CmpE 489/COGS 500: Cognitive Science

Week 5

Multisensory integration

Adapted from Albert Ali Salah's slides

Feedback summary

- neuron model representations
  - Quiz+assignment
  - Extra lecture?
- Havada kaliyor – muhendislik/bilim
  - Programming hws?
- Add-drop: program tekrardan aciklandi
- Some examples do together
- not from social sciences, feel lost → Readings at copy store
- 2-3 hafta oncesinden readingler - sinav

- Icerik, misafir konusmacilar iyi
- Intro olarak yeterli
- Ogrenci cesitliligi: konular havada, muhendislik
- Midterm?
- Okumalar:
  - Farklı backgroundlardan gelen öğrenciler için ek okumaların artırılması verimliliği artırabilir.
  - Readings at copy store

Change in policy

- Group 1 (original)
  - 10 assignments: 30%
  - Midterm: 20%
  - Final: 20%
- Group 2 (new)
  - 4 assignments: 10%
  - Midterm: 30%
  - Final: 30%

Midterm

- 07.11.2017?

Quiz

- Write down the general difference between David Marr's and Tim Van Gelder's approaches to cognition.
- Should we get rid of computation if mind works in a non-representational way?

Perceptual fusion

- Individual senses
- Interactions between all “five” senses
- Types of fusion
  - Perceptual fusion
  - Immediate cross-modal bias
  - After effects

Methods to study multi-sensory integration

- Providing contradictory stimuli

Prism experiments

- George Stratton, 1897
  - inverted vision
  - recalibration of touch, movement and sound perception
  - 6 days for adaptation
- Linden et al., 1999, “The myth of upright vision”
  - no inverted vision
  - but rapid adaptation

Prism experiments

https://www.york.ac.uk/psychology/about/outreach/prisms/

- Role of interaction

Baby barn owl

SCIENTIFIC AMERICAN

SPACE PERCEPTION IN THE CHICK
Author(s): Eckhard H. Hess
Source: *Scientific American*, Vol. 195, No. 1 (July 1956), pp. 71-82

The Journal of Neuroscience, September 1989, 9(9): 3297–3305

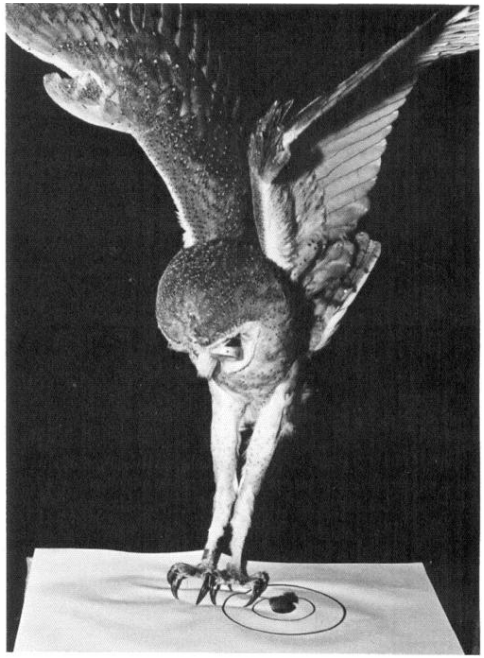
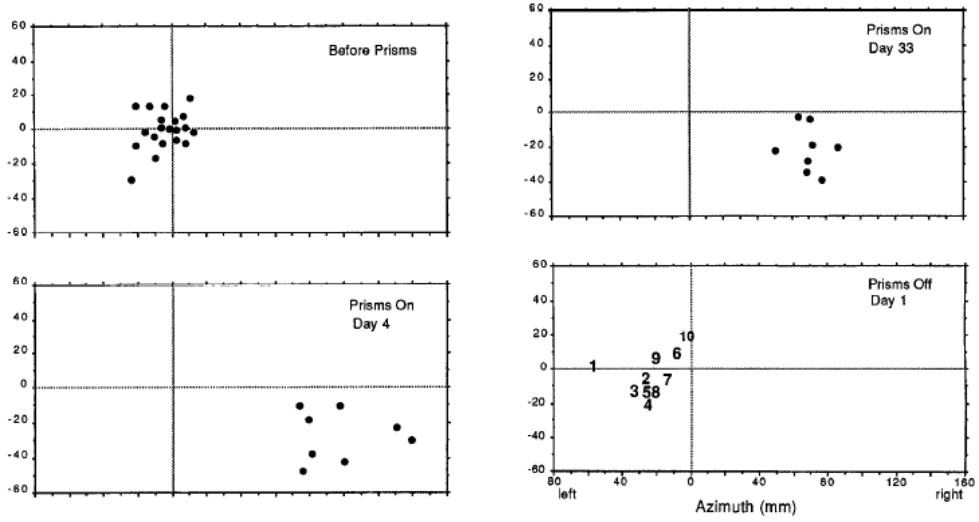


Figure 1. A strike by owl 3 after 60 d of prism experience. The ow had worn prisms from the day the eyelids first opened. The prisms displaced the visual field 23° to the right. Visuomotor adaptation is fa from complete. The bull's-eye target was used for photography only Normally, the target was placed on a uniformly white piece of paper.

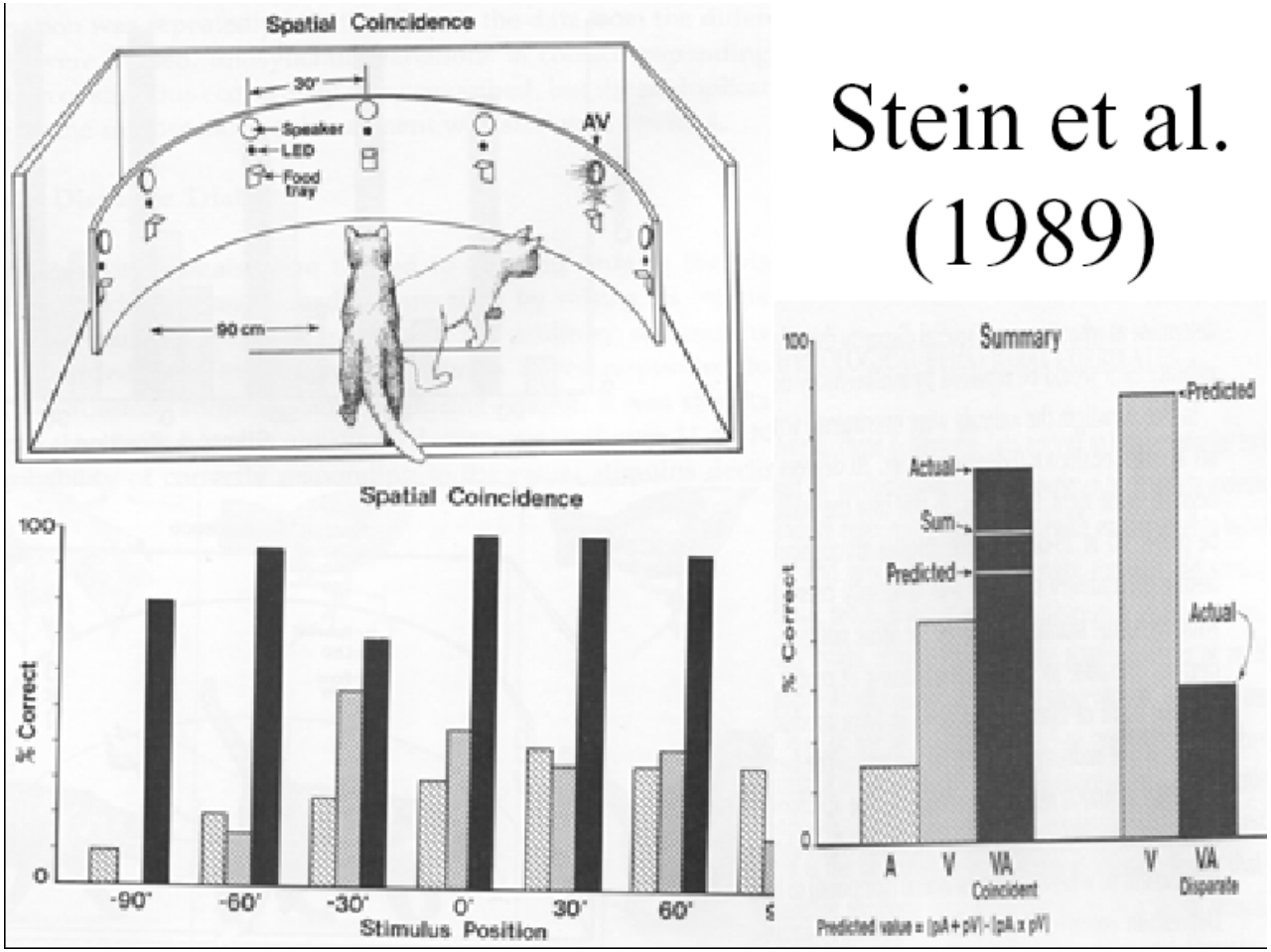
Visuomotor Adaptation to Displacing Prisms by Adult and Baby Barn Owls

Eric I. Knudsen and Phyllis F. Knudsen

Department of Neurobiology, Stanford University School of Medicine, Stanford, California 94305

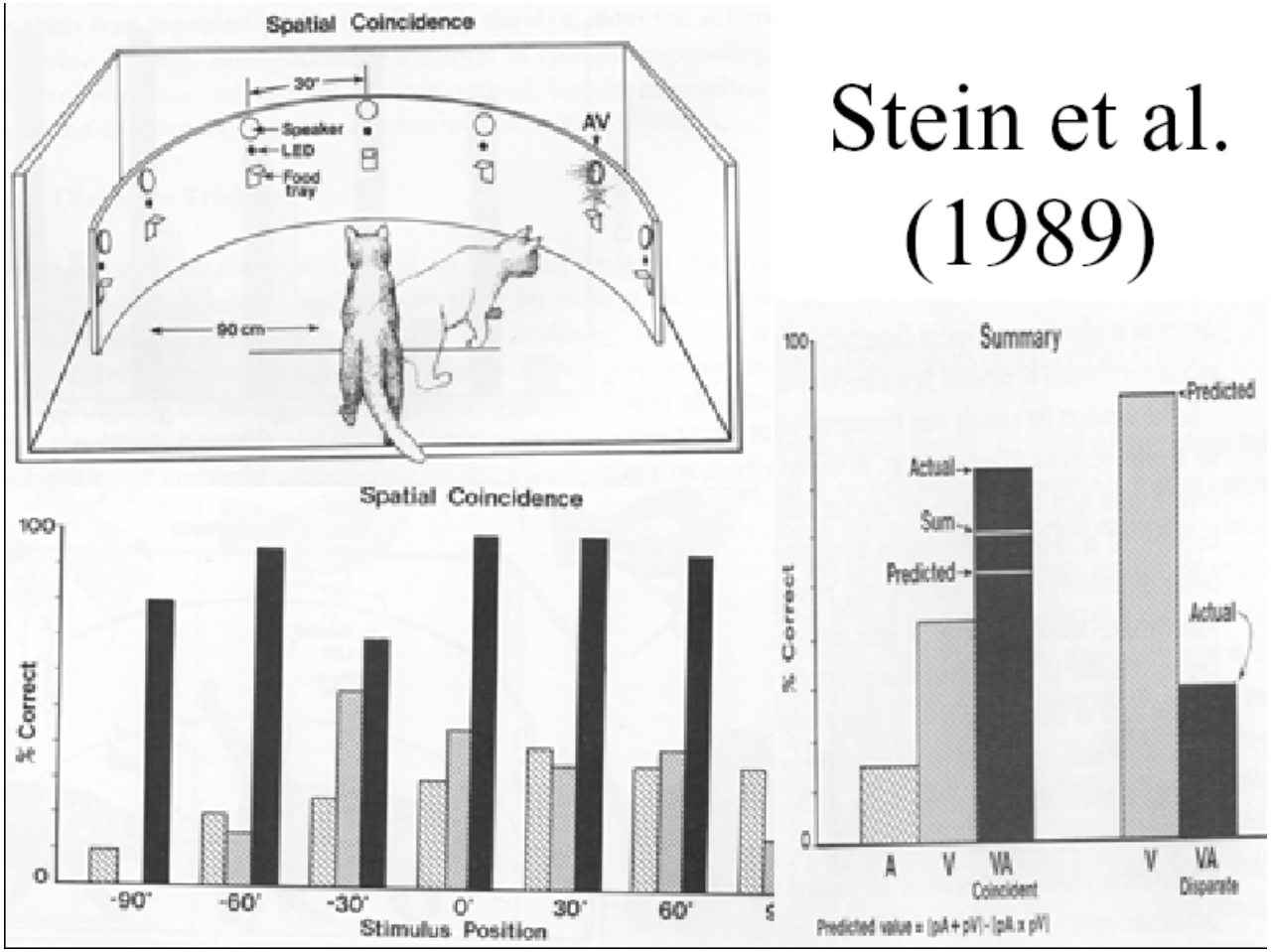


Multisensory integration in cortex



Stein et al. (1989)

Multisensory integration in cortex



Stein et al. (1989)

Sight and hearing: Mc Gurk effect

letters to nature

Nature **264**, 746 - 748 (23 December 1976); doi:10.1038/264746a0

Hearing lips and seeing voices

HARRY MCGURK & JOHN MACDONALD

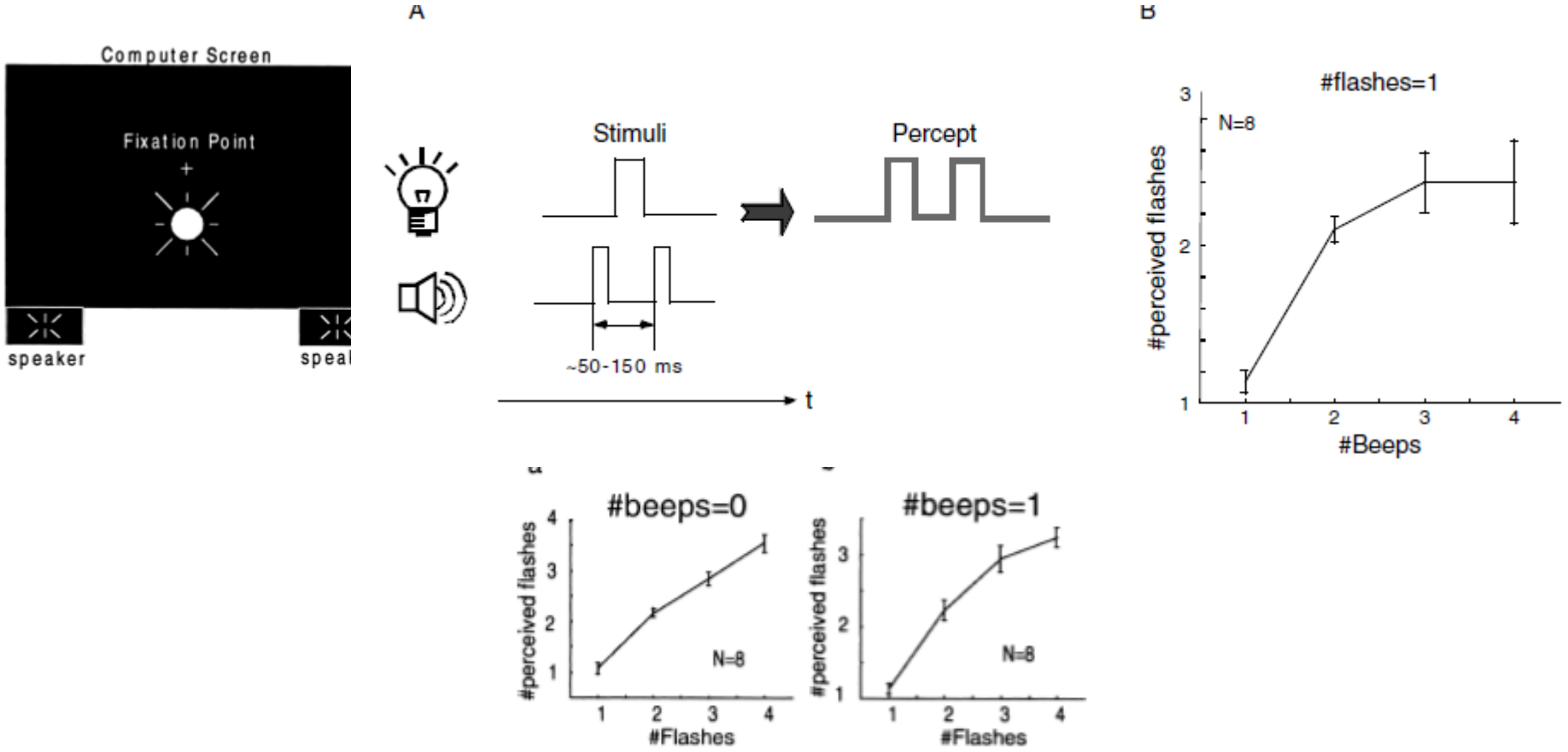
Department of Psychology, University of Surrey, Guildford, Surrey GU2 5XH, UK

MOST verbal communication occurs in contexts where the listener can see the speaker as well as hear him. However, speech perception is normally regarded as a purely auditory process. The study reported here demonstrates a previously unrecognised influence of vision upon speech perception. It stems from an observation that, on being shown a film of a young woman's talking head, in which repeated utterances of the syllable [ba] had been dubbed on to lip movements for [ga], normal adults reported hearing [da]. With the reverse dubbing process, a majority reported hearing [bagba] or [gaba]. When these subjects listened to the soundtrack from the film, without visual input, or when they watched untreated film, they reported the syllables accurately as repetitions of [ba] or [ga]. Subsequent replications confirm the reliability of these findings; they have important implications for the understanding of speech perception.

Sight and hearing: Ventriloquist illusion

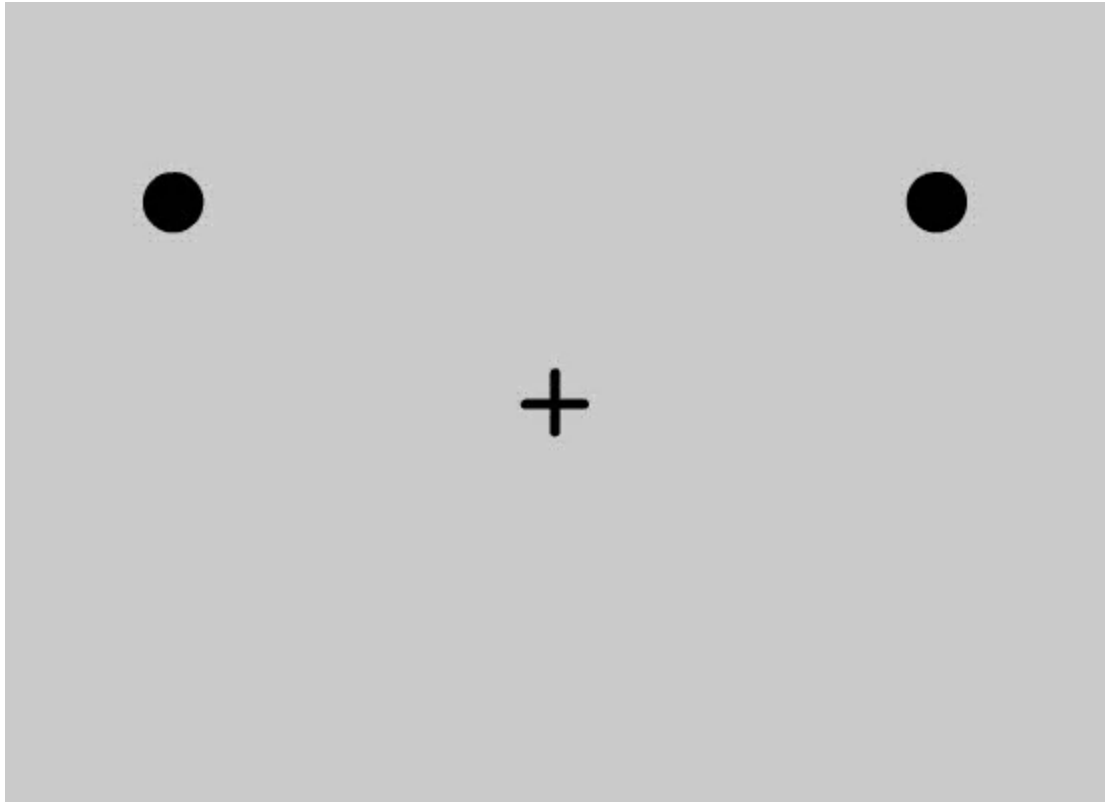
- ventriloquist effect (Howard & Templeton,1966)

Sight and hearing: Flashes and beeps



Shams, L., Y. Kamitani, S. Shimojo, Nature, 2000.

Sight and hearing: Moving disks



Sekuler, Lau, Sekuler, Nature, 1997

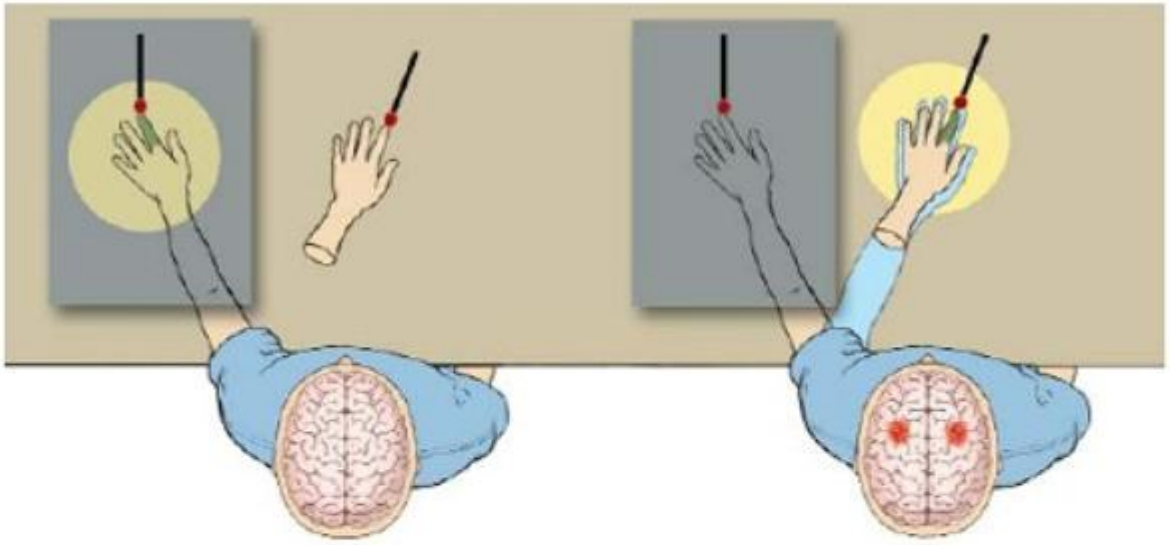
http://www.michaelbach.de/ot/mot_bounce/

Cocktail party effect

Illusion – fooling the self-perception

- How to fool visual perception?

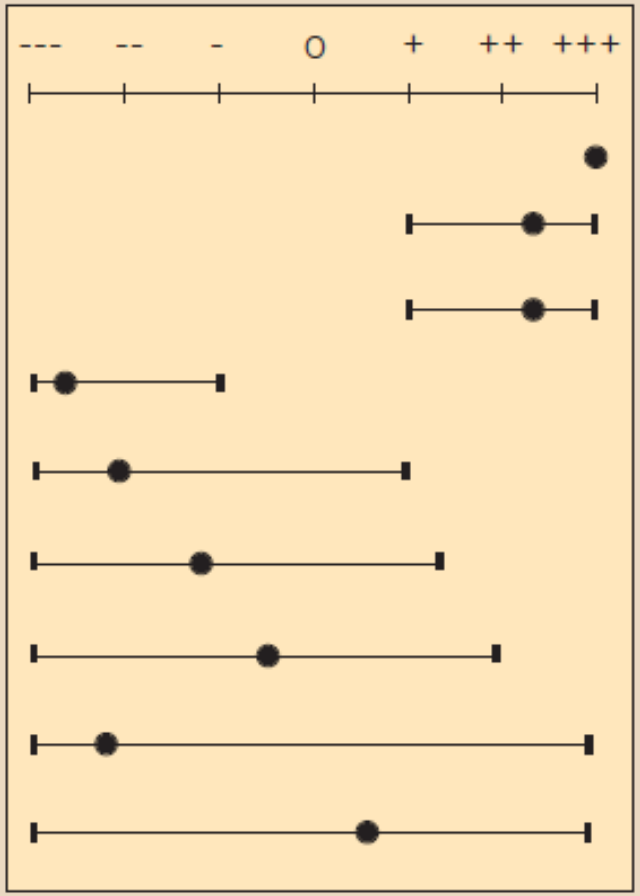
Sight and touch: Rubber hand illusion



Botvinick & Cohen,Nature 391, 1998

Rubber hands feel touch that eyes see

Sight and touch: Rubber hand illusion



During the experiment there were times when:

- It seemed as if I were feeling the touch of the paintbrush in the location where I saw the rubber hand touched.
- It seemed as though the touch I felt was caused by the paintbrush touching the rubber hand.
- I felt as if the rubber hand were my hand.
- It felt as if my (real) hand were drifting towards the right (towards the rubber hand).
- It seemed as if I might have more than one left hand or arm.
- It seemed as if the touch I was feeling came from somewhere between my own hand and the rubber hand.
- It felt as if my (real) hand were turning 'rubbery'.
- It appeared (visually) as if the rubber hand were drifting towards the left (towards my hand).
- The rubber hand began to resemble my own (real) hand, in terms of shape, skin tone, freckles or some other visual feature.

Botvinick, M., J. Cohen, Nature, vol.391, pp.756, 1998.

Touch and hearing: Parchment illusion

- Jousmäki and Hari (1998)
- Rubbing hands while listening to sounds
- Changing frequency
- Subjective feeling of dry or moisturized hands obtained

Touch and smell: Silk stockings

- Among identical stockings, the one that smelled like flowers was found to be of higher quality (Laird, 1932)
- Subjects did not refer to olfaction to explain their decisions
- Smells are found to influence perceived softness of textiles.

Sight and smell: Wine tasting

- Fake color can mislead wine experts
- With closed eyes, the experts have a much higher success rate
- Facilitation of smell perception in the presence of correlated visual input (Gottfried and Dolan, 2003)
- Certains smells are consistently associated with certain colors in naming tasks (Gilbert et al. 1996)

Taste and smell: Apples and potatoes

- Without smell, taste perception is impaired
- Some taste perceptions increase sensitivity to smells with which they are associated (Diamond et al. 2005)
- It is possible to teach subjects new taste-smell pairings
- Areas that respond to both smell and taste are in the caudal orbitofrontal cortex, amygdala, insular cortex and its adjoining areas, and anterior cingulate cortex (De Araujo et al., 2003).

Modulations of Visual Perception by Sound

- Vision alters other modalities
  - McGurk effect, ventriloquist effect
  - Rubber hand, Touch/view → draw
- Sound changes temporal resolution, duration, rate, → modality appropriateness
  - Vision has higher spatial resolution
  - Audition has higher temporal resolution
- Sound can
  - alter the interpretation of ambiguous visual motion event
  - alter perception of non-ambiguous visual events
  - create new perception. induced rabbit from Kamitani group.
  - Alter vision in motion perception.
-

Activity

- Which modality dominates, and why?
- How can you test this?

Dominance of modalities

- *Discontinuity Hypothesis*
  - Shams, Kamitani ve Shimojo, 2002
  - The modality where perception is discontinued is dominant
- *Modality Appropriateness Hypothesis*
  - Welch ve Warren, 1980
  - The modality that facilitates the task is dominant
- *Information Reliability Hypothesis*
  - Schwartz, Robert-Ribes ve Escudier, 1998
  - The reliable modality is dominant
- *Directed Attention Hypothesis*
  - Welch ve Warren, 1980
  - The attended modality is dominant

- Colliding / transpassing balls
- Count lights and sounds
- Barn owls' sound localization error
- Ventriloquist effect
- Cocktail party

Perceptual Integration – Neural Evidence

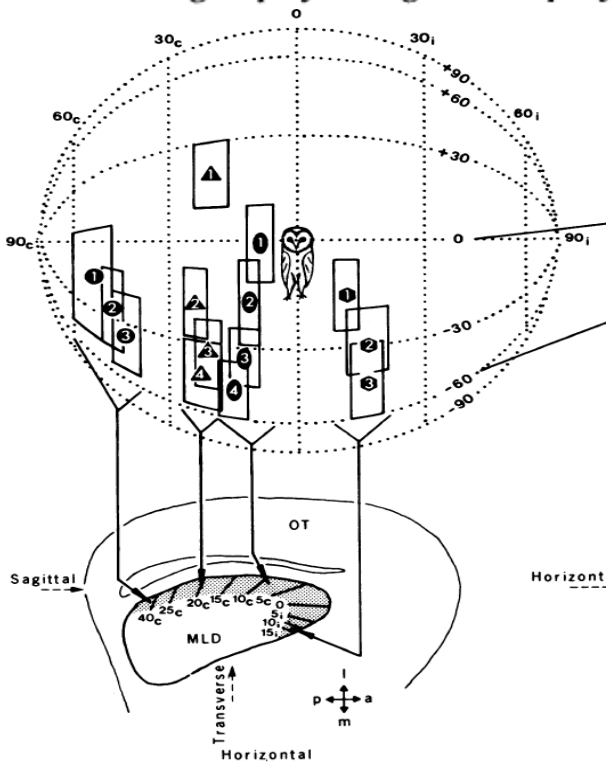
Receptive fields

- The **receptive field** of an individual sensory neuron is the particular region of the sensory space (e.g., the body surface, or the visual field) in which a stimulus will modify the firing of that neuron. Receptive fields corresponding to
  - Simple/complex cells in V1 area
  - Neurons in somatosensory and primary motor cortices
  - Auditory cortex?

Baby barn owl

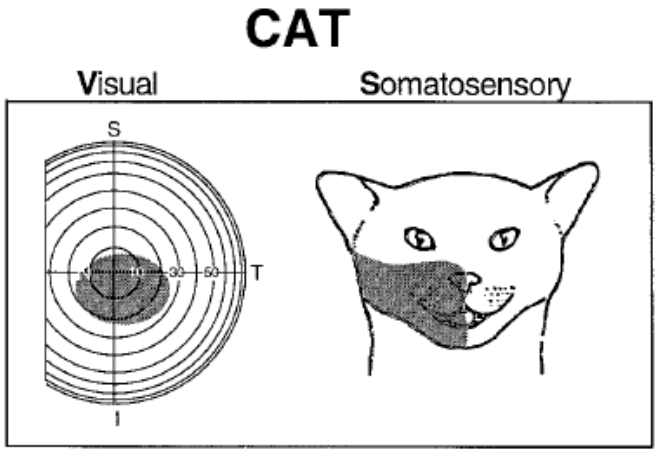
A Neural Map of Auditory Space in the Owl

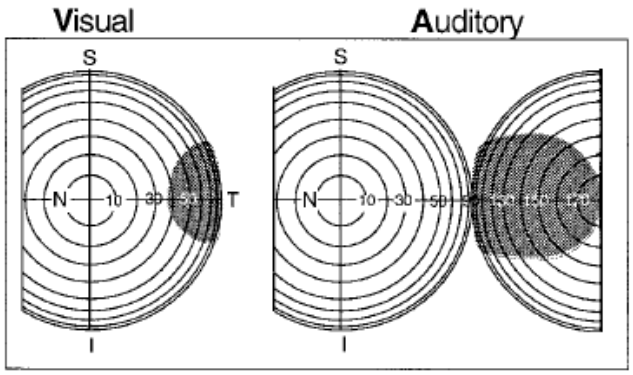
Abstract. *Auditory units that responded to sound only when it originated from a limited area of space were found in the lateral and anterior portions of the midbrain auditory nucleus of the owl* (Tyto alba). *The areas of space to which these units responded (their receptive fields) were largely independent of the nature and intensity of the sound stimulus. The units were arranged systematically within the midbrain auditory nucleus according to the relative locations of their receptive fields, thus creating a physiological map of auditory space.*

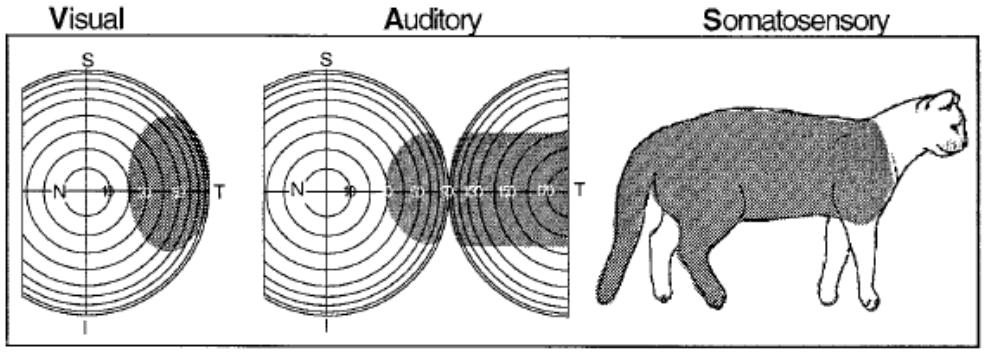


A neural map of auditory space in the owl Knudsen, Eric I. and Konishi, Masakazu (1978) A neural map of auditory space in the owl. Science, 200 (4343). pp. 795-797

Receptive fields



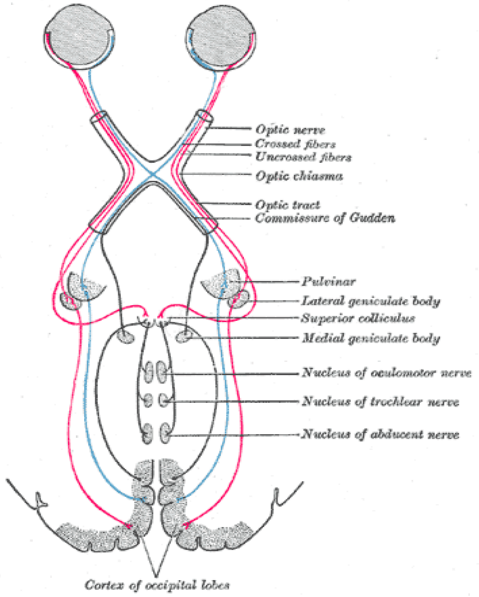


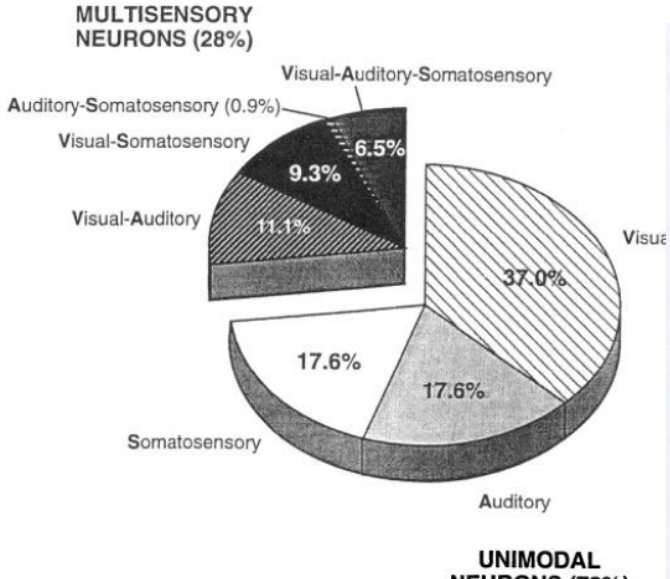


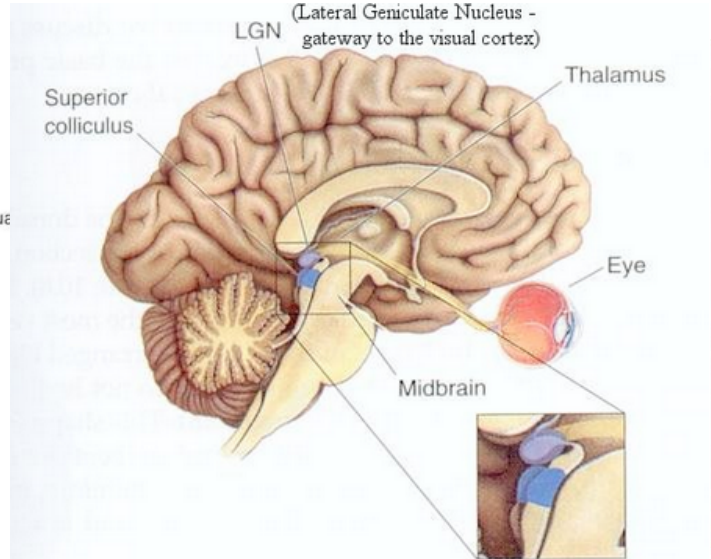
Wallace and Stein, 1996

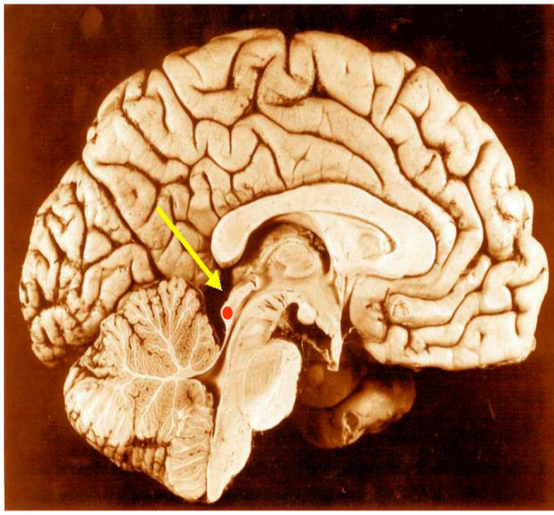
Superior colliculus

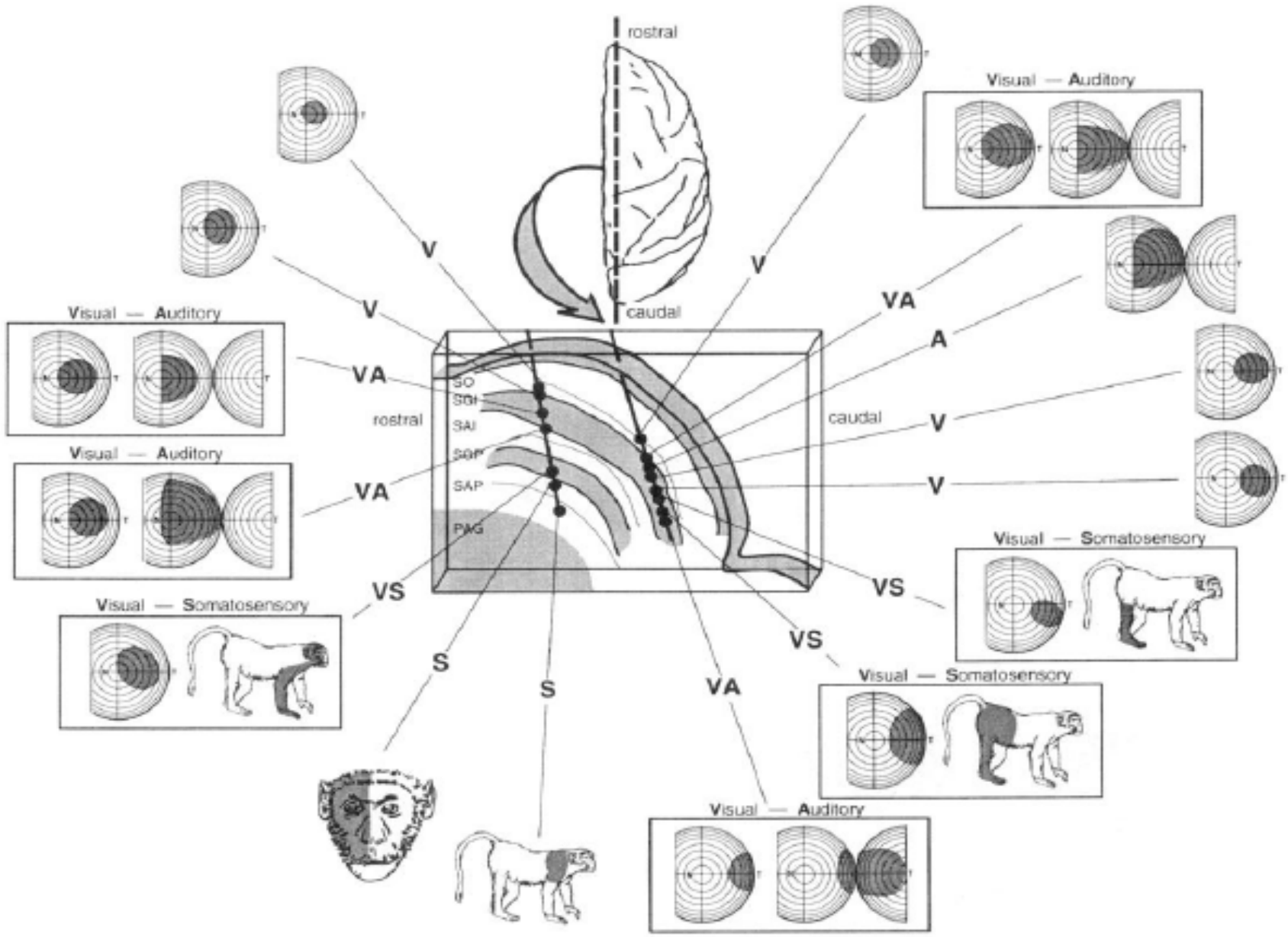
- A paired structure of the mammalian midbrain.
- Other vertebrates: optic tectum










rostral
caudal
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PMG
rostral
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Visual — Auditory
Visual — Auditory
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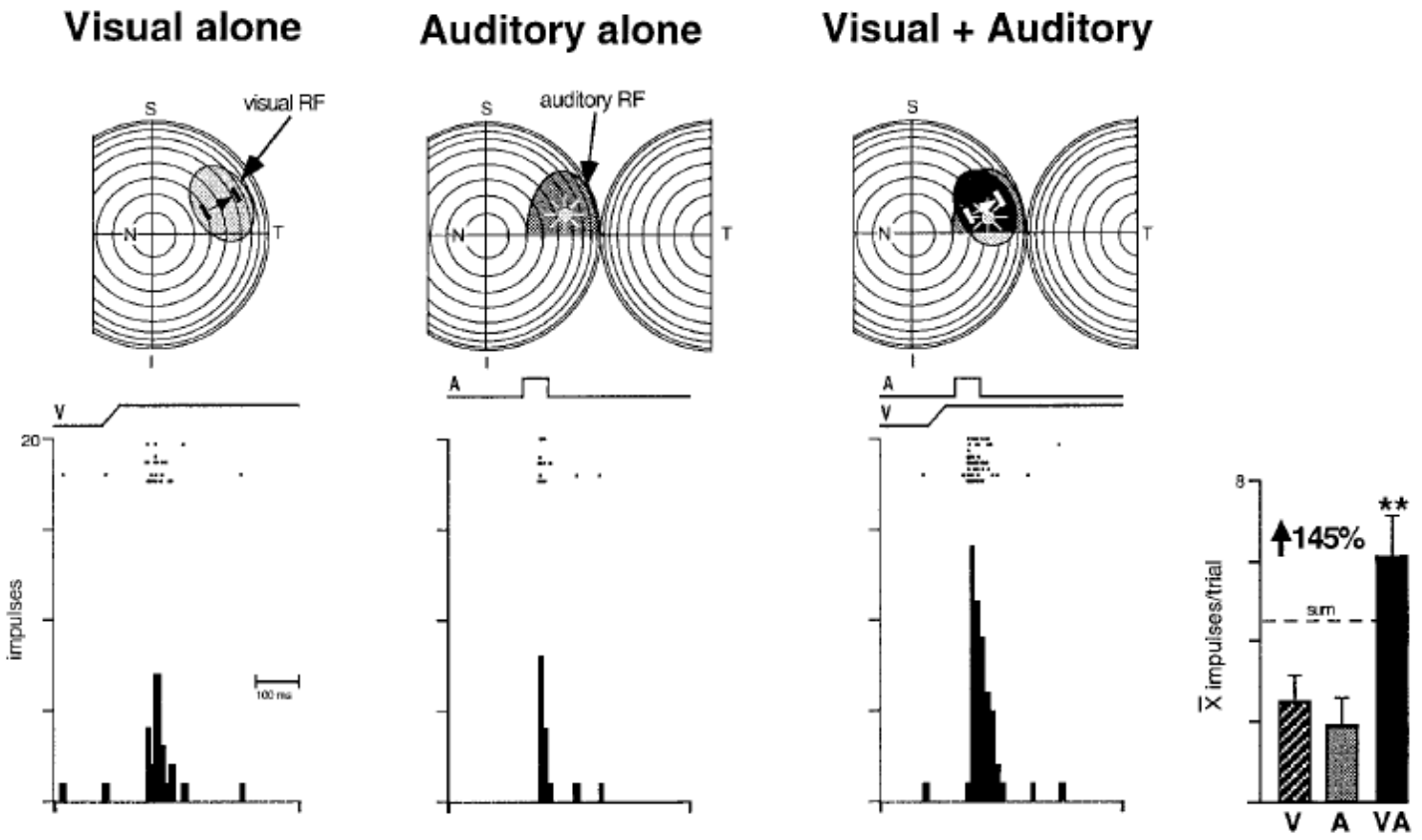
Visual — Somatosensory
Visual — Somatosensory
Visual — Auditory

Multisensory enhancement



Wallace and Stein, 1996