of the most important neuroscientific findings during the last decade has been that the central nervous system (CNS) is capable of reacting with plastic reorganization to altered conditions. The ability of the CNS to exhibit such plasticity had now been demonstrated in the auditory, visual and somatosensory systems. Owing to the development of noninvasive functional imaging techniques, such as magnetoencephalography and functional magnetic resonance imaging, these alterations can now be traced not only in animals, but also in humans. This publication presents noninvasive studies of the functional organization and reorganization of the human auditory cortex compared with invasive animal investigations. Among the topics covered are the relationship between function and structure of the auditory cortex, representation of speech sounds at different levels of the auditory system, hemispheric differences, plastic reorganization of tonotopic maps after cochlear damage, and learning-induced receptive field plasticity. Neuroscientists, neurologists and neurophysiologists will find the sections on cortical plasticity of particular interest, while audiologists will appreciate the valuable data on the functional organization of the auditory system. Plasticity of synapses is not static across the lifespan. As the brain matures and ages, the ability of neurons to undergo structural and functional change becomes more limited. Further, there are a number of modulatory factors that influence the expression of synaptic plasticity. Here, three approaches were taken to examine and manipulate plasticity in the auditory thalamocortical system of rats. Using an in vivo preparation, long-term potentiation (LTP) and paired pulse (PP) responses were used as measures of long- and short-term plasticity, respectively. First, the effect of intracortical zinc application in the primary auditory cortex (A1) on LTP was examined. Following theta burst stimulation (TBS) of the medial geniculate nucleus (MGN), juvenile and middle-age rats, but not young adults, showed greater levels of LTP with zinc application relative to age-matched control animals. Next, PP responses were examined between rats reared in unaltered acoustic conditions and those reared in continuous white noise (WN) from postnatal day (PD) 5 to PD 50-60 (i.e., subjected to patterned sound deprivation). Rats reared in WN demonstrated less PP depression relative to controls, indicating that WN rearing alters short-term thalamocortical synaptic responses. Furthermore, control males showed no change in PP response following LTP induction, indicating a postsynaptic locus of LTP, whereas increased PP depression following LTP induction was seen in WN animals, suggestive of a presynaptic involvement in LTP. Finally, differences in plasticity between male and female rats were investigated, and the result of early WN exposure on both sexes was examined. Males and females did not show consistent differences in LTP expression; however WN exposure appeared to affect LTP of females less than their male counterparts. PP responses were then compared between WN-reared males and females, and no difference was found. This indicates that short-term plastic properties of auditory thalamocortical synapses between the sexes do not differ, even though plasticity on a longer time scale following sensory deprivation does indicate some difference. Together, the experiments summarized here identify some of the important factors that contribute to the regulation of short- and long-term synaptic plasticity in the central auditory system of the mammalian brain. Neuroplasticity refers to the ability of the nervous system to change in response to experience or injury. These changes can be positive (i.e., language acquisition) or negative (i.e., tinnitus). The release of neuromodulators like norepinephrine are critical for neuroplasticity, and regions responsible for their release are modulated by vagus nerve stimulation (VNS). When VNS is paired with a sensory stimulus, specific and lasting changes are observed in the nervous system. In addition, VNS is FDA-approved in the treatment of drug resistant epilepsy and depression, and has been proven to be safe and effective for thousands of patients. Several patients benefited from VNS tone-pairing therapy as a treatment for tinnitus in recent clinical trials. However, no patient was completely cured of his/her tinnitus. A potential reason for these results is that more plasticity must be driven in VNS tone-paired treatment for patients to have maximal benefit. Therefore, VNS parameters must be evaluated to ensure the best settings for driving plasticity are being used clinically. To accomplish this goal, the rate, train duration, and number of VNS pulses were evaluated. Results suggest that 30 Hz is better at driving plasticity than rates a much higher (120 Hz) or lower (7.5 Hz) levels. Longer (2000 ms) VNS pulse trains are not capable of driving plasticity. However, it is possible to drive plasticity using one-fourth of the stimulation used in previous experiments. These results suggest that the magnitude of plasticity driven by VNS is sensitive to changes in multiple stimulation parameters. The high temporal precision of VNS-tone pairing protocols may help to explain the cellular mechanisms responsible for the beneficial effects of precisely timed VNS during restoration of sensory or motor function.

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