Cognitive Media Processing #4

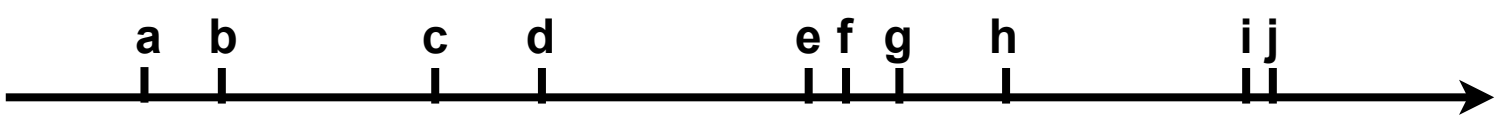
Nobuaki Minematsu

Menu of the last lecture

- Emotional and expressive information processing
  - Definition of emotional and expressive information
  - Quantitative measurement of the information
  - Emotion and the brain -- which region of the brain deals with the emotion?
- Emotional information and multimedia sensory information
  - The five senses and emotion
  - Integration of information transmitted using different kinds of media
- Transmission of emotional information
  - Encoding, transmission, and decoding of the information
  - PUI, visualization, facial expressions, etc
  - Some examples of emotional systems
- Summary
- Announcement on the next lecture
  - The first assignment is given at the end of the next lecture.

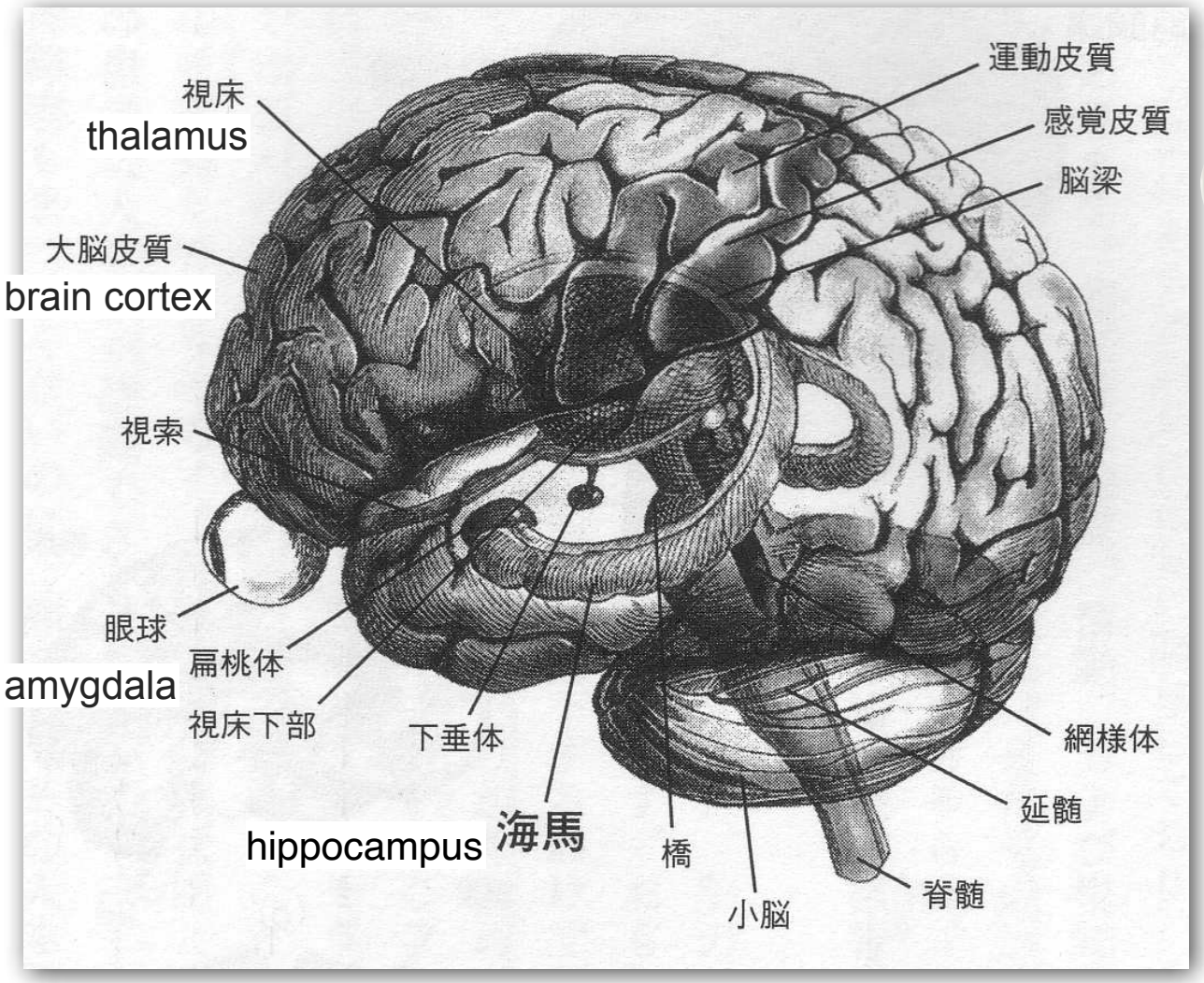
Quantification of expressive info.

- Quantitative representation of expressive information
  - Mapping from a physical media space into an expressive media space.
    - Use of questionnaire (subjective judgment) to give some quantitative scores to emotional expressions such as expressive arts and products.
      - Quantification of expressiveness
    - ME (Magnitude Estimation) method
      - Subjects give scores of magnitude to a given stimulus by comparing it to the standard stimulus.
      - Mapping between scores and a set of stimuli is done by assuming the power law (べき法則) between physical observation and our sensation.
    - Paired comparison (一対比較法)
      - Out of N stimuli, subjects have to compare all the possible pairs (${}_N C_2$) and select one which has a larger magnitude.
        - The number of comparisons is proportional to N^2.
      - All the stimuli can be aligned (plotted) on a single scale of the property of interest.
    - Multi-dimensional scaling (MDS)
      - Subjective difference is quantitatively measured between any pair of the N stimuli of interest.
      - An N x N distance matrix can define a geometrical shape in a multi-dimensional space.
      - This shape is projected nonlinearly onto a two-dimensional plane.



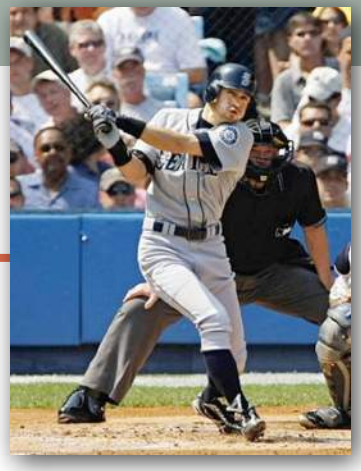
Emotions and the brain

- Which region of the brain process the emotion?
  - Deep structure of the brain



Location of the two amygdalae

From the old brain to the new b



- Low road and high road
  - Sensory inputs are collected to reach Thalamus (視床).
  - Neural activities are transmitted to the cortex (new) and to Amygdala (old).
  - Processing in the old brain is faster than that in the new brain.

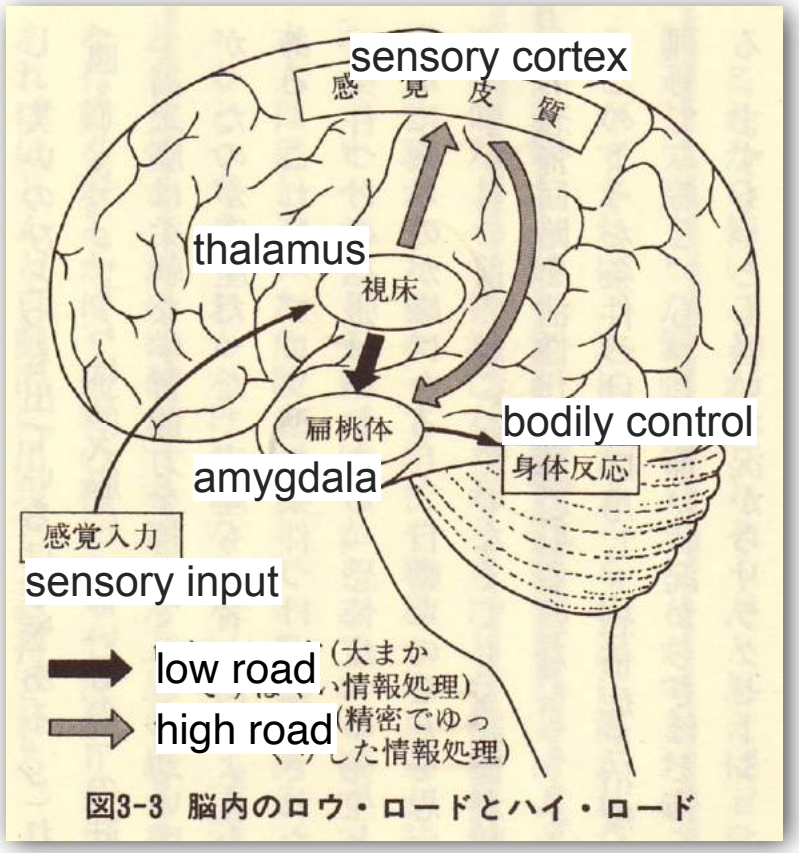


図3-3 脳内のロウ・ロードとハイ・ロード

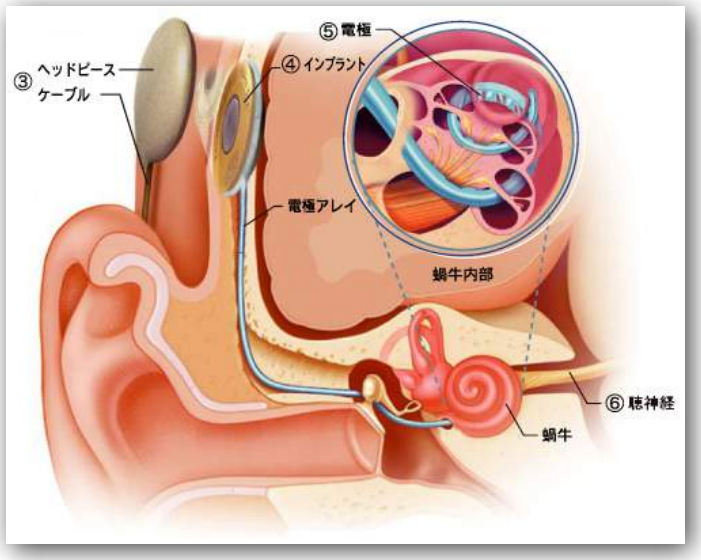
Monkeys are frightened at a swinging/moving rope because the rope reminds the monkeys of snakes. This is the case even when the monkeys have never seen snakes in their lives so far.

Emotions and multimedia

- Practical applications to support handicapped individuals
  - Machines (mechanical sensors) and the brain (the nerves) are connected.

This artificial arm/hand can sense the heat!!

This wheelchair can be controlled by “wishing.”



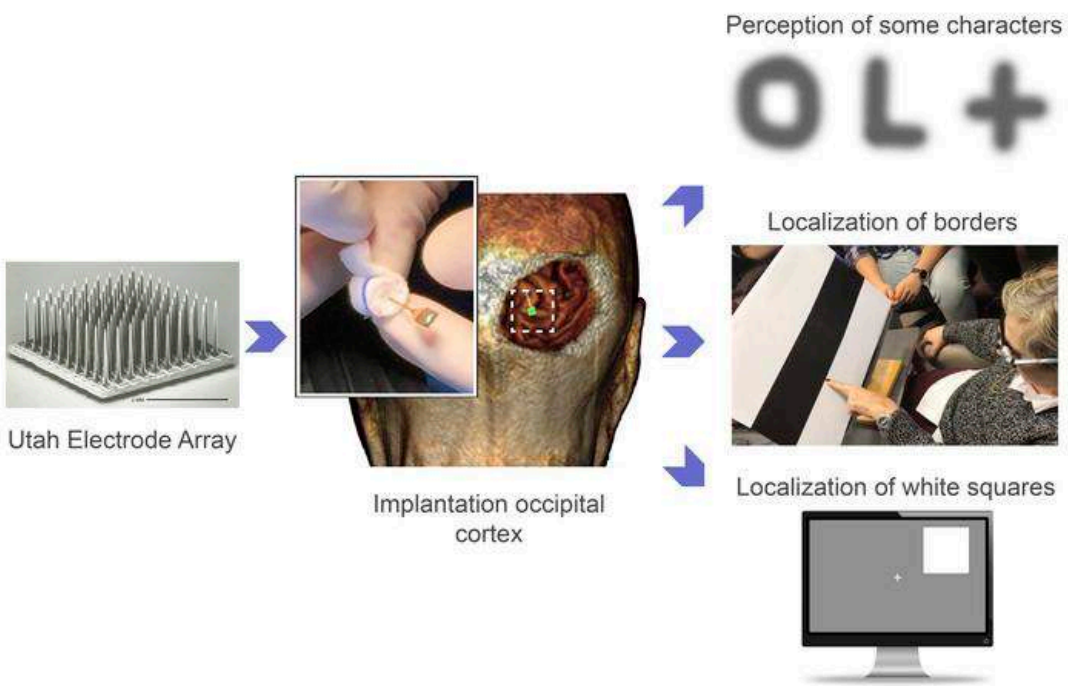
Cochlear implant

Integration or replacement of sensation

- “I can see through my tongue.”
  - CCD camera’s output (images) are transmitted to the tongue as electric signals.
    - Plasticity of the brain (脳の可塑性)
  - Blind individuals can see objects.
    - Individuals who were born as blind can see for the first time in their lives!!
    - Our sensation of “seeing” is the same as their sensation of “seeing”?

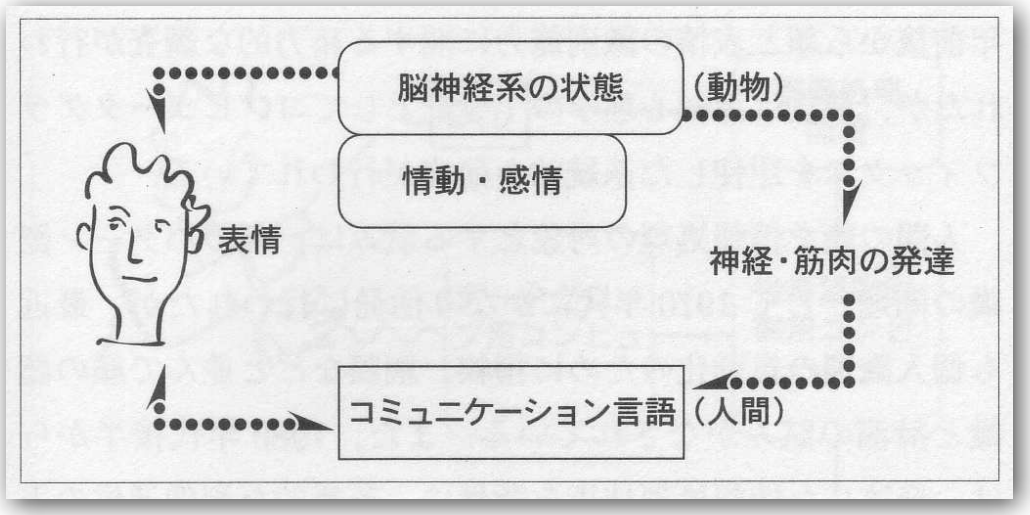
Integration or replacement of sensation

- A digital camera is connected directly to one's visual cortex.
  - "Visual percepts evoked with an Intracortical 96-channel microelectrode array inserted in human occipital cortex," *J. Clinical Investigation*, 2021
    - https://doi.org/10.1172/JCI151331



Face! Face! Face!

- Facial expression and expressive information
  - Control of facial muscles = unconscious control
    - This is the reason why an intentional (feigned/fake) smile is unnatural.
  - Expressive (and unconscious) information communication using faces.
    - This strategy is possessed only by humans and anthropoid apes (類人猿).
    - Autistic individuals have a severe difficulty on reading facial expressions.
      - Lack of the theory of mind.
    - Normally developed individuals, even young children, are experts of reading faces.
  - Newly born babies (1 hour after birth) have ability of face discrimination
    - Face discrimination ability is inborn, not acquired through experiences.



Face! Face! Face!

- Some experimental facts

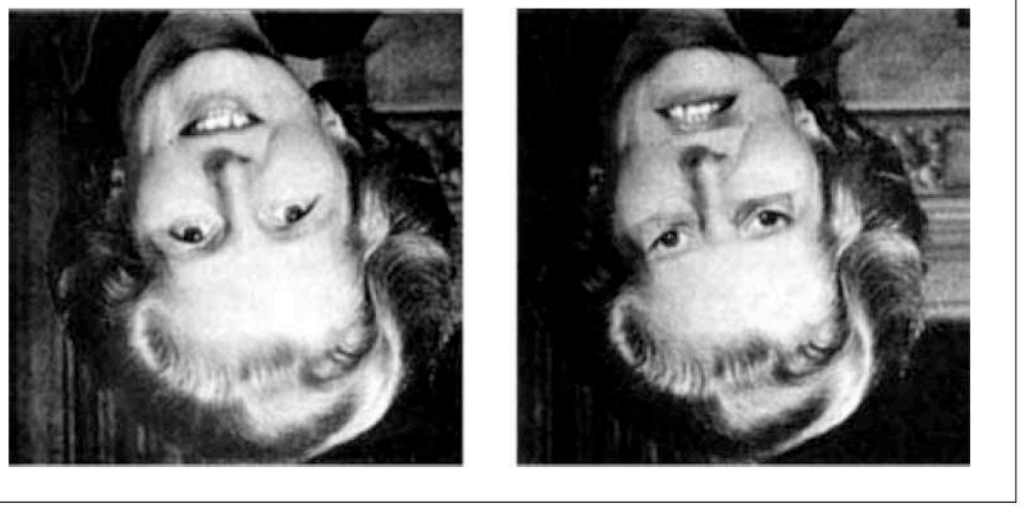
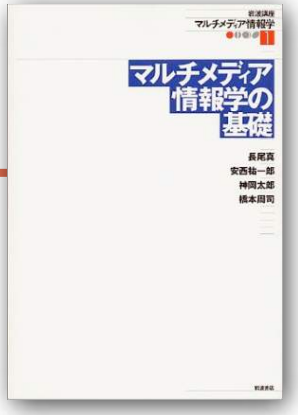


図2　サッチャー錯視（Thompson,1980）

図1　顔と見えるか，果物と見えるか
（M. Moscovitch et al, Journal of Cognitive Neuroscience, 9, 1997）
普通はこの絵を見て，顔と果物を同時に見ることができる．しかし，物体失認の患者はこれに人の顔は見えても，果物を見ることができなかった．反対に相貌失認の患者の場合は，果物ばかりが目立つであろう．

Title of each lecture



- Theme-1
  - ~~Multimedia information and humans~~
  - ~~Multimedia information and interaction between humans and machines~~
  - ~~Multimedia information used in expressive and emotional processing~~
  - A wonder of sensation - synesthesia -
- Theme-2
  - Speech communication technology - articulatory & acoustic phonetics -
  - Speech communication technology - speech analysis -
  - Speech communication technology - speech recognition -
  - Speech communication technology - speech synthesis -
- Theme-3
  - A new framework for “human-like” speech machine #1
  - A new framework for “human-like” speech machine #2
  - A new framework for “human-like” speech machine #3
  - A new framework for “human-like” speech machine #4

A Wonder of Sensation
- Synesthesia -

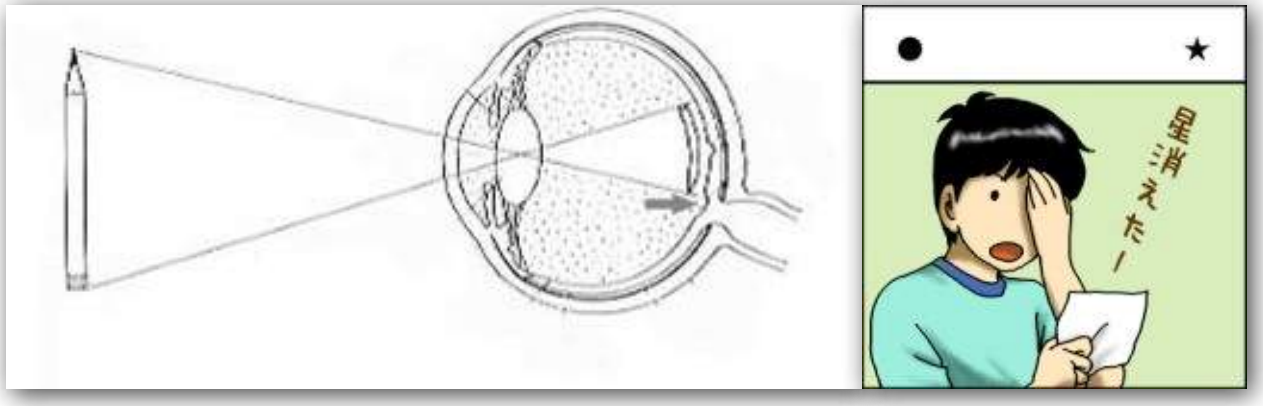
Nobuaki Minematsu

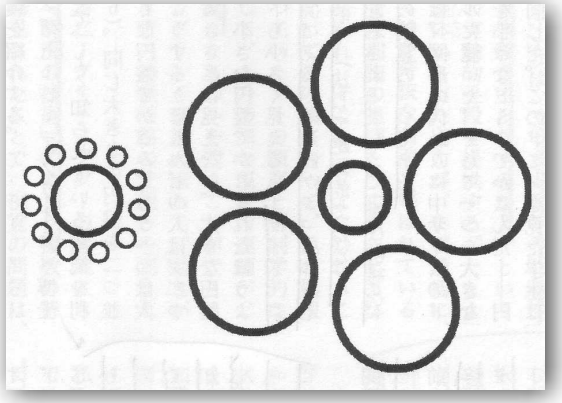
Today's menu

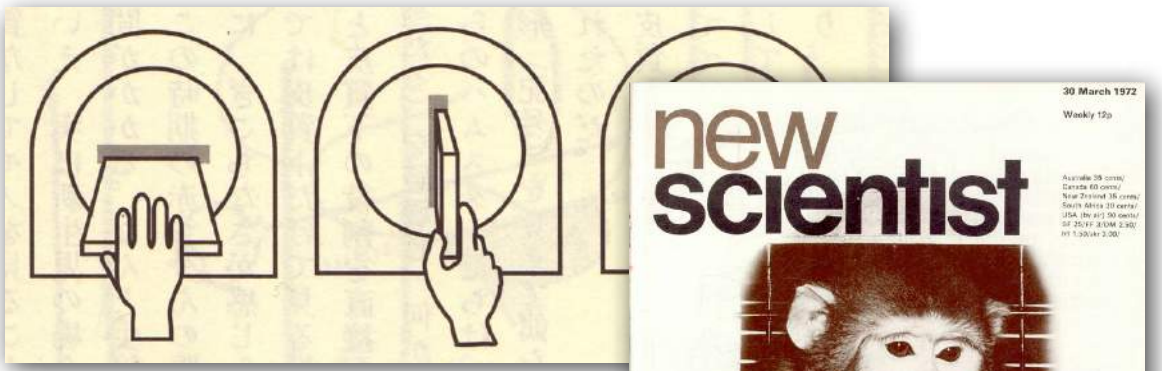
- Wonders of sensation that I've talked about so far.
  - Unconscious processing
  - Blind spot, blind sight, color illusion, size illusion, etc
- Other wonders of sensation
  - Visual sensation described by a doctor with brain damage.
  - Some peculiar behaviors of autistic individuals
  - A claim on brain info. processing from a brain scientist
- BBC documentary
  - "Derek Tastes of Earwax" ("共感覚の不思議")
  - "Seeing colors by hearing sounds"
  - **https://bit.ly/CMP-D4**
- The first assignment
- Summary

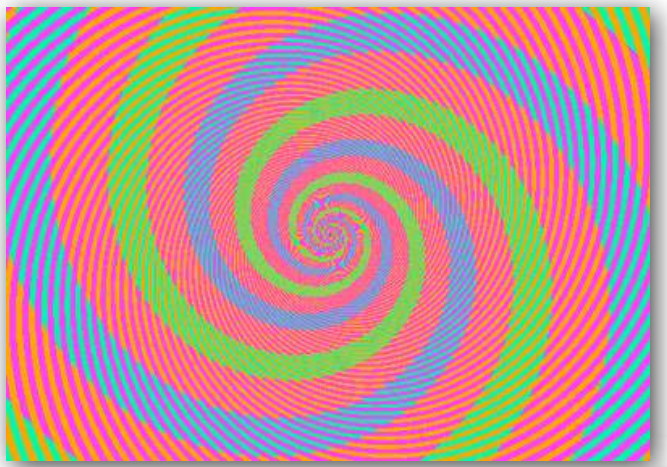
Wonders of sensation

- Examples of unconscious processing



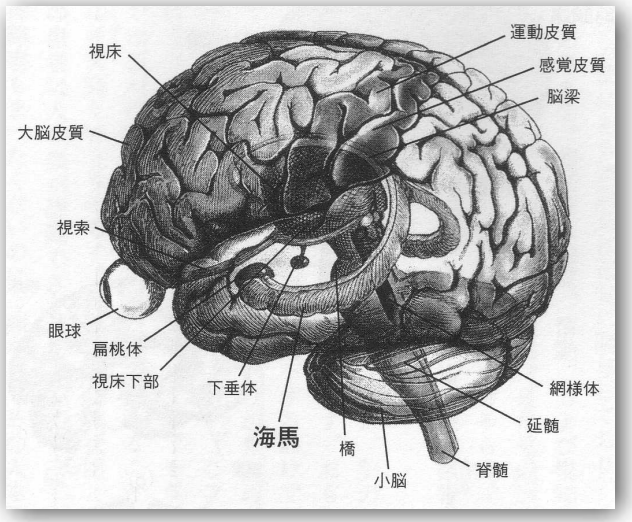






Emotional processing and the brain

- Emotions in the brain (low road) = rough but very rapid
  - Mostly unconscious and implicit (prelogical)



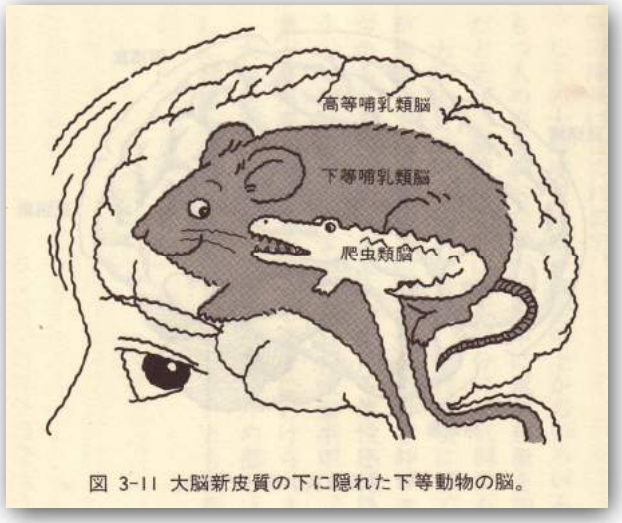


図 3-11 大脳新皮質の下に隠れた下等動物の脳。

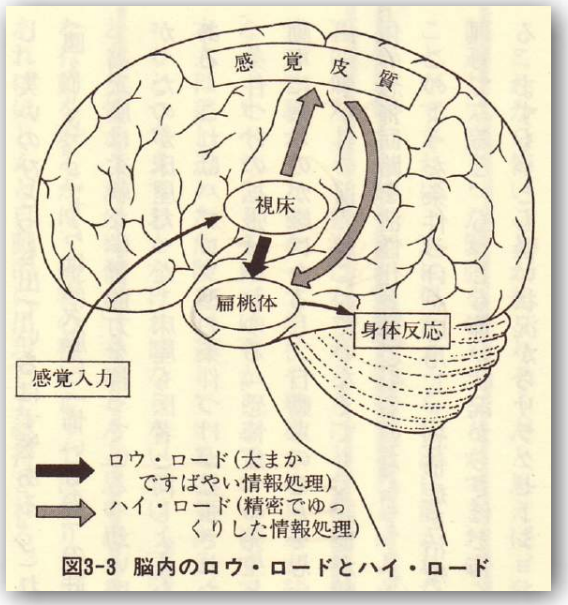
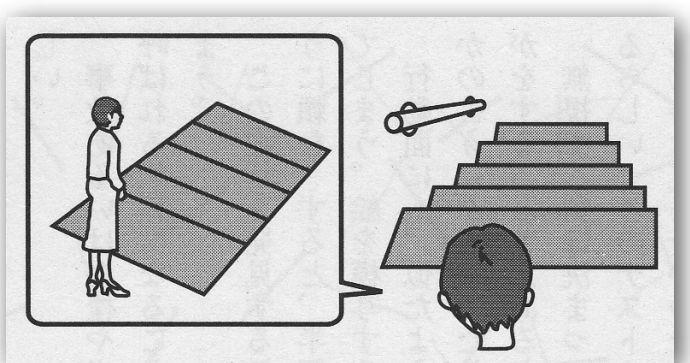


図3-3 脳内のロウ・ロードとハイ・ロード

- Your “conscious” world
  - What you can see, hear, touch, taste and smell “consciously”.
    - Only a part of human information processing
    - Enormous amount of unconscious and background processing.
  - How to make “human-like” information processing on machines?
    - Researchers (engineers) have to be aware of our “unconscious” processing.

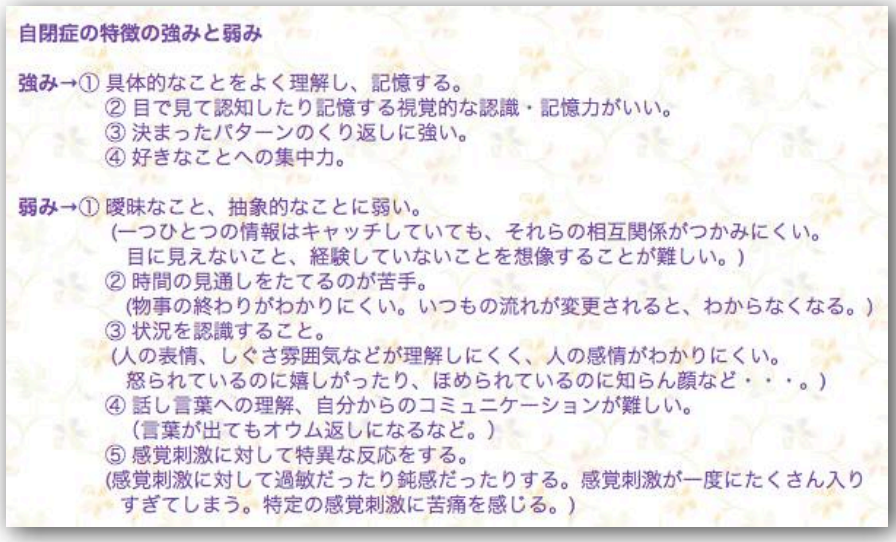
Some facts caused by brain damages

- “I’m living with a damaged brain.” (Dr. Kikuko Yamada)
  - Higher-level brain dysfunction (高次脳機能障害)
    - A part of the brain does not function well and she can be aware of that.
    - A medical doctor herself describes what she can sense through her damaged brain.
  - Seeing = conversion of a 2D image into a 3D image
    - What happens if the visual region of the brain has some dysfunction.
    - Stairs = just a plane with some linear segments
      - Cannot tell whether the stairs go up or down.
    - Chopsticks partially hidden at the background of a rice bowl.
      - Two separate objects cannot be bound into one object.
    - Shadows cannot give depth perception.
      - No difference between the two images below.



Sensation by autistics

- What are autistics good at and poor at?
  - Good at
    - remembering very detailed aspects of stimuli.
      - Especially their visual memory is often extraordinary.
    - processing constantly repeated patterns.
    - concentrating a (given) specific task.
  - Poor at
    - dealing with something abstract or invisible.
    - capturing the relations of things although good at capturing a specific one thing.
      - Good at capturing an element but poor at capturing elements as a whole.
    - dealing with temporal development such as future planning
    - understanding the environments properly.
      - Hidden messages are difficult to detect, ex. facial expressions, metaphors, etc.
    - understanding spoken language.
      - In cases of severely damaged autistics, their first language is written language.
    - smooth communication with others.
    - dealing properly with sensory stimuli.
      - Their sensitivity of sensory stimuli is too good. Can hear the sounds that non-autistics cannot hear.
      - Difficult to select important stimuli / difficult to ignore irrelevant stimuli.

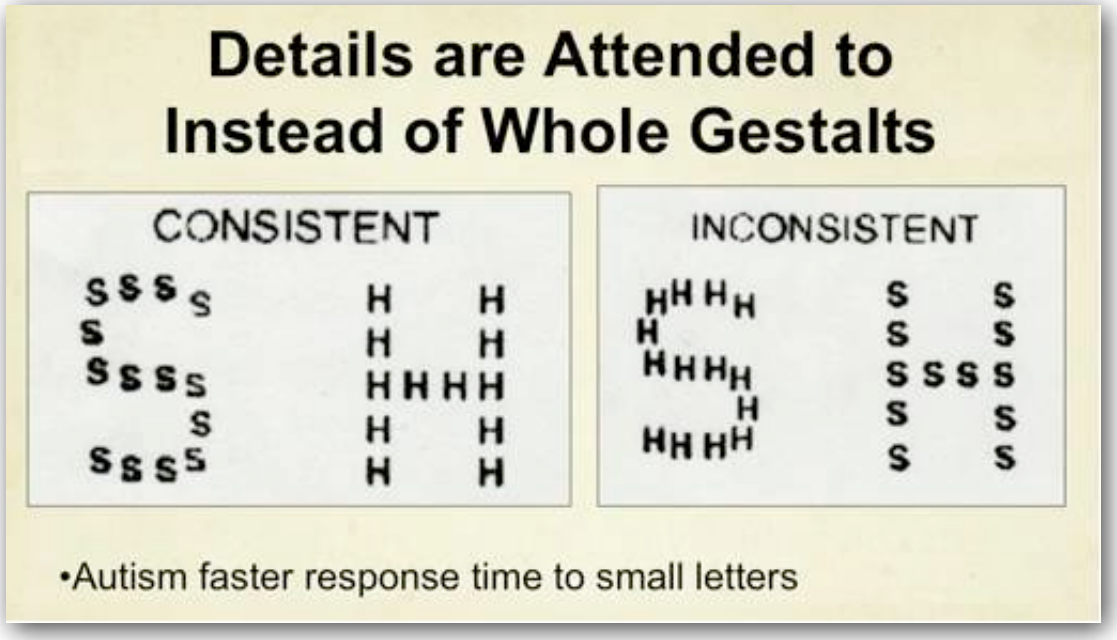

自閉症の特徴の強みと弱み

強み→① 具体的なことをよく理解し、記憶する。
② 目で見て認知したり記憶する視覚的な認識・記憶力がいい。
③ 決まったパターンのくり返しに強い。
④ 好きなことへの集中力。

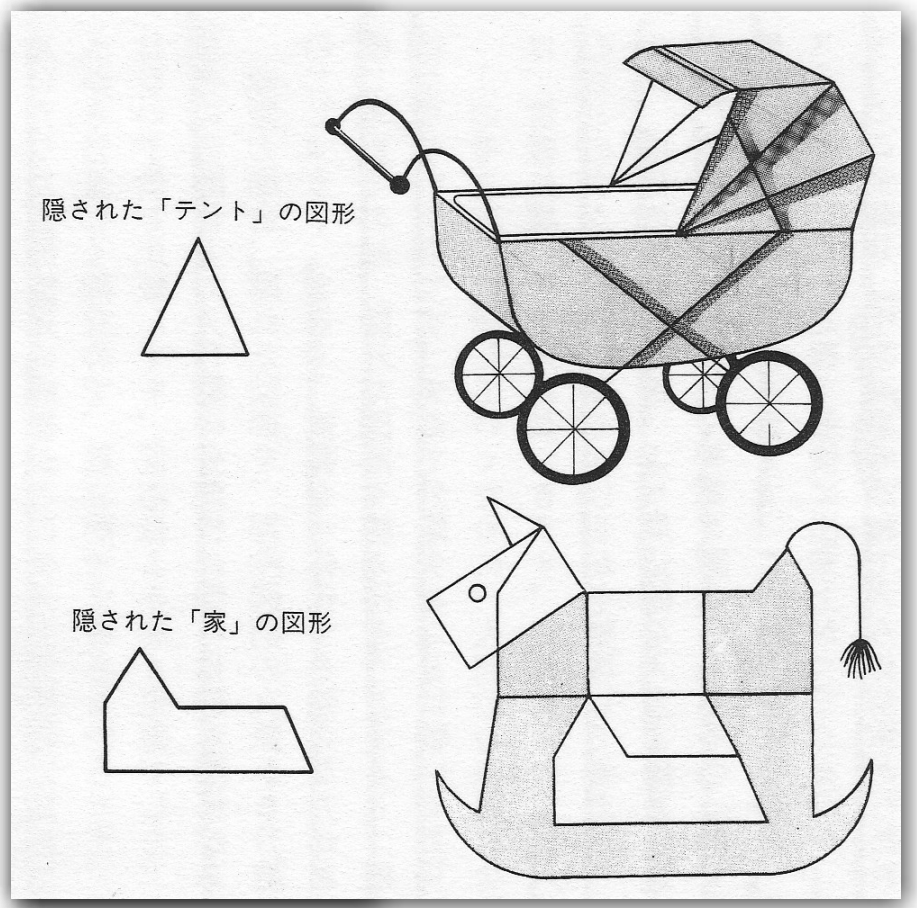
弱み→① 曖昧なこと、抽象的なことに弱い。
(一つひとつの情報はキャッチしていても、それらの相互関係がつかみにくい。
目に見えないこと、経験していないことを想像することが難しい。)
② 時間の見通しをたてるのが苦手。
(物事の終わりがわかりにくい。いつもの流れが変更されると、わからなくなる。)
③ 状況を認識すること。
(人の表情、しぐさ雰囲気などが理解しにくく、人の感情がわかりにくい。
怒られているのに嬉しがったり、ほめられているのに知らん顔など・・・。)
④ 話し言葉への理解、自分からのコミュニケーションが難しい。
(言葉が出てもオウム返しになるなど。)
⑤ 感覚刺激に対して特異な反応をする。
(感覚刺激に対して過敏だったり鈍感だったりする。感覚刺激が一度にたくさん入りすぎてしまう。特定の感覚刺激に苦痛を感じる。)

Sensation by autistics

- Which do you perceive at first?

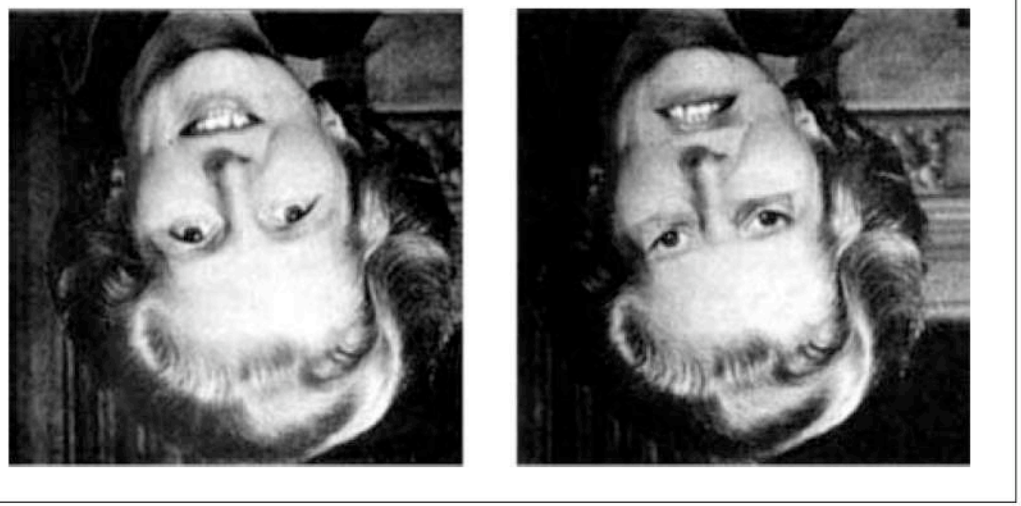


- Find this piece in the whole picture.



Face! Face! Face!

- Some experimental facts



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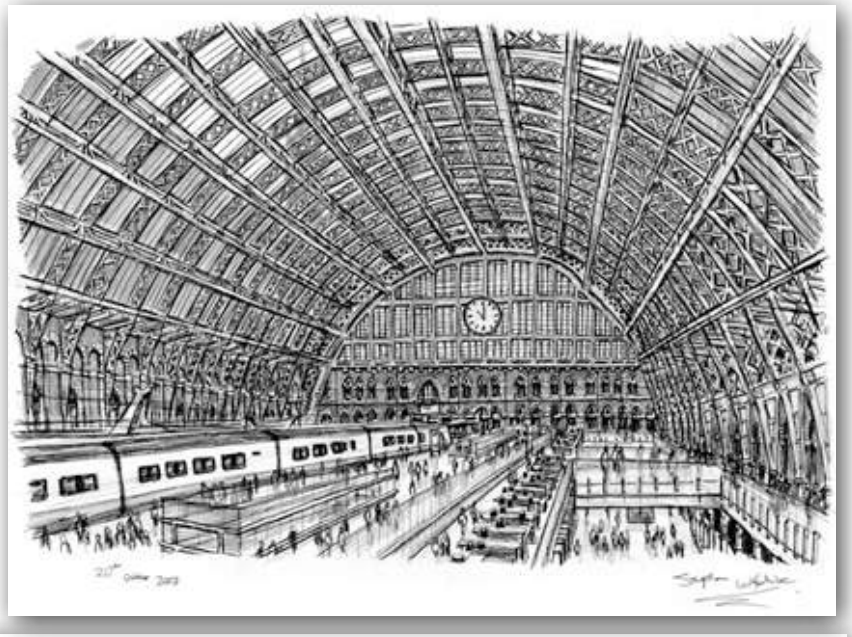
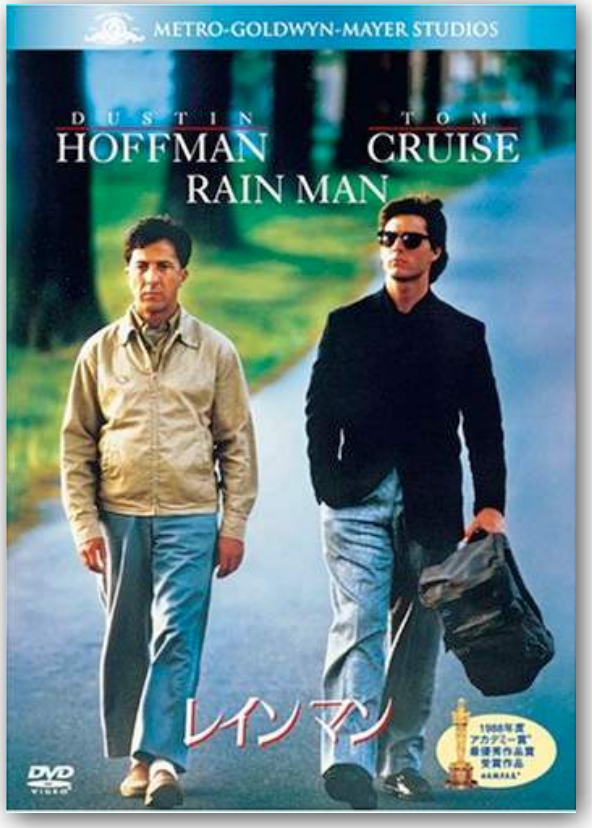
Sensation by autistics

- Stephen Wiltshire as “human camera”
  - Extraordinary memory of visual stimuli, especially buildings in a landscape.
  - But poor at spoken language, environmental changes, etc.



Sensation by autistics

- Kim Peak as “walking library”
  - A model of “Rain Man” in the movie entitled as “Rain Man”
    - He has an extraordinary memory of numbers.
  - He can remember all the sentences in the books that he read.
  - But he is poor at reading between lines, detecting hidden messages.

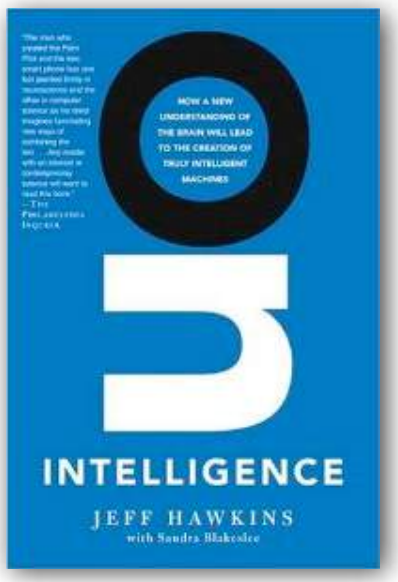


A report from CBS news

- The Tool Man

A claim from a brain scientist

- Rewiring in the brain
  - Visual information can be linked to the tongue.
    - “Taste” region of the brain can be rewired to “vision” region of the brain.
    - “Audition” region of the brain can be rewired to “vision” region of the brain.
- The essence/core of info. processing is the same among regions?
  - Visual cortex, auditory cortex, motor cortex, etc
    - The function of brain regions seems to be different from each other.
  - Organizing principle for cerebral function (V. Mountcastle, 1978)
    - 大脳皮質の構成原理
    - The function of each region seem rather independent but the unit of the cerebral cortex (大脳皮質), which is called “column”, has a very similar anatomical structure in any region.
    - Implies that a universal information algorithm exists in the cerebral cortex, irrespective of physical differences in sensory stimuli?

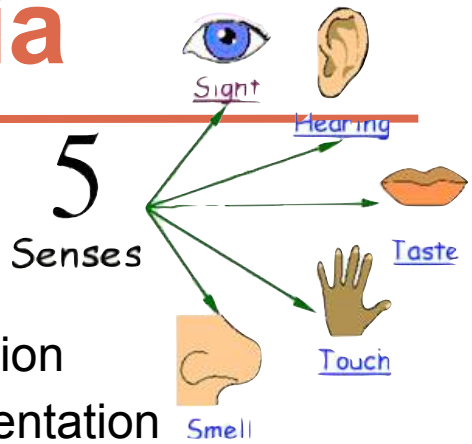


Announcement on the next lecture

- Date: Oct 24 (Tue), 14:55 -- 16:40
- After showing some slides, a 45-min documentary film on synesthesia will be presented. The video files are stored at Google Drive at UTokyo.
  - **https://bit.ly/CMP-D4**
  - Two versions are prepared (English and Japanese)
  - You can select which one to view based on your language performance.

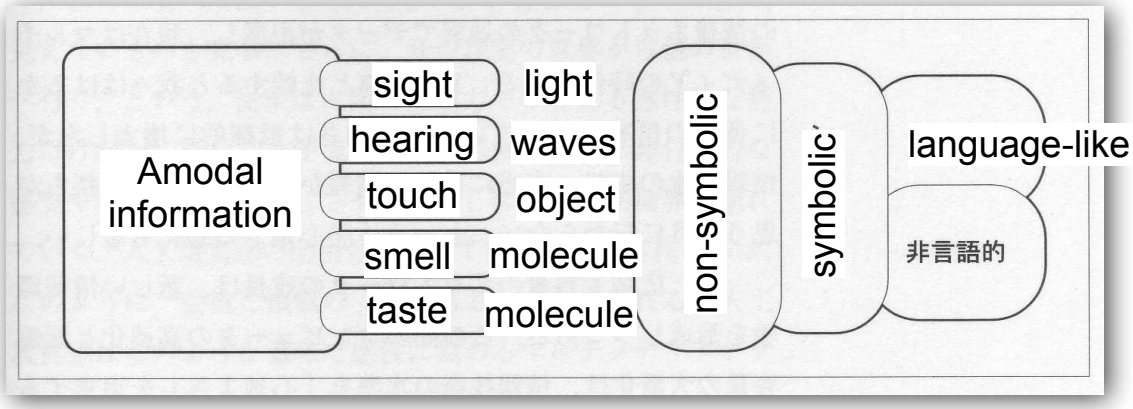
- The 1st assignment is given “before” you view the video.

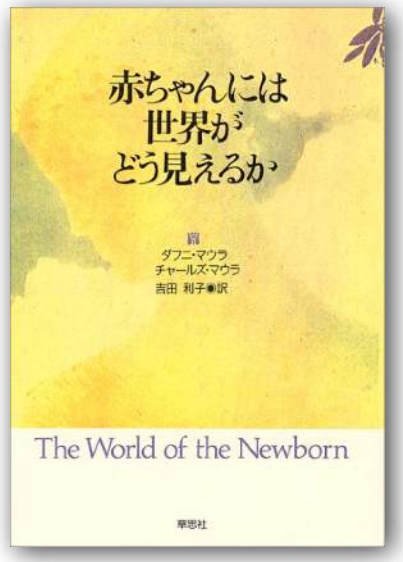
Emotions and multimedia



- Expressive information and the five senses
  - Sight, hearing, touch, (taste, and smell)
    - Symbolic representation and non-symbolic representation of information
    - Symbols can be organized by some syntax into a higher-level representation
    - Modality-dependent and modality-independent information
  - Information exchange via. a combination of different media (forms)

sense	media	method of expression	interface
sight	light	painting, gesture	physical
hearing	sound waves	speech, music	
touch	force, mechanics	body motions	
taste	molecule, temperature	dishes, drinks	chemical
smell	molecule	dishes, cosmetic	





“Seeing colors in sounds”

- “音に色が見える世界” (J. Iwasaki)

図3　著者には平仮名・片仮名がこのような共感覚色に見えている。

図8　著者が同じ部首の各漢字に見ている共感覚色。

図7　著者が色彩を表す漢字に見ている共感覚色。

図9　「立」、「日」、「心」を近づけて「意」を作るときに、著者が見ている共感覚色。

“Seeing colors in sounds”

- “音に色が見える世界” (J. Iwasaki)

図16 著者がラテン文字に見ている共感覚色。

図17 著者が数字・数概念に見ている共感覚色。

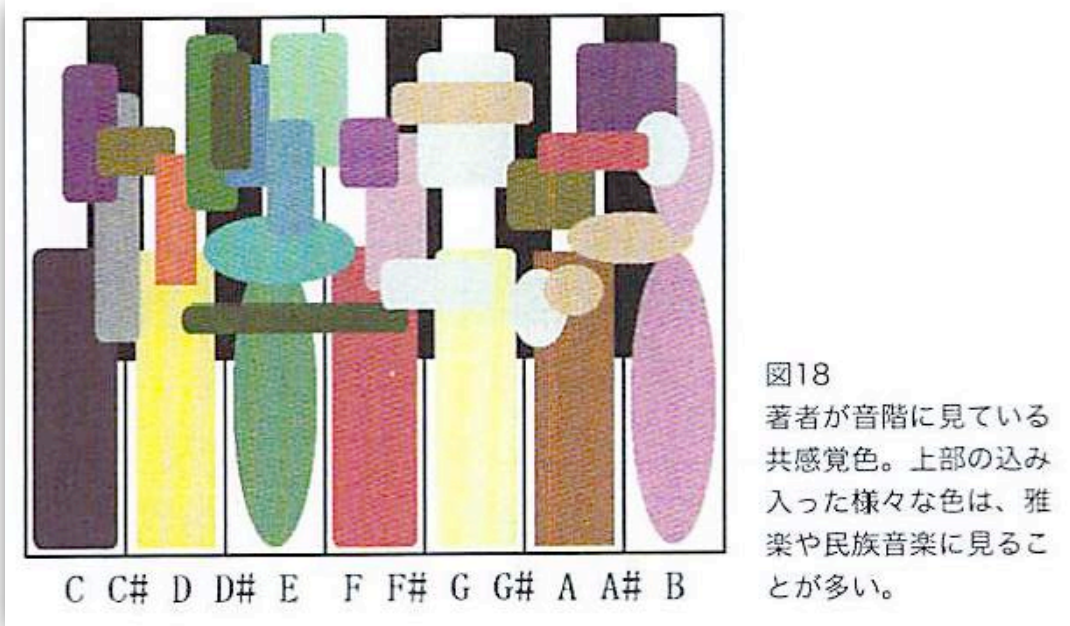


図18
著者が音階に見ている共感覚色。上部の込み入った様々な色は、雅楽や民族音楽に見ることが多い。

Today's menu

- Wonders of sensation that I've talked about so far.
  - Unconscious processing
  - Blind spot, blind sight, color illusion, size illusion, etc
- Other wonders of sensation
  - Visual sensation described by a doctor with brain damage.
  - Some peculiar behaviors of autistic individuals
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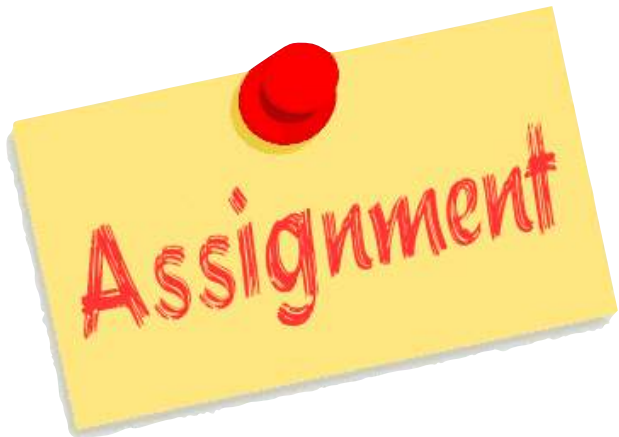
- BBC documentary
  - "Derek Tastes of Earwax" ("共感覚の不思議")
  - "Seeing colors by hearing sounds"
  - **https://bit.ly/CMP-D4**
- The first assignment
- Summary

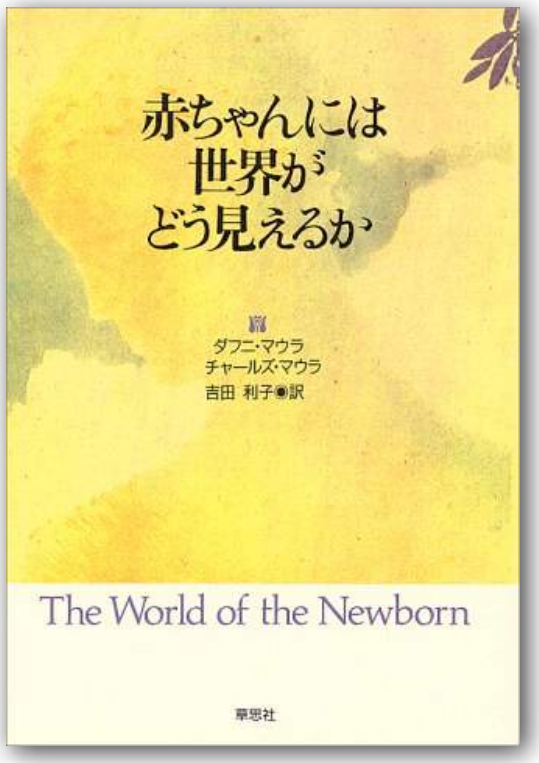
Assignment

- Assignment
  - Read a research paper related to the first four lectures of this class.
  - **Submit two PDF files: 1) the paper and 2) summarization of the paper and your comments on the paper**
  - All the materials used in the lectures are available at:
    - https://www.gavo.t.u-tokyo.ac.jp/~mine/japanese/CMP/class.html
    - Ramachandran's article on synesthesia is also found there.
- Length
  - Two or more pages of A4 size for 2)
- Submission
  - Your report should be submitted via. ITC-LMS.
  - **The filenames must be in the following format.**
    - **[student_id]_paper.pdf and [student_id]_[name].pdf**
    - **36-302439_paper.pdf (paper)**
    - **36-302439_NobuakiMinematsu.pdf (summary and comments)**
- Deadline = 23:59:59 on Nov. 7.



A wonder of sensation

- A 45-min documentary film on synesthesia made by BBC
  - Perceiving colors while seeing or hearing numbers
  - https://bit.ly/CMP-D4 (Two videos are available in English and in Japanese)
- Every baby is like that.
  - “The world of the newborn” (D. Maurer and C. Maurer, 1989)



Recommended books