Stanford



Eric I. Knudsen

Edward C. and Amy H. Sewall Professor in the School of Medicine, Emeritus

Department of Neurobiology

Curriculum Vitae available Online

CONTACT INFORMATION

- **Alternate Contact**

  Eric Knudsen - Professor

  Email eknudsen@stanford.edu

  Tel 650-723-5492

Bio

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Department of Neurobiology
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

ADMINISTRATIVE APPOINTMENTS

- Professor, Stanford University School of Medicine - Neurobiology, (1988- present)
- Chair, Stanford University School of Medicine - Neurobiology, (2001-2006)

HONORS AND AWARDS

- Newcomb Cleveland Prize, American Association for the Advancement of Science (1978)
- Young Investigator Award, Society for Neuroscience (1984)
- Troland Research Award, National Academy of Sciences (1988)
- Claude Pepper Award, National Institute of Deafness and Communicative Disorders (1991)
- Edward C. and Amy H. Sewall Professorship, Stanford University School of Medicine (1995)
- Fellow, American Academy of Arts and Sciences (1996)
- Givaudan-Roure Award, Association for Chemoreception Sciences (1996)
- Member, National Academy of Sciences (2002)
- W. Alden Spencer Award, College of Physicians and Surgeons, Columbia University (2002)
- Peter Gruber Prize in Neuroscience, Society for Neuroscience (2005)
- Karl Spencer Lashley Award, American Philosophical Society (2008)
- Member, American Philosophical Society (2016)

PROFESSIONAL EDUCATION

- B.A., UC, Santa Barbara , Zoology (1971)

- M.A., UC, Santa Barbara , Neuroscience (1973)
- Ph.D., UC, San Diego , Neuroscience (1976)

COMMUNITY AND INTERNATIONAL WORK

- National Scientific Council on the Developing Child, Washington D.C.

LINKS

- Chicken Behavior Movie: Orientation discrimination task: https://web.stanford.edu/~dsridhar/temp/chick_grating%20mask%20movie.m4v
- Chicken Behavior Movie: Cued detection task: https://web.stanford.edu/~dsridhar/temp/chicken%20cue%20task.m4v

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

We study mechanisms of attention and strategies of information processing in the central nervous system of birds (barn owls and chickens), using neurophysiological, pharmacological, anatomical and behavioral techniques. Studies focus on neural circuits that contribute to spatial attention (location-specific gain control of sensory responses). Both bottom-up mechanisms and top-down mechanisms are investigated. In addition, we study the rules by which auditory and visual information is combined into a single representation in the brain. Techniques offered in this laboratory include acoustic stimulation, extracellular recording, microstimulation, neuropharmacology, in vitro recording, immunohistochemistry, anatomical pathway tracing, and behavioral analysis.

Teaching

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Neurosciences (PhD Program)

Publications

PUBLICATIONS

- **Evolution of neural processing for visual perception in vertebrates.** *The Journal of comparative neurology*
  Knudsen, E. I.
  2020
- **Neural Circuits That Mediate Selective Attention: A Comparative Perspective.** *Trends in neurosciences*
  Knudsen, E. I.
  2018
- **Space-Specific Deficits in Visual Orientation Discrimination Caused by Lesions in the Midbrain Stimulus Selection Network** *CURRENT BIOLOGY*
  Knudsen, E. I., Schwarz, J. S., Knudsen, P. F., Sridharan, D.
  2017; 27 (14): 2053-+
- **Does the Superior Colliculus Control Perceptual Sensitivity or Choice Bias during Attention? Evidence from a Multialternative Decision Framework.** *journal of neuroscience*
  Sridharan, D., Steinmetz, N. A., Moore, T., Knudsen, E. I.
  2017; 37 (3): 480-511
- **Spatially precise visual gain control mediated by a cholinergic circuit in the midbrain attention network** *NATURE COMMUNICATIONS*
  Asadollahi, A., Knudsen, E. I.
  2016; 7
- **Selective disinhibition: A unified neural mechanism for predictive and post hoc attentional selection** *VISION RESEARCH*
  Sridharan, D., Knudsen, E. I.

2015; 116: 194-209

- **Gamma oscillations in the midbrain spatial attention network: linking circuits to function** *CURRENT OPINION IN NEUROBIOLOGY*
  Sridharan, D., Knudsen, E. I.
  2015; 31: 189-198
- **Cholinergic control of gamma power in the midbrain spatial attention network.** *journal of neuroscience*
  Bryant, A. S., Goddard, C. A., Huguenard, J. R., Knudsen, E. I.
  2015; 35 (2): 761-775
- **Descending Control of Neural Bias and Selectivity in a Spatial Attention Network: Rules and Mechanisms** *NEURON*
  Mysore, S. P., Knudsen, E. I.
  2014; 84 (1): 214-226
- **Descending control of neural bias and selectivity in a spatial attention network: rules and mechanisms.** *Neuron*
  Mysore, S. P., Knudsen, E. I.
  2014; 84 (1): 214-226
- **Parallel Midbrain Microcircuits Perform Independent Temporal Transformations** *JOURNAL OF NEUROSCIENCE*
  Goddard, C. A., Huguenard, J., Knudsen, E.
  2014; 34 (24): 8130-8138
- **Parallel midbrain microcircuits perform independent temporal transformations.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
  Goddard, C. A., Huguenard, J., Knudsen, E.
  2014; 34 (24): 8130-8
- **Selective attention in birds.** *Current biology*
  Sridharan, D., Schwarz, J. S., Knudsen, E. I.
  2014; 24 (11): R510-3
- **Visuospatial selective attention in chickens.** *Proceedings of the National Academy of Sciences of the United States of America*
  Sridharan, D., Ramamurthy, D. L., Schwarz, J. S., Knudsen, E. I.
  2014; 111 (19): E2056-65
- **Spatially Reciprocal Inhibition of Inhibition within a Stimulus Selection Network in the Avian Midbrain.** *PloS one*
  Goddard, C. A., Mysore, S. P., Bryant, A. S., Huguenard, J. R., Knudsen, E. I.
  2014; 9 (1)
- **Distinguishing bias from sensitivity effects in multialternative detection tasks.** *J. Vision*
  Sridharan, D., Steinmetze, N. A., Moore, T., Knudsen, E. I.
  2014; 14 (9): 1-32
- **Distinguishing bias from sensitivity effects in multialternative detection tasks.** *Journal of vision*
  Sridharan, D., Steinmetz, N. A., Moore, T., Knudsen, E. I.
  2014; 14 (9)
- **Distinguishing bias from sensitivity effects in multialternative detection tasks.** *Journal of vision*
  Sridharan, D., Steinmetz, N. A., Moore, T., Knudsen, E. I.
  2014; 14 (9)
- **Spatial Probability Dynamically Modulates Visual Target Detection in Chickens** *PLOS ONE*
  Sridharan, D., Ramamurthy, D. L., Knudsen, E. I.
  2013; 8 (5)
- **A shared inhibitory circuit for both exogenous and endogenous control of stimulus selection** *NATURE NEUROSCIENCE*
  Mysore, S. P., Knudsen, E. I.
  2013; 16 (4): 473-U143
- **Magnetic tracking of eye position in freely behaving chickens.** *Frontiers in systems neuroscience*
  Schwarz, J. S., Sridharan, D., Knudsen, E. I.

2013; 7: 91-?

- **Gamma Oscillations Are Generated Locally in an Attention-Related Midbrain Network** *NEURON*
  Goddard, C. A., Sridharan, D., Huguenard, J. R., Knudsen, E. I.
  2012; 73 (3): 567-580
- **Reciprocal Inhibition of Inhibition: A Circuit Motif for Flexible Categorization in Stimulus Selection** *NEURON*
  Mysore, S. P., Knudsen, E. I.
  2012; 73 (1): 193-205
- **The role of a midbrain network in competitive stimulus selection** *CURRENT OPINION IN NEUROBIOLOGY*
  Mysore, S. P., Knudsen, E. I.
  2011; 21 (4): 653-660
- **Control from below: the role of a midbrain network in spatial attention** *EUROPEAN JOURNAL OF NEUROSCIENCE*
  Knudsen, E. I.
  2011; 33 (11): 1961-1972
- **Flexible Categorization of Relative Stimulus Strength by the Optic Tectum** *JOURNAL OF NEUROSCIENCE*
  Mysore, S. P., Knudsen, E. I.
  2011; 31 (21): 7745-7752
- **Space coding by gamma oscillations in the barn owl optic tectum** *JOURNAL OF NEUROPHYSIOLOGY*
  Sridharan, D., Boahen, K., Knudsen, E. I.
  2011; 105 (5): 2005-2017
- **Rules of Competitive Stimulus Selection in a Cholinergic Isthmic Nucleus of the Owl Midbrain** *JOURNAL OF NEUROSCIENCE*
  Asadollahi, A., Mysore, S. P., Knudsen, E. I.
  2011; 31 (16): 6088-6097
- **Signaling of the Strongest Stimulus in the Owl Optic Tectum** *JOURNAL OF NEUROSCIENCE*
  Mysore, S. P., Asadollahi, A., Knudsen, E. I.
  2011; 31 (14): 5186-5196
- **Stimulus-driven competition in a cholinergic midbrain nucleus** *NATURE NEUROSCIENCE*
  Asadollahi, A., Mysore, S. P., Knudsen, E. I.
  2010; 13 (7): 889-U138
- **A Dominance Hierarchy of Auditory Spatial Cues in Barn Owls** *PLOS ONE*
  Witten, I. B., Knudsen, P. F., Knudsen, E. I.
  2010; 5 (4)
- **Global Inhibition and Stimulus Competition in the Owl Optic Tectum** *JOURNAL OF NEUROSCIENCE*
  Mysore, S. P., Asadollahi, A., Knudsen, E. I.
  2010; 30 (5): 1727-1738
- **Visual Modulation of Auditory Responses in the Owl Inferior Colliculus** *JOURNAL OF NEUROPHYSIOLOGY*
  Bergan, J. F., Knudsen, E. I.
  2009; 101 (6): 2924-2933
- **Distinct Mechanisms for Top-Down Control of Neural Gain and Sensitivity in the Owl Optic Tectum** *NEURON*
  Winkowski, D. E., Knudsen, E. I.
  2008; 60 (4): 698-708
- **A Hebbian learning rule mediates asymmetric plasticity in aligning sensory representations** *JOURNAL OF NEUROPHYSIOLOGY*
  Witten, I. B., Knudsen, E. I., Sompolinsky, H.
  2008; 100 (2): 1067-1079
- **Intrinsic excitability of cholinergic neurons in the rat parabigeminal nucleus** *JOURNAL OF NEUROPHYSIOLOGY*
  Goddard, C. A., Knudsen, E. I., Huguenard, J. R.

2007; 98 (6): 3486-3493

- **Top-down control of Multimodal sensitivity in the barn owl optic tectum** *JOURNAL OF NEUROSCIENCE*
  Winkowski, D. E., Knudsen, E. I.
  2007; 27 (48): 13279-13291
- **Adaptive auditory plasticity in developing and adult animals** *PROGRESS IN NEUROBIOLOGY*
  Keuroghlian, A. S., Knudsen, E. I.
  2007; 82 (3): 109-121
- **Fundamental components of attention** *ANNUAL REVIEW OF NEUROSCIENCE*
  Knudsen, E. I.
  2007; 30: 57-78
- **Auditory and visual space maps in the cholinergic nucleus isthmi pars parvocellularis of the barn owl** *JOURNAL OF NEUROSCIENCE*
  Maczko, K. A., Knudsen, P. F., Knudsen, E. I.
  2006; 26 (49): 12799-12806
- **Dynamic shifts in the owl's auditory space map predict moving sound location** *NATURE NEUROSCIENCE*
  Witten, I. B., Bergan, J. F., Knudsen, E. I.
  2006; 9 (11): 1439-1445
- **Adaptation in the auditory space map of the barn owl** *JOURNAL OF NEUROPHYSIOLOGY*
  Gutfreund, Y., Knudsen, E. I.
  2006; 96 (2): 813-825
- **Economic, neurobiological, and behavioral perspectives on building America's future workforce** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Knudsen, E. I., Heckman, J. J., Cameron, J. L., Shonkoff, J. P.
  2006; 103 (27): 10155-10162
- **Top-down gain control of the auditory space map by gaze control circuitry in the barn owl** *NATURE*
  Winkowski, D. E., Knudsen, E. I.
  2006; 439 (7074): 336-339
- **Auditory-visual fusion in speech perception in children with cochlear implants** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Schorr, E. A., Fox, N. A., Van Wassenhove, V., Knudsen, E. I.
  2005; 102 (51): 18748-18750
- **Why seeing is believing: Merging auditory and visual worlds** *NEURON*
  Witten, I. B., Knudsen, E. I.
  2005; 48 (3): 489-496
- **Hunting increases adaptive auditory map plasticity in adult barn owls** *JOURNAL OF NEUROSCIENCE*
  Bergan, J. F., Ro, P., Ro, D., Knudsen, E. I.
  2005; 25 (42): 9816-9820
- **Anatomical traces of juvenile learning in the auditory system of adult barn owls** *NATURE NEUROSCIENCE*
  Linkenhoker, B. A., von der Ohe, C. G., Knudsen, E. I.
  2005; 8 (1): 93-98
- **Sensitive periods in the development of the brain and behavior** *JOURNAL OF COGNITIVE NEUROSCIENCE*
  Knudsen, E. I.
  2004; 16 (8): 1412-1425
- **Multiple sites of adaptive plasticity in the owl's auditory localization pathway** *JOURNAL OF NEUROSCIENCE*
  DeBello, W. M., Knudsen, E. I.
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- **Adaptive plasticity in the auditory thalamus of juvenile barn owls** *JOURNAL OF NEUROSCIENCE*

Miller, G. L., Knudsen, E. I.
2003; 23 (3): 1059-1065

- **Incremental training increases the plasticity of the auditory space map in adult barn owls** *NATURE*
  Linkenhoker, B. A., Knudsen, E. I.
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- **Gated visual input to the central auditory system** *SCIENCE*
  Gutfreund, Y., Zheng, W. M., Knudsen, E. I.
  2002; 297 (5586): 1556-1559
- **Instructed learning in the auditory localization pathway of the barn owl** *NATURE*
  Knudsen, E. I.
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- **The optic tectum controls visually guided adaptive plasticity in the owl's auditory space map** *NATURE*
  Hyde, P. S., Knudsen, E. I.
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- **A topographic instructive signal guides the adjustment of the auditory space map in the optic tectum** *JOURNAL OF NEUROSCIENCE*
  Hyde, P. S., Knudsen, E. I.
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- **GABAergic inhibition antagonizes adaptive adjustment of the owl's auditory space map during the initial phase of plasticity** *JOURNAL OF NEUROSCIENCE*
  Zheng, W. M., Knudsen, E. I.
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- **Adaptive axonal remodeling in the midbrain auditory space map** *JOURNAL OF NEUROSCIENCE*
  DeBello, W. M., Feldman, D. E., Knudsen, E. I.
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- **Early auditory experience induces frequency-specific, adaptive plasticity in the forebrain gaze fields of the barn owl** *JOURNAL OF NEUROPHYSIOLOGY*
  Miller, G. L., Knudsen, E. I.
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- **Adaptive adjustment of connectivity in the inferior colliculus revealed by focal pharmacological inactivation** *JOURNAL OF NEUROPHYSIOLOGY*
  Gold, J. I., Knudsen, E. I.
  2001; 85 (4): 1575-1584
- **Traces of learning in the auditory localization pathway** *National Academy of Sciences Colloquium on Auditory Neuroscience - Development, Transduction, and Integration*
  Knudsen, E. I., Zheng, W. M., DeBello, W. M.
  NATL ACAD SCIENCES.2000: 11815–20
- **Topographic projection from the optic tectum to the auditory space map in the inferior colliculus of the barn owl** *JOURNAL OF COMPARATIVE NEUROLOGY*
  Hyde, P. S., Knudsen, E. I.
  2000; 421 (2): 146-160
- **A site of auditory experience-dependent plasticity in the neural representation of auditory space in the barn owl's inferior colliculus** *JOURNAL OF NEUROSCIENCE*
  Gold, J. I., Knudsen, E. I.
  2000; 20 (9): 3469-3486
- **Abnormal auditory experience induces frequency-specific adjustments in unit tuning for binaural localization cues in the optic tectum of juvenile owls** *JOURNAL OF NEUROSCIENCE*
  Gold, J. I., Knudsen, E. I.
  2000; 20 (2): 862-877

- **Hearing impairment induces frequency-specific adjustments in auditory spatial tuning in the optic tectum of young owls** *JOURNAL OF NEUROPHYSIOLOGY*
  Gold, J. I., Knudsen, E. I.
  1999; 82 (5): 2197-2209
- **Mechanisms of experience-dependent plasticity in the auditory localization pathway of the barn owl** *JOURNAL OF COMPARATIVE PHYSIOLOGY A-NEUROETHOLOGY SENSORY NEURAL AND BEHAVIORAL PHYSIOLOGY*
  Knudsen, E. I.
  1999; 185 (4): 305-321
- **Functional selection of adaptive auditory space map by GABA(A)-mediated inhibition** *SCIENCE*
  Zheng, W. M., Knudsen, E. I.
  1999; 284 (5416): 962-965
- **Early visual experience shapes the representation of auditory space in the forebrain gaze fields of the barn owl** *JOURNAL OF NEUROSCIENCE*
  Miller, G. L., Knudsen, E. I.
  1999; 19 (6): 2326-2336
- **Maps versus clusters: different representations of auditory space in the midbrain and forebrain** *TRENDS IN NEUROSCIENCES*
  Cohen, Y. E., Knudsen, E. I.
  1999; 22 (3): 128-135
- **Experience-dependent plasticity and the maturation of glutamatergic synapses** *NEURON*
  Feldman, D. E., Knudsen, E. I.
  1998; 20 (6): 1067-1071
- **Sensitive periods for visual calibration of the auditory space map in the barn owl optic tectum** *JOURNAL OF NEUROSCIENCE*
  Brainard, M. S., Knudsen, E. I.
  1998; 18 (10): 3929-3942
- **Pharmacological specialization of learned auditory responses in the inferior colliculus of the barn owl** *JOURNAL OF NEUROSCIENCE*
  Feldman, D. E., Knudsen, E. I.
  1998; 18 (8): 3073-3087
- **Capacity for plasticity in the adult owl auditory system expanded by juvenile experience** *SCIENCE*
  Knudsen, E. I.
  1998; 279 (5356): 1531-1533
- **Forebrain pathway for auditory space processing in the barn owl** *JOURNAL OF NEUROPHYSIOLOGY*
  Cohen, Y. E., Miller, G. L., Knudsen, E. I.
  1998; 79 (2): 891-902
- **Representation of binaural spatial cues in Field L of the barn owl forebrain** *JOURNAL OF NEUROPHYSIOLOGY*
  Cohen, Y. E., Knudsen, E. I.
  1998; 79 (2): 879-890
- **An anatomical basis for visual calibration of the auditory space map in the barn owl's midbrain** *JOURNAL OF NEUROSCIENCE*
  Feldman, D. E., Knudsen, E. I.
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- **Representation of frequency in the primary auditory field of the barn owl forebrain** *JOURNAL OF NEUROPHYSIOLOGY*
  Cohen, Y. E., Knudsen, E. I.
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- **Disruption of auditory spatial working memory by inactivation of the forebrain archistriatum in barn owls** *NATURE*
  Knudsen, E. I., KNUDSEN, P. F.
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- **Contribution of the forebrain archistriatal gaze fields to auditory orienting behavior in the barn owl** *EXPERIMENTAL BRAIN RESEARCH*

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- **Newly learned auditory responses mediated by NMDA receptors in the owl inferior colliculus** *SCIENCE*
  Feldman, D. E., Brainard, M. S., Knudsen, E. I.
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- **BINAURAL TUNING OF AUDITORY UNITS IN THE FOREBRAIN ARCHISTRIATAL GAZE FIELDS OF THE BARN OWL - LOCAL-ORGANIZATION BUT NO SPACE MAP** *JOURNAL OF NEUROSCIENCE*
  Cohen, Y. E., Knudsen, E. I.
  1995; 15 (7): 5152-5168
- **CHARACTERIZATION OF A FOREBRAIN GAZE FIELD IN THE ARCHISTRIATUM OF THE BARN OWL - MICROSTIMULATION AND ANATOMICAL CONNECTIONS** *JOURNAL OF NEUROSCIENCE*
  Knudsen, E. I., Cohen, Y. E., MASINO, T.
  1995; 15 (7): 5139-5151
- **DYNAMICS OF VISUALLY GUIDED AUDITORY PLASTICITY IN THE OPTIC TECTUM OF THE BARN OWL** *JOURNAL OF NEUROPHYSIOLOGY*
  Brainard, M. S., Knudsen, E. I.
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- **CREATING A UNIFIED REPRESENTATION OF VISUAL AND AUDITORY SPACE IN THE BRAIN** *ANNUAL REVIEW OF NEUROSCIENCE*
  Knudsen, E. I., Brainard, M. S.
  1995; 18: 19-43
- **SITE OF AUDITORY PLASTICITY IN THE BRAIN-STEM (VLVP) OF THE OWL REVEALED BY EARLY MONAURAL OCCLUSION** *JOURNAL OF NEUROPHYSIOLOGY*
  Mogdans, J., Knudsen, E. I.
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- **NMDA AND NON-NMDA GLUTAMATE RECEPTORS IN AUDITORY TRANSMISSION IN THE BARN OWL INFERIOR COLLICULUS** *JOURNAL OF NEUROSCIENCE*
  Feldman, D. E., Knudsen, E. I.
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- **SUPERVISED LEARNING IN THE BRAIN** *JOURNAL OF NEUROSCIENCE*
  Knudsen, E. I.
  1994; 14 (7): 3985-3997
- **AUDITORY TUNING FOR SPATIAL CUES IN THE BARN OWL BASAL GANGLIA** *JOURNAL OF NEUROPHYSIOLOGY*
  Cohen, Y. E., Knudsen, E. I.
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- **REPRESENTATION OF INTERAURAL LEVEL DIFFERENCE IN THE VLVP, THE FIRST SITE OF BINAURAL COMPARISON IN THE BARN OWLS AUDITORY-SYSTEM** *HEARING RESEARCH*
  Mogdans, J., Knudsen, E. I.
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- **ADAPTIVE PLASTICITY OF THE AUDITORY SPACE MAP IN THE OPTIC TECTUM OF ADULT AND BABY BARN OWLS IN RESPONSE TO EXTERNAL EAR MODIFICATION** *JOURNAL OF NEUROPHYSIOLOGY*
  Knudsen, E. I., ESTERLY, S. D., Olsen, J. F.
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  Brainard, M. S., Knudsen, E. I.
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- **EARLY MONAURAL OCCLUSION ALTERS THE NEURAL MAP OF INTERAURAL LEVEL DIFFERENCES IN THE INFERIOR COLLICULUS OF THE BARN OWL** *BRAIN RESEARCH*

Mogdans, J., Knudsen, E. I.
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- **PARALLEL PATHWAYS MEDIATING BOTH SOUND LOCALIZATION AND GAZE CONTROL IN THE FOREBRAIN AND MIDBRAIN OF THE BARN OWL** *JOURNAL OF NEUROSCIENCE*
  Knudsen, E. I., KNUDSEN, P. F., MASINO, T.
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- **ORIENTING HEAD MOVEMENTS RESULTING FROM ELECTRICAL MICROSTIMULATION OF THE BRAIN-STEM TEGMENTUM IN THE BARN OWL** *JOURNAL OF NEUROSCIENCE*
  MASINO, T., Knudsen, E. I.
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- **AUDITORY LEARNING IN OWLS** *7th Novo Nordisk Foundation Symposium on Memory Concepts - 1993*
  Brainard, M. S., Knudsen, E. I.
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- **VISUAL CALIBRATION OF THE NEURAL REPRESENTATION OF AUDITORY SPACE IN THE BARN OWL** *3rd International Symposium on Dynamics of Perception*
  Brainard, M. S., Knudsen, E. I.
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- **ANATOMICAL PATHWAYS FROM THE OPTIC TECTUM TO THE SPINAL-CORD SUBSERVING ORIENTING MOVEMENTS IN THE BARN OWL** *EXPERIMENTAL BRAIN RESEARCH*
  MASINO, T., Knudsen, E. I.
  1992; 92 (2): 194-208
- **ADAPTIVE ADJUSTMENT OF UNIT TUNING TO SOUND LOCALIZATION CUES IN RESPONSE TO MONAURAL OCCLUSION IN DEVELOPING OWL OPTIC TECTUM** *JOURNAL OF NEUROSCIENCE*
  Mogdans, J., Knudsen, E. I.
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- **VISION-INDEPENDENT ADJUSTMENT OF UNIT TUNING TO SOUND LOCALIZATION CUES IN RESPONSE TO MONAURAL OCCLUSION IN DEVELOPING OWL OPTIC TECTUM** *JOURNAL OF NEUROSCIENCE*
  Knudsen, E. I., Mogdans, J.
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- **NEURAL DERIVATION OF SOUND SOURCE LOCATION - RESOLUTION OF SPATIAL AMBIGUITIES IN BINAURAL CUES** *JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA*
  Brainard, M. S., Knudsen, E. I., ESTERLY, S. D.
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- **Dynamic space codes in the superior colliculus.** *Current opinion in neurobiology*
  Knudsen, E. I.
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- **VISUAL INSTRUCTION OF THE NEURAL MAP OF AUDITORY SPACE IN THE DEVELOPING OPTIC TECTUM** *SCIENCE*
  Knudsen, E. I., Brainard, M. S.
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- **STRETCHED AND UPSIDE-DOWN MAPS OF AUDITORY SPACE IN THE OPTIC TECTUM OF BLIND-REARED OWLS - ACOUSTIC BASIS AND BEHAVIORAL-CORRELATES** *JOURNAL OF NEUROSCIENCE*
  Knudsen, E. I., ESTERLY, S. D., DULAC, S.
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- **EARLY VISUAL DEPRIVATION RESULTS IN A DEGRADED MOTOR MAP IN THE OPTIC TECTUM OF BARN OWLS** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  DULAC, S., Knudsen, E. I.
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