utc
Université de Technologie
Compiègne

Costech
Connaissances Organisation et
Systèmes Techniques
EA 2223

Enaction and Technical devices

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Costech - Groupe Suppléance Perceptive

Enaction et sciences cognitives
6 - 12 septembre 2007- Fréjus

Plan

I. Perceptive supplementation

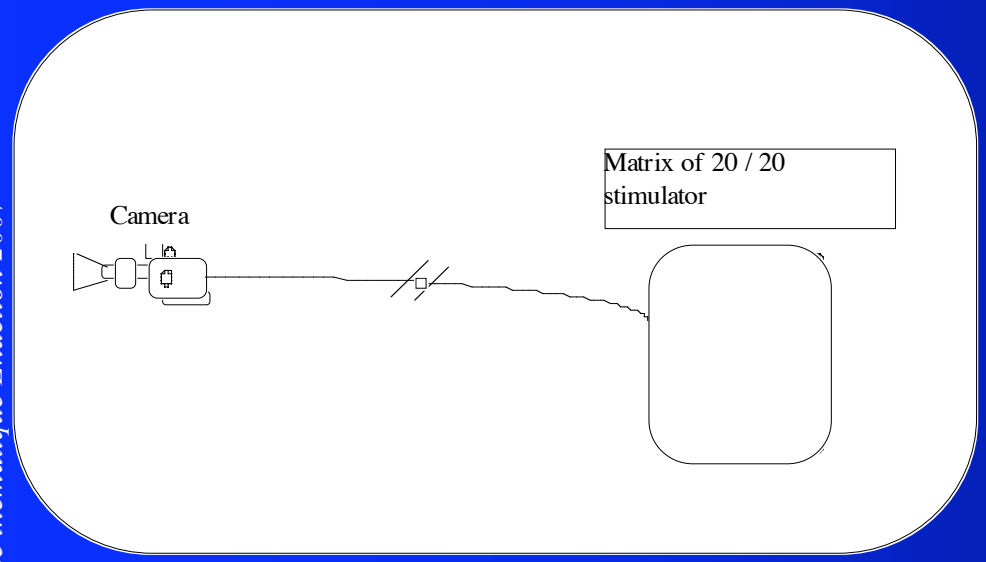
II. Space of localisation and externalism

III. Form recognition and situated cognition

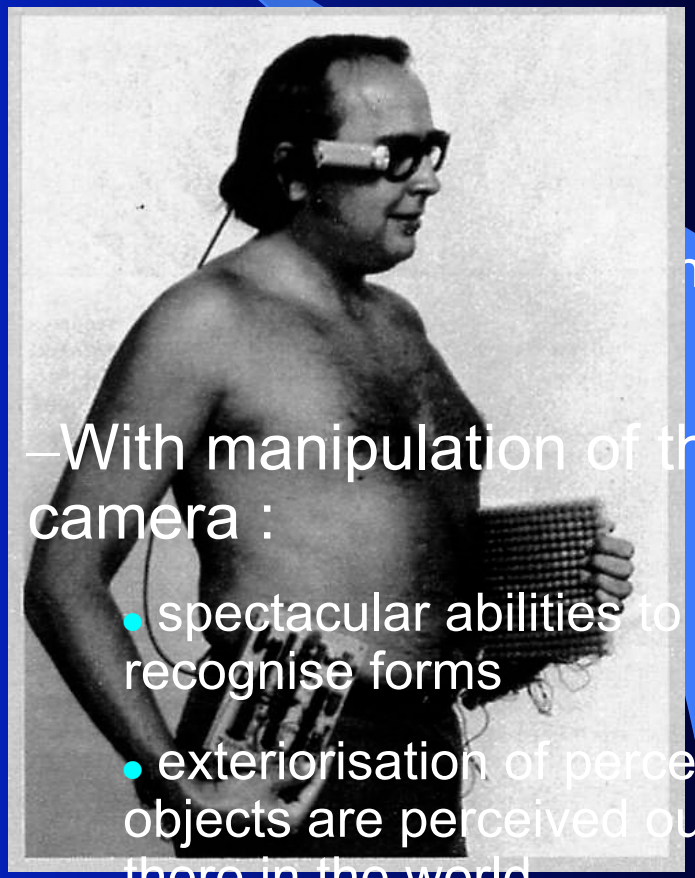
IV. Social adoption and esthetics

I. Perceptive Supplementation

Sensorimotor Coupling Devices : Tactile Vision Substitution Systems



Paul Bach y Rita



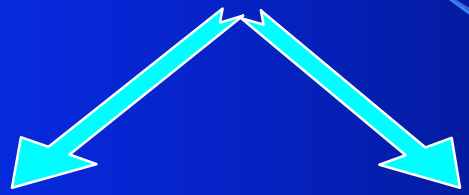
n the

–With manipulation of the camera :

- spectacular abilities to recognise forms
- exteriorisation of perception : objects are perceived out there in the world

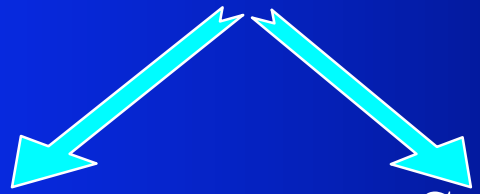
Objectives and Methodologies

The genesis of a perceptual modality in adults



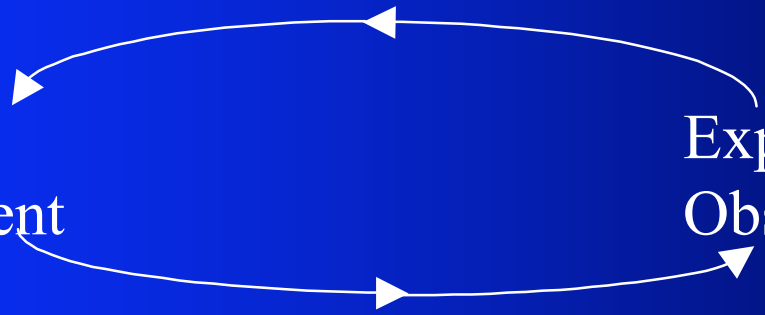
Psychophysiology
3rd person

Phenomenology
1st person



Study of technology

Study of cognition



Technical
Development

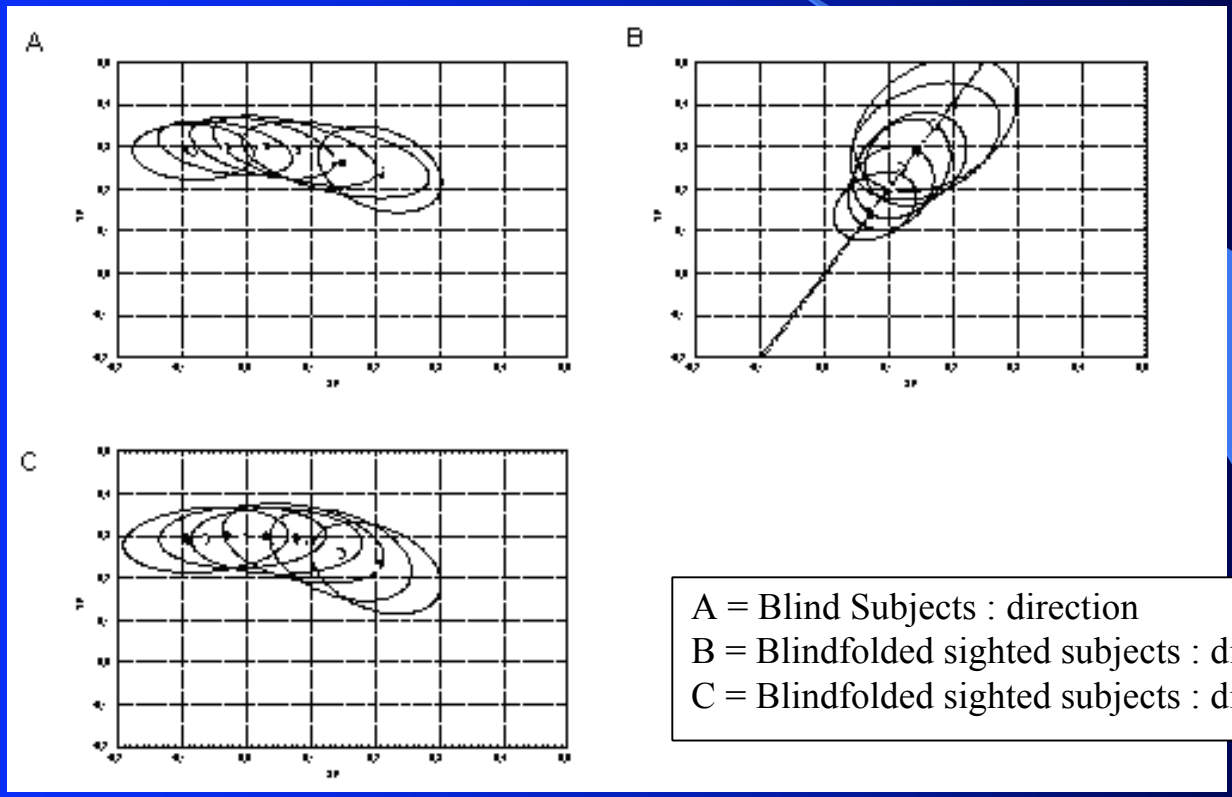
Experimentation,
Observation

II. Space of localisation and externalism

II.1. Minimalist sensori-motor coupling device

Lived experience of spatial exteriority

Results : confidence ellipses



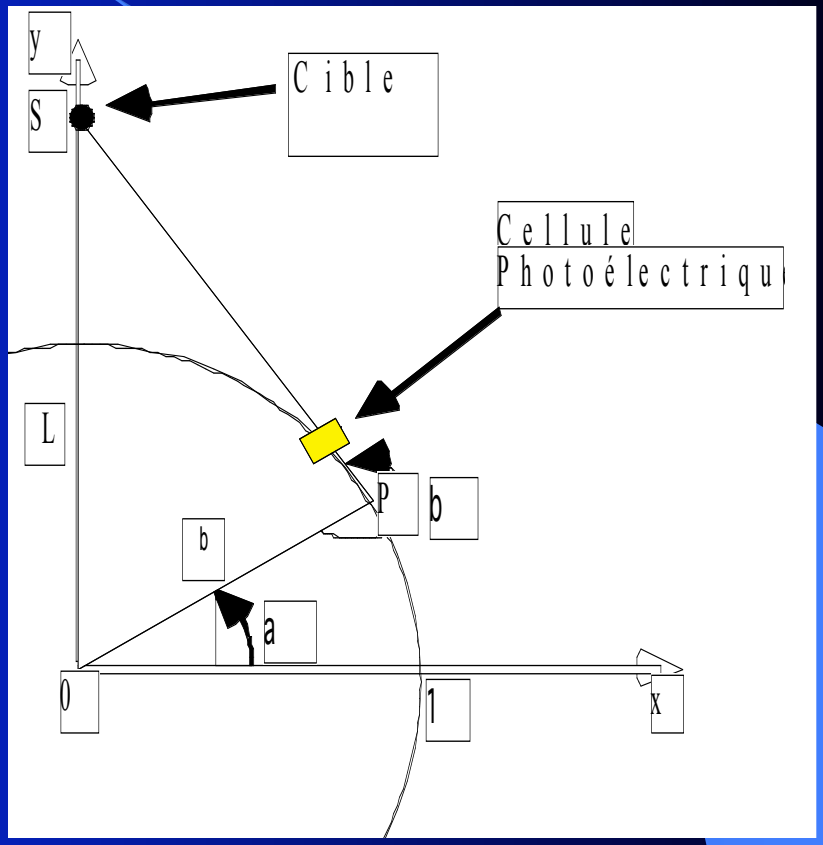
A = Blind Subjects : direction
B = Blindfolded sighted subjects : distance
C = Blindfolded sighted subjects : direction

Bianca Hardy, Marie-Martine Ramantsoa, and Sylvain Hanneton.

Explanation

Perception :

- **Localisation**
- **Projection in space**
- **Neglect of sensory input**

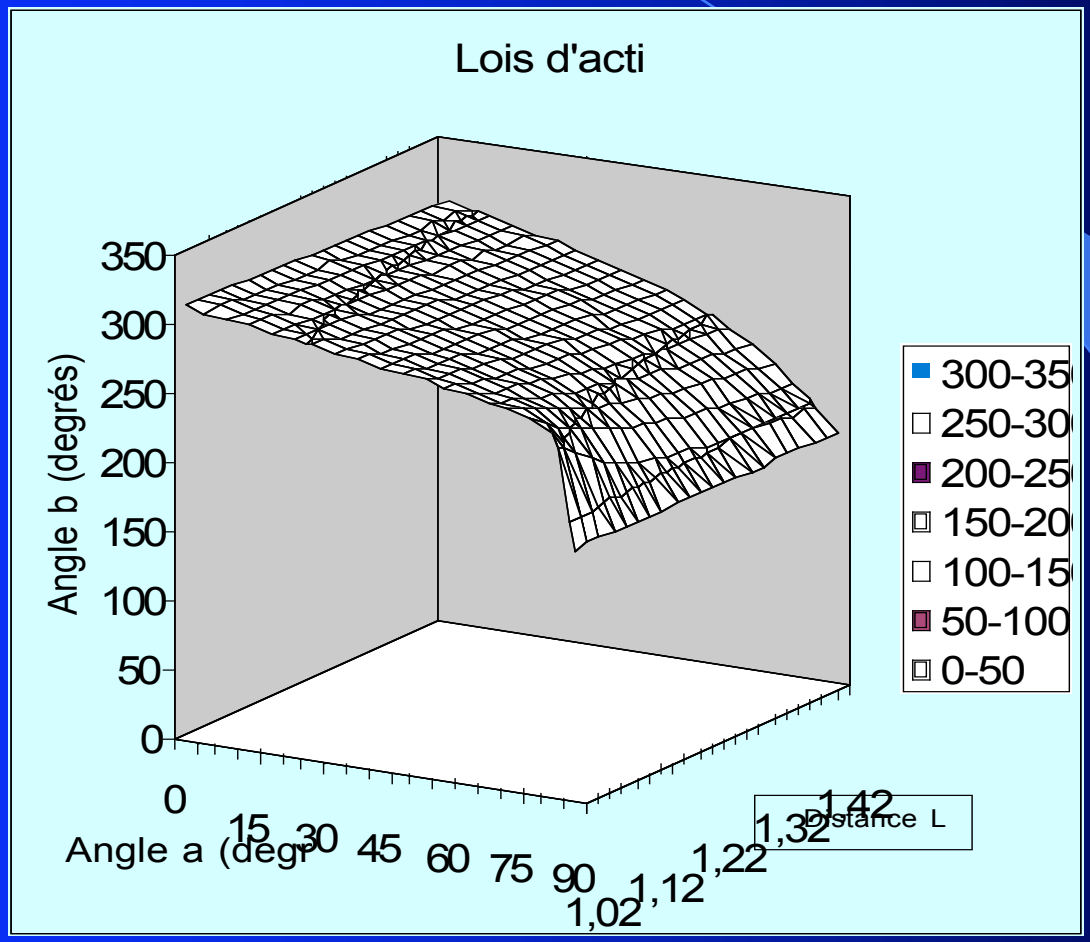


But : two "contacts" with the target are not sufficient.

(1) $L = b(\sin\alpha - \cos\alpha \tan(\alpha+\beta))$ Où $\alpha : [0, \pi/2]$ et $\beta :]3\pi/2-\alpha, 2\pi$ [

Laws of sensory-motor contingency

Kevin O'Regan / Alva Noe



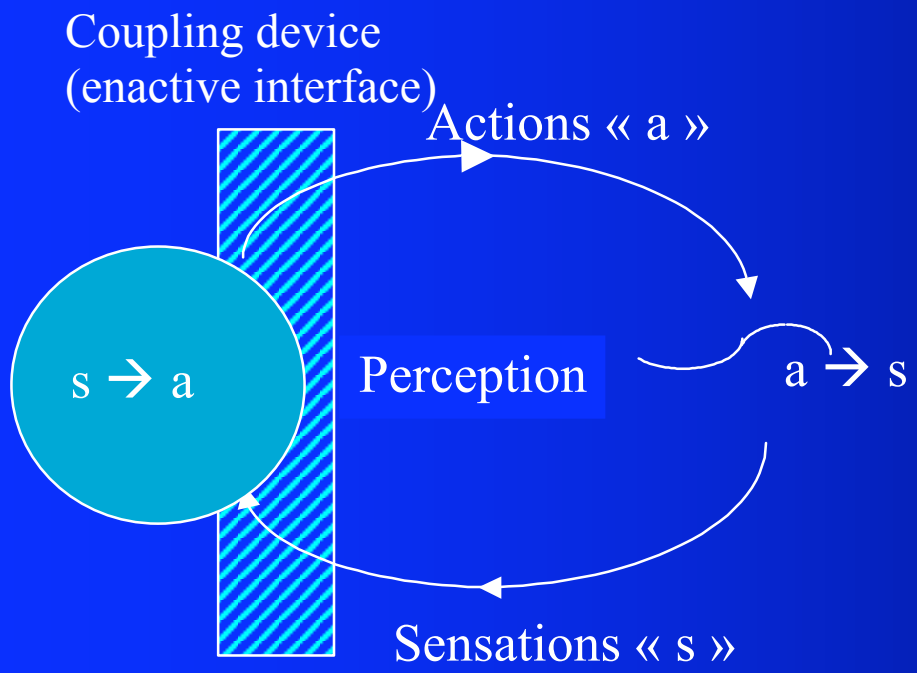
(2) $\beta = 2\pi - \alpha + \text{Atan}\left((b \sin\alpha - L) / b \cos\alpha \right)$

II.2. Enaction: Active Perception

If the movements cease, there is not spatialisation of the object

No perception without action :

- Invariance and reversibility : exteriority
- Constitution, enaction ≠ representation



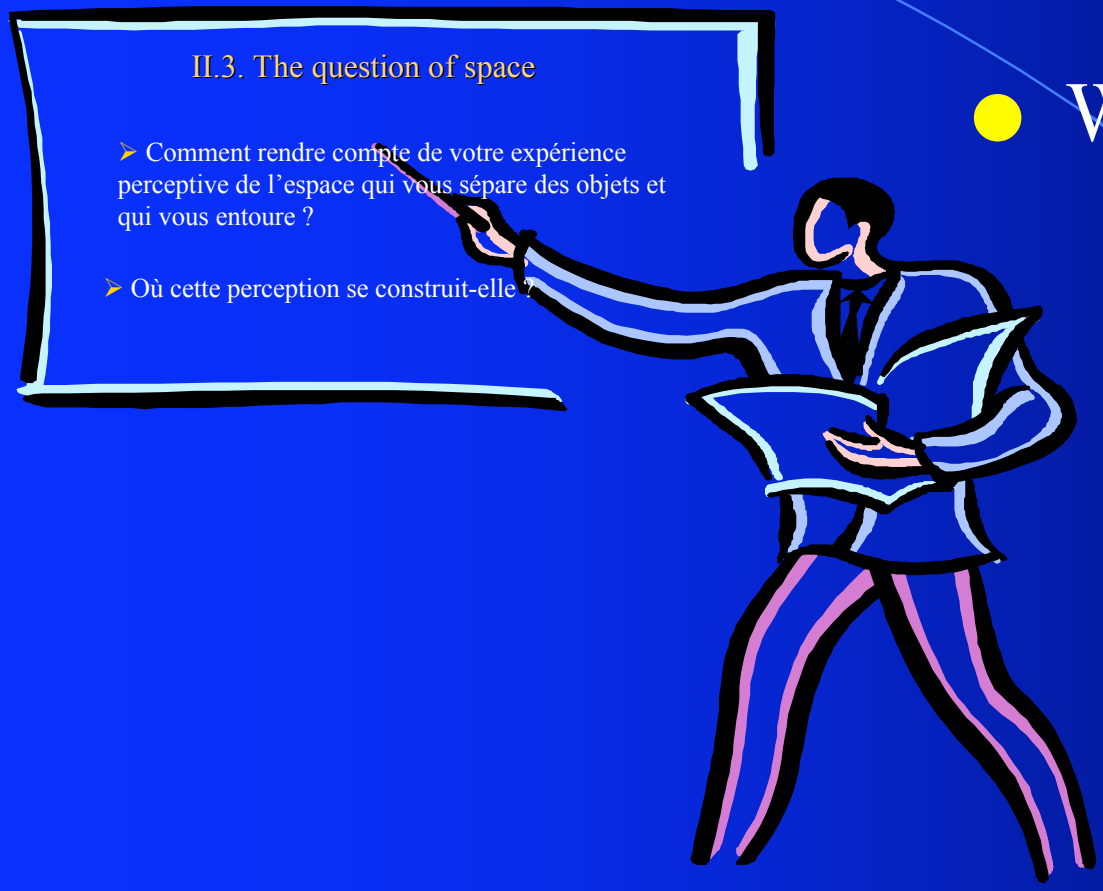
The constitution of spatial percepts is realized by the determination of an invariant relation between:

- actions (movements of the instrument) and
- sensory input.

II.3. The question of space

- In our experiments, since there is no spatiality of the sensory data: space of perception must be constituted.

II.3. The question of space



- Where is perception?

II.3. The question of space

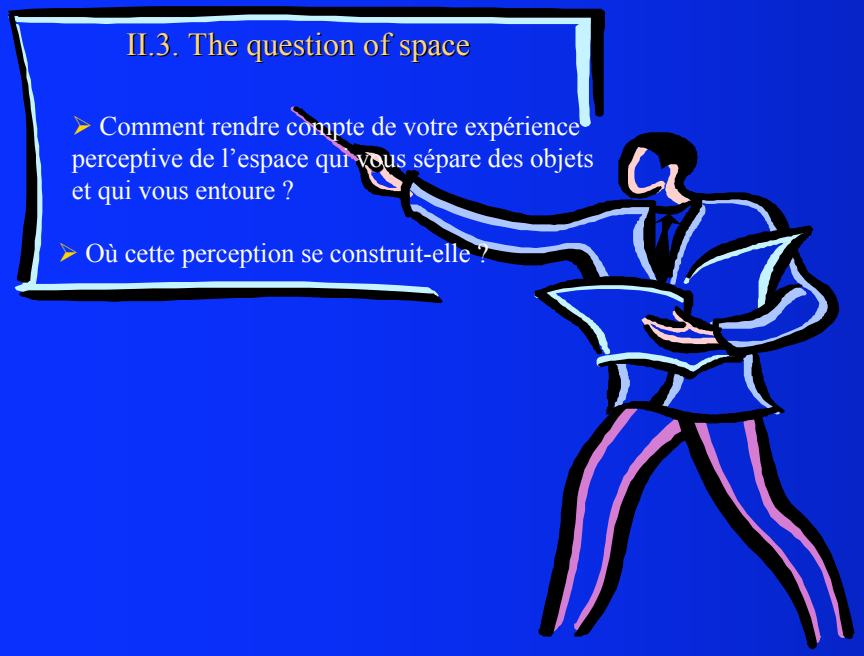
Classical approach :

- One seeks: how, in space, the subject can have “here” a perception of the object “out there”?
- Data processing of visual information in the brain to build a representation of the object out there. Your perception results from the construction of a representation behind your eyes, in your brain.

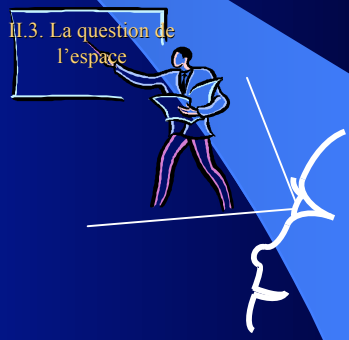
- It is necessary to built “here” a space of representation in which the object will be understood as being “over there”.
- Henri Poincaré: space of perception is a group of displacements, constructed by search for fields of reversibility

Internalism : Construction of this space of representation by the relations between information on actions (proprioceptive and/or efferent copies) and exteroceptive informations.

II.3. The question of space



Representation of space



- Ontological cost : Two spaces : internal space of representation and external physical space
- Many problems:
  - feeling of immersion in space
  - common knowledge
- **« Those who walk in their head »**

Only one space !
Externalism

- We must give an account of the phenomenological experience: there is only one space.

Phenomenological constitution (*1st person)*

- If the perceptive activity ceases, there is no more spatialization of the object.
- If the possibilities of action are reduced, there is no more depth
- The depth requires the capacity to engage in perceived space. Here thanks to the size of the arm: spatiality of the lived body
- A space within which there is a separation between a point of view, and objects perceived.

The invariants of the sensorimotrice activity, constitute at the same time:

Positions of the point of view

Point of view:
all that moves with me

Positions of the objects

Objects :
all that compared to what I move

Objective correspondents (*3rd person)*

There is only one space

- For perception and action,
- For the lived body and the objects

- Constitution of this space of action and perception with concrete body engagement (spatiality of the lived body) and sensory returns.

- Practical group of displacements.

Where is space of perception?

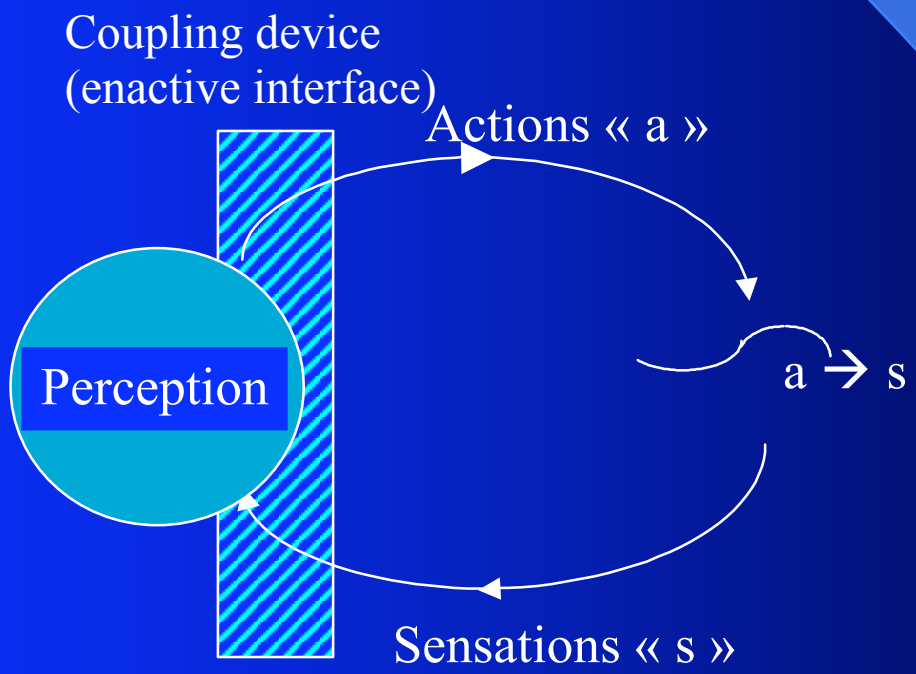
In the brain? or where the body acts?

The "submarine" or the "plunger"

The internal space of representation is different from external physical space

The space of perceived objects is the space of body and action

Enaction: Active Perception



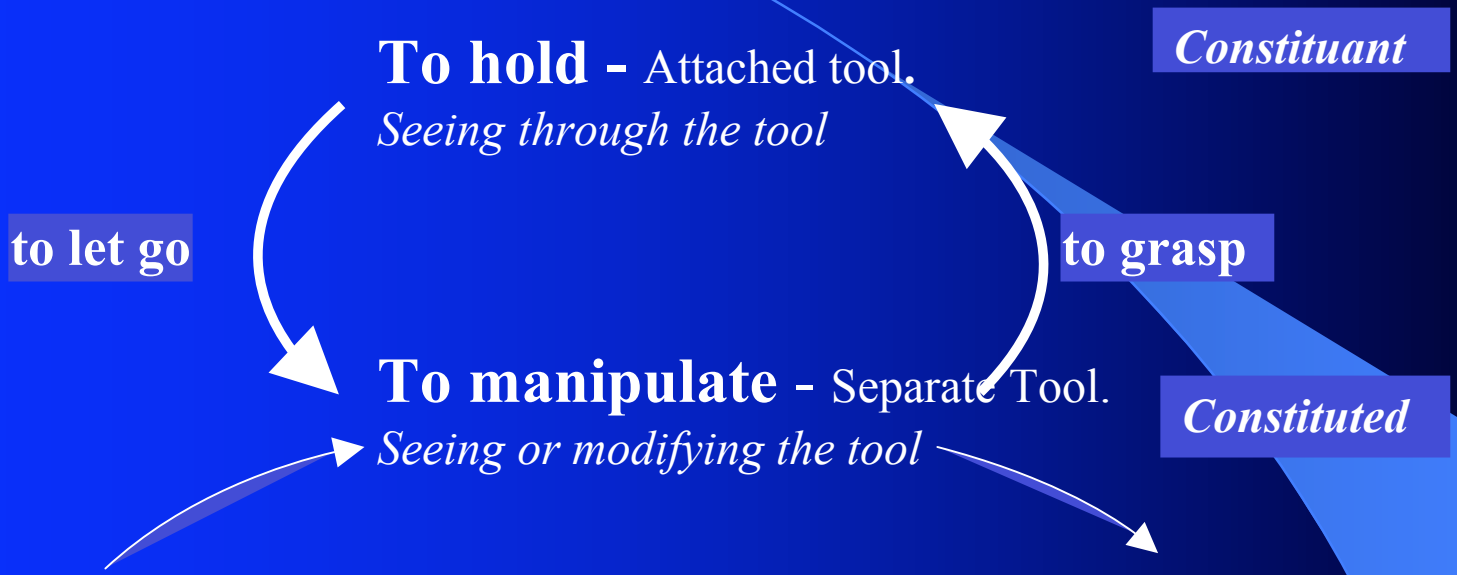
II.4. Consequences

Representation	Enaction
Internalism	Externalism

Tool, technical mediation

Internal model of the mediation for the calculation of a representation	Active constitution of the lived world (umwelt) through the technical mediation

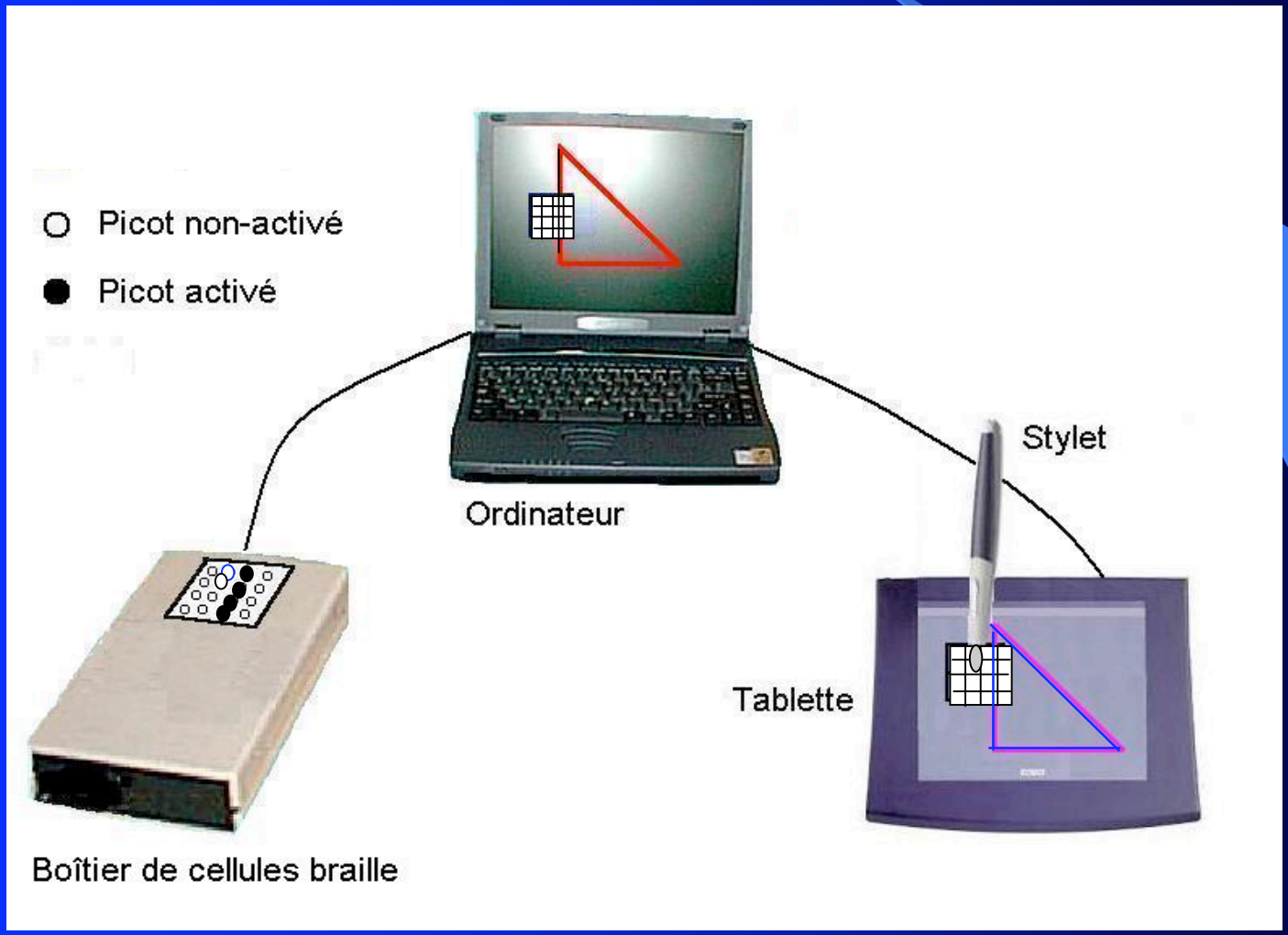
The two modes of existence of a tool



- What makes it possible to perceive is transparent for this perception.
- The limit between subject and object is built secondarily, through the distinction between what moves with me, and what exhibits a relative motion to me when I move.

III. Form recognition

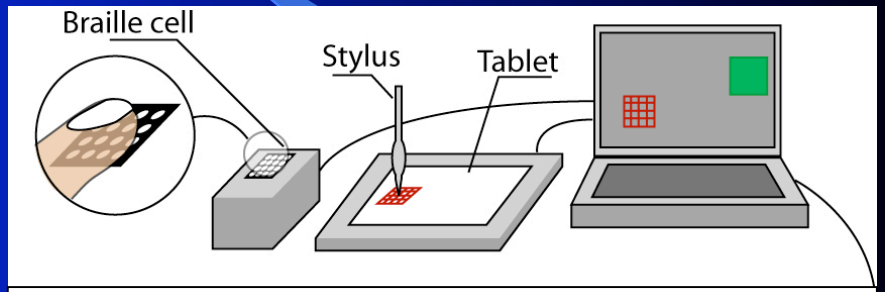
Methodological principle: minimal device.

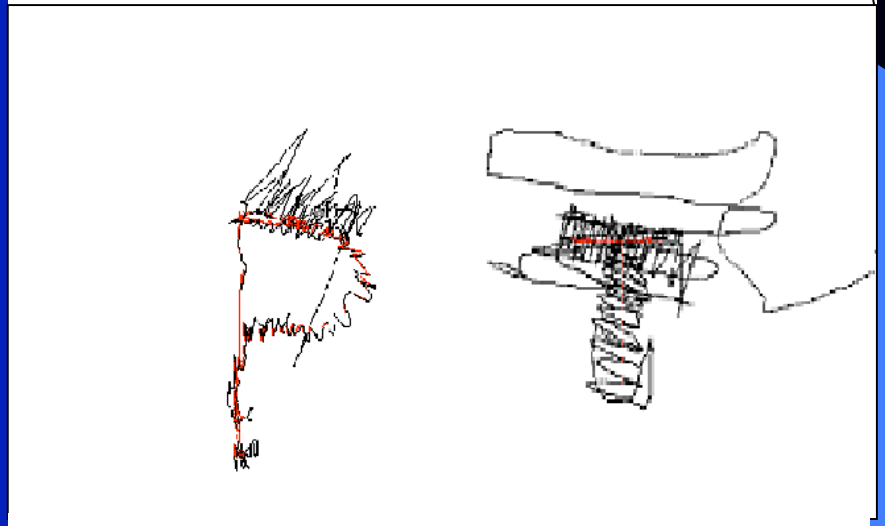


III.1. Method of minimalism (Tactos)

- We use minimalist devices: very few sensory information (one all or none stimulation) and limited possibilities of action.

- By restricting to the maximum the possibilities of sensation and of action one forces a spatial and temporal deployment of the perceptive activity.

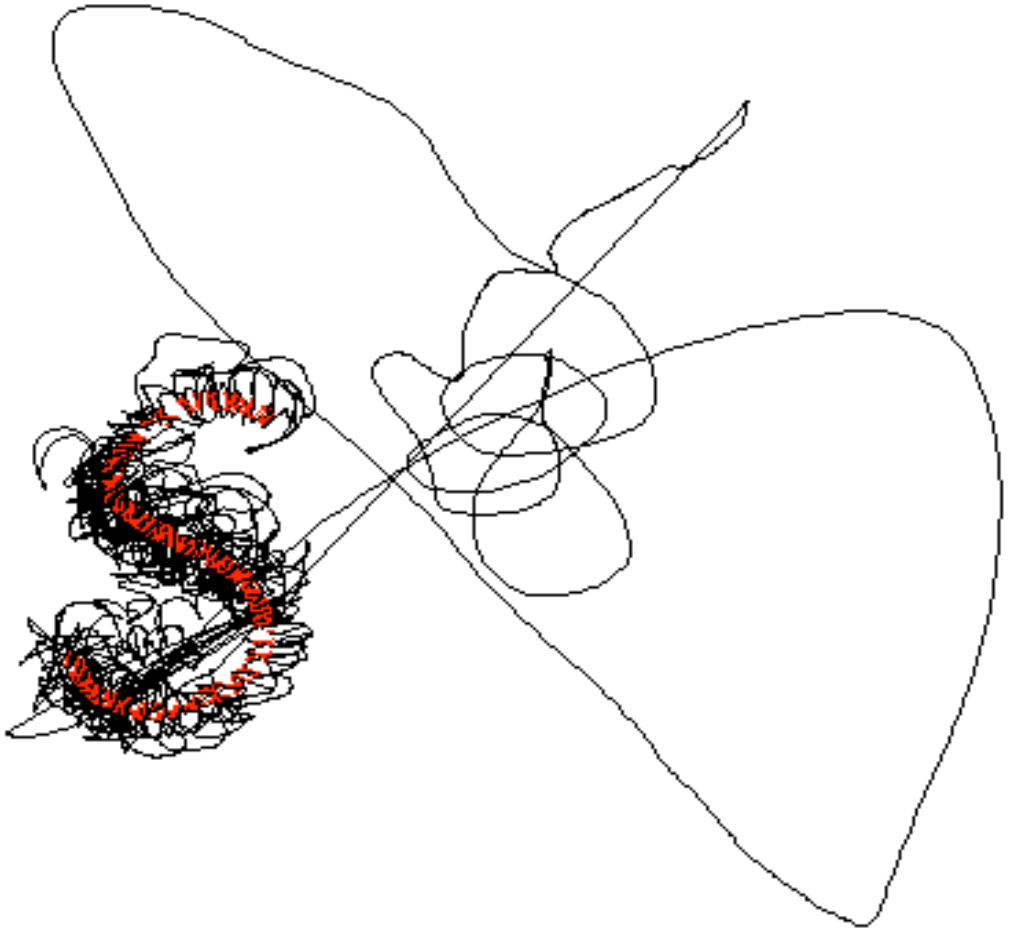




Examples of perceptive trajectories

Experiments and Results

- Ability to recognize shapes

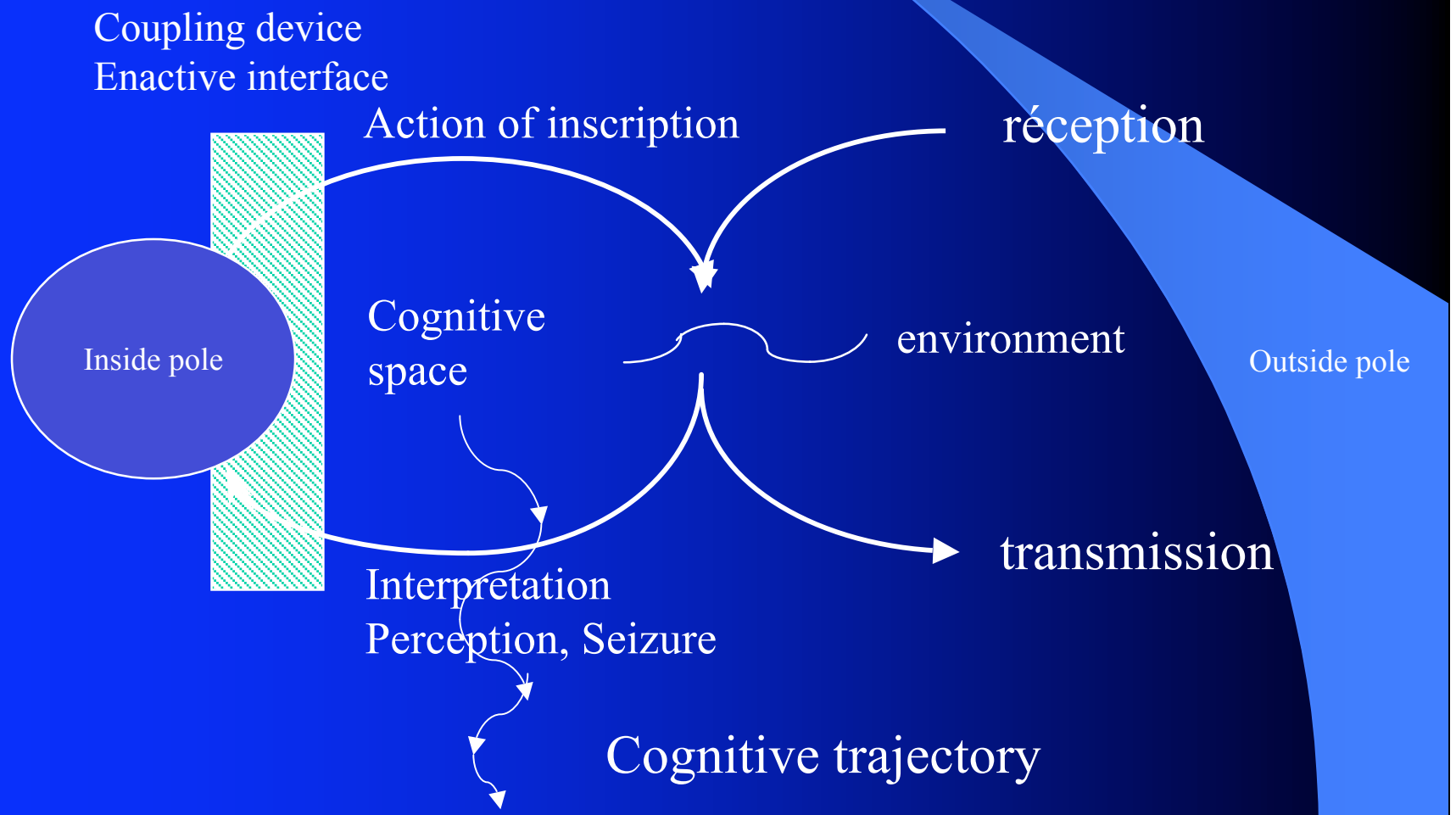


Perceptive trajectories

- Spatial and temporal deployment of the perceptive activity as a trajectory
- Emergence of stereotyped behaviors
  - Micro-scanning orthogonal to the contour
    - Localisation
  - Contour following
    - But, subjects are frequently lost in the «tactile picture» : proprioceptive drift
  - Perception of forms
    - Gesture of constitution of the perceived shape (Similar to the gesture of drawing)
  - Independance with respect to the tactile, visual or auditory mode of stimulation

Situated Cognition

Cognitive Trajectory in situation



Cognitive Technologies

How a cognitive tool can really help us to think ?...
even further: how can it condition new ways of thinking ?

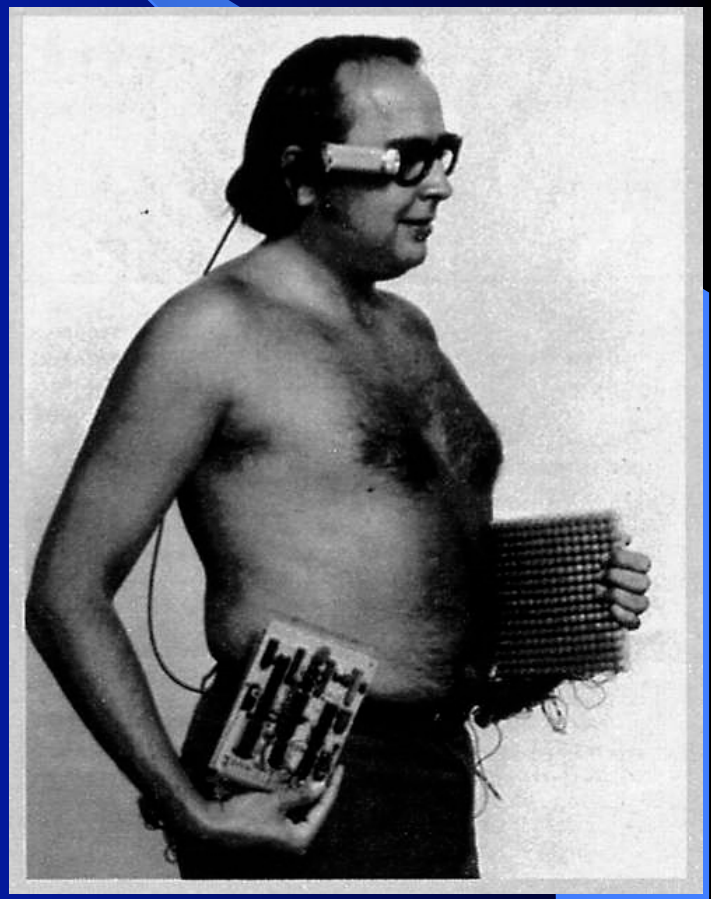
Information spatialisation (« raison graphique ») : table, list, formula…

A1	B1	C1
A2	B2	C2
A3	B3	?

IV. Social adoption and esthetics

IV.1. TVSS: technical success... and social failure

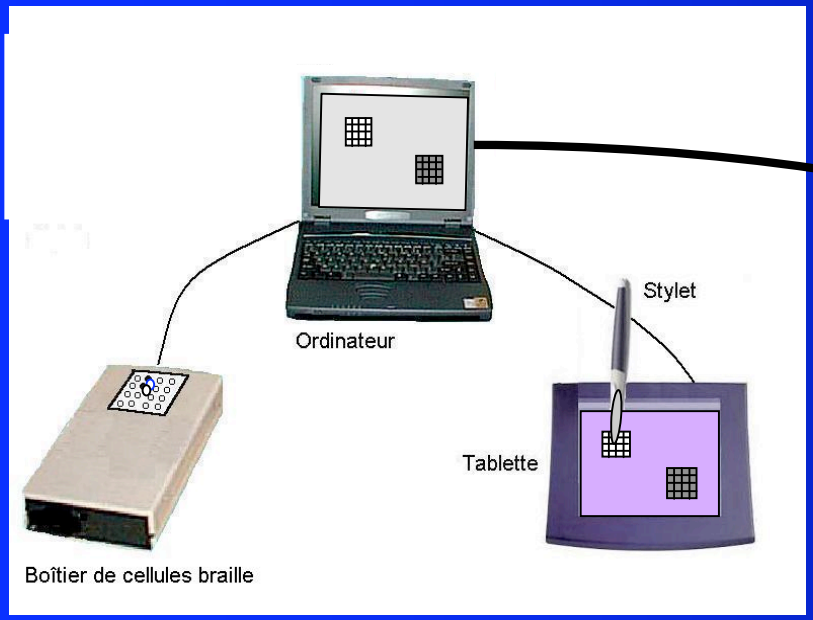
- Disappointment, rejection :
  - Absence of emotional values attached to the percepts
  - Embarassment with respect to the glance of others: feeling to carry a monstrous equipment.
- Hypothesis
  - Early training
  - Perceptive interactions

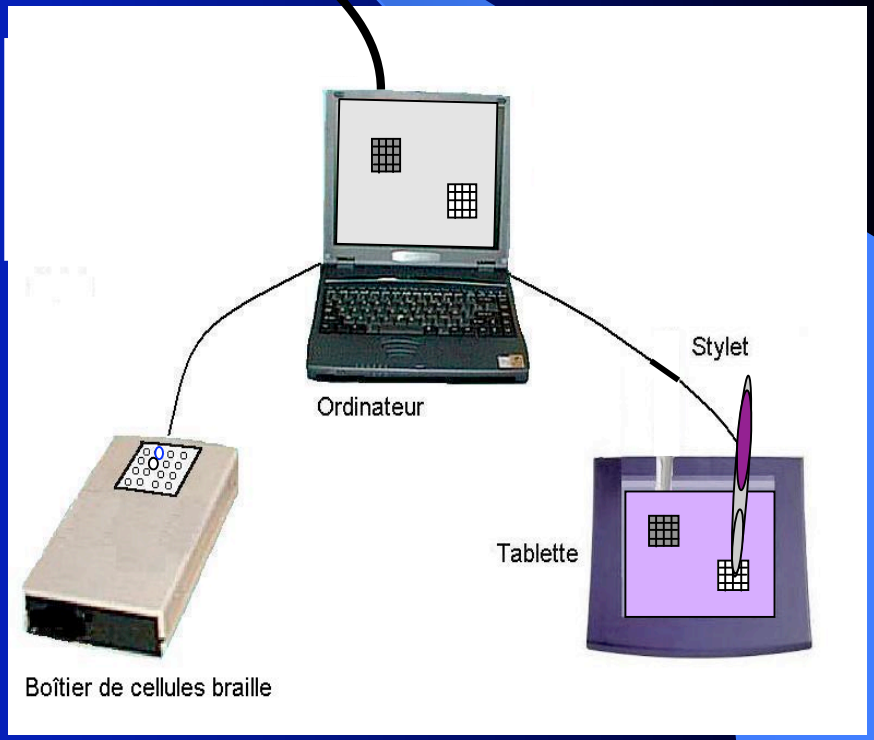


Emotional values

- Technical mediations offer to their users new spaces of action and perception.
- What are the emotional values attributed to the new objects of perception?
- What is the specific aesthetic of this perceptual modality?
- Our hypothesis : emotional values can emerge thanks to collaborative interactions in a community of users sharing the same technical interface.
- Firstly, how through the use of technical devices can we feel the presence of another subject?

IV.2. Perceptual crossing





Reciprocal perception of the perceptive activity of others: "distal caresses"

A preliminary experiment :

Recognition of others

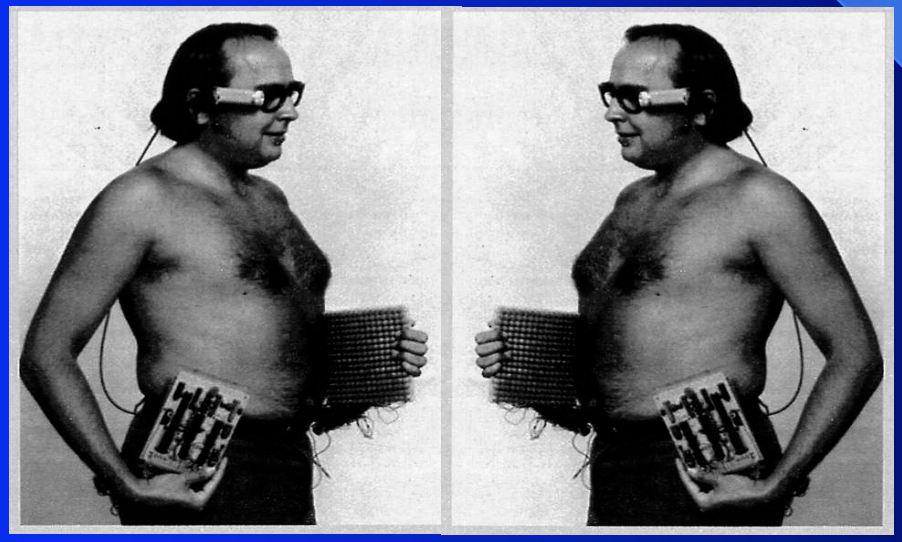
- How in everyday life or through technical devices can we differenciate another person from an object or a program?
  - Classical approaches in the philosophy of mind : representationnalism
    - Adoption of an « Intentional stance »; criteria which trigger « attribution of intentionality »
    - Recognition is cognitive and hypothetical: Inference based on already well-defined perceptive data
- However, in our experience as well as in phenomenological descriptions :
    - The recognition of others is immediate, perceptive and not cognitive.

Perceptual crossing

- When we catch someone's eye, it seems that we do not only perceive forms and movements; rather, we see directly an intentional presence that is looking at us.
- Our hypothesis : Perceptual crossing allows the recognition of the intentionality of another subject.
- Perceptual crossing in general: situation in which two perceptual activities of the same nature interact (e.g., a mutual gaze or a mutual touch).
- In this situation I directly perceive others like a perceptive activity turned towards me, i.e. to my own perceptive activity.

Prothetized perceptual crossing

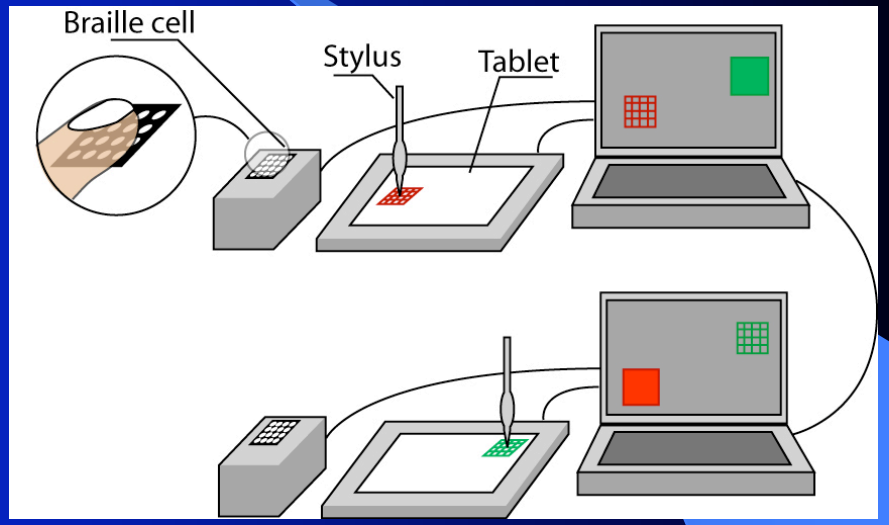
Perceptual crossing can take very different forms according to the technical support of the interactions: phone, internet, VR, perceptive supplementation (sensory substitution system), …



Technical interface can be used as tools to give an empirical content to our hypothesis. They allow the experimental study of a purified perceptive crossing

Method of minimalism (Tactos)

- We use minimalist devices: very few sensory information (one all or none stimulation) and limited possibilities of action.

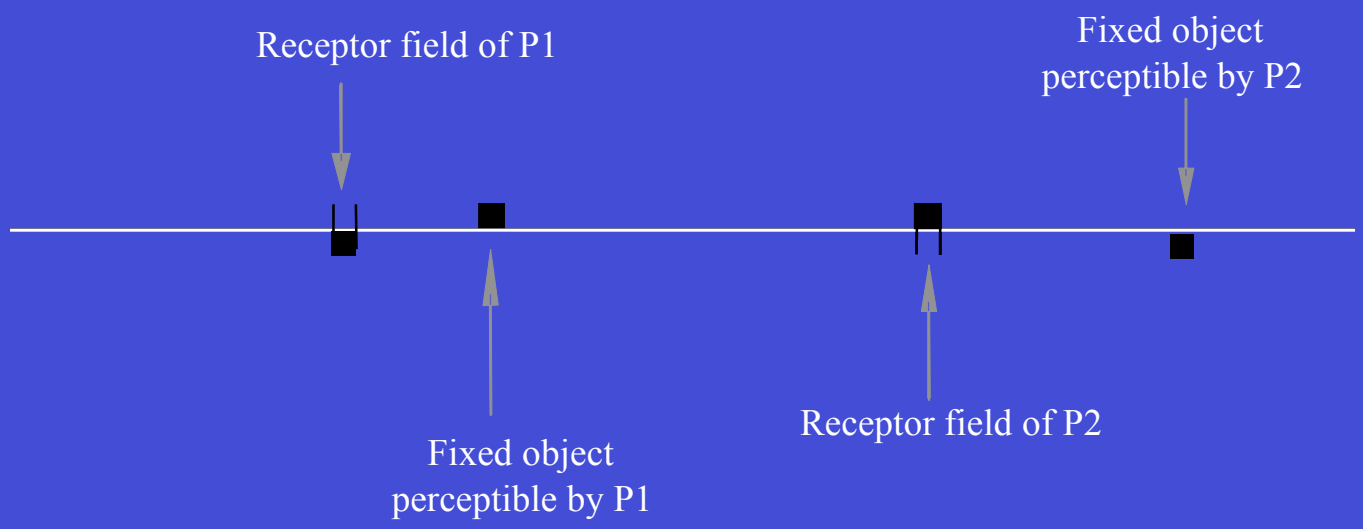


- By restricting to the maximum the possibilities of sensation and of action one forces a spatial and temporal deployment of the perceptive activity.
- We can thus study a perceptual crossing purified and general, functionally independent of a particular sensory modality.

Experimental protocol (1/3)

- Pairs of blindfolded participants were placed in separate rooms.
- Each participant moved a receptor field along a one-dimensional space (a torus) via the displacement of a computer mouse.
- Several objects consisting of black pixels were situated on this line.
- Each time the receptor field covered a black pixel, an all-or-none tactile stimulation was delivered on the participant's index pad.

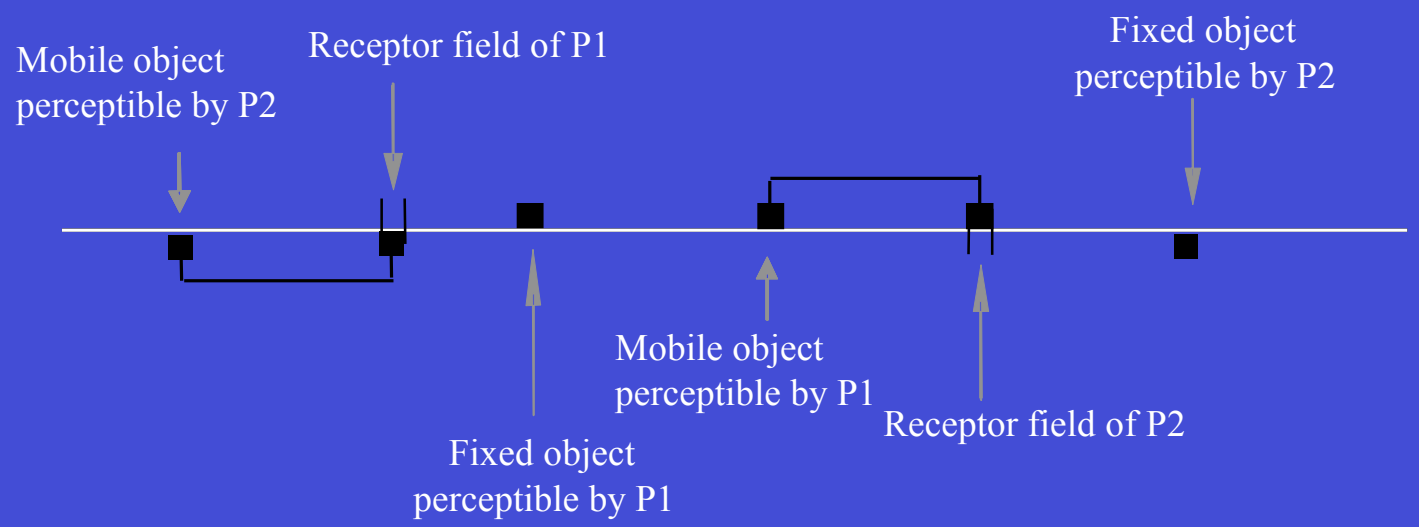
Experimental device



Experimental protocol (2/3)

- Each participant could encounter three types of object:
  - A fixed 4-pixel wide object.
  - A mobile 4-pixel wide object.
  - The 4-pixel receptor field of the other participant. Thus, when the two participants' receptor field overlapped, both of them received an all-or-none tactile stimulation.
- They have to click when they judged that their tactile sensations resulted from having met the receptor field of the other participant.
- Behavior of the mobile object : must be as complex as the movements of the receptor field of the partner.
  - It was attached by a virtual rigid link at a distance of 50 pixels from the center of this receptor field.

Experimental device



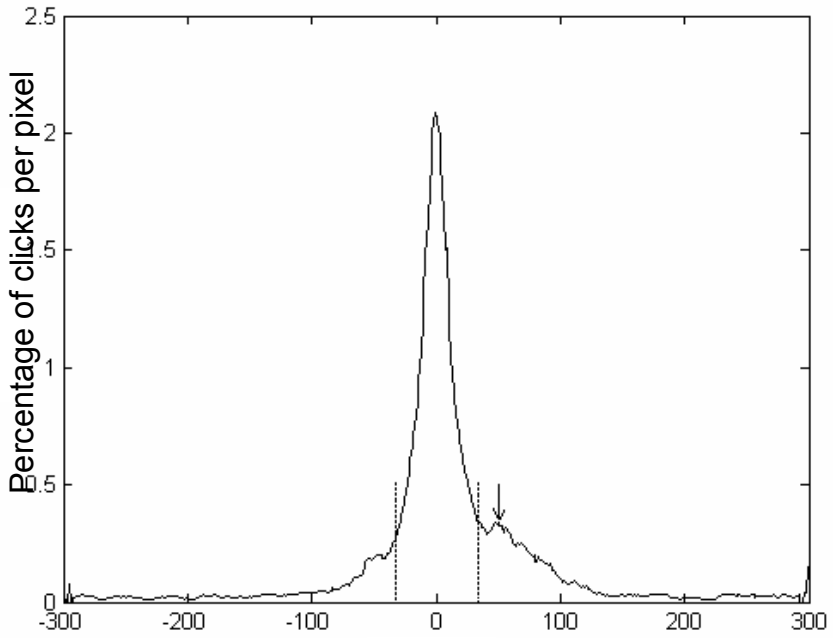
Experimental protocol (3/3)

- There is thus no difference of form or movement between the mobile object and the receptor field.
- Subjects have to click when they judged that their tactile sensations resulted from having met the receptor field of the other participant.
- Of course, the relation of the mobile object to the receptor field of the other participant was not explained.

- Participants performed the experiment once (20 subjects). They were trained on the device during 3 phases of 1 minute each: exploration of a fixed 4-pixel wide object; exploration of an object moving at a constant speed of 15 pixels per second; and of the same object at a constant speed of 30 pixels per second.
- The perceptive trajectories, the sensory stimulations and the clicks are recorded.

Results (1/2)

Frequency distribution of clicks as a function of the distance between the two participants



	Receptor field		Mobile object		Fixed object	
Percentage of clicks	65.9 %	± 3.9	23.0 %	± 10.4	11.0 %	± 8.9
Percentage of stimulation	52.2 %	± 15.2	15.2 %	± 6.2	32.7 %	± 11.8
Ratio clicks / stimulations	1.26		1.51		0.33	

63% of the distribution laid between ± 30 pixels, as indicated by the dotted lines. Note the slight peak at a distance of 50 pixels that corresponds to clicks on the mobile object

Results (2/2)

- Participants interacting in a minimalist environment can recognize when the succession of all-or-none tactile stimuli they receive are due to meeting the receptor field of another participant…

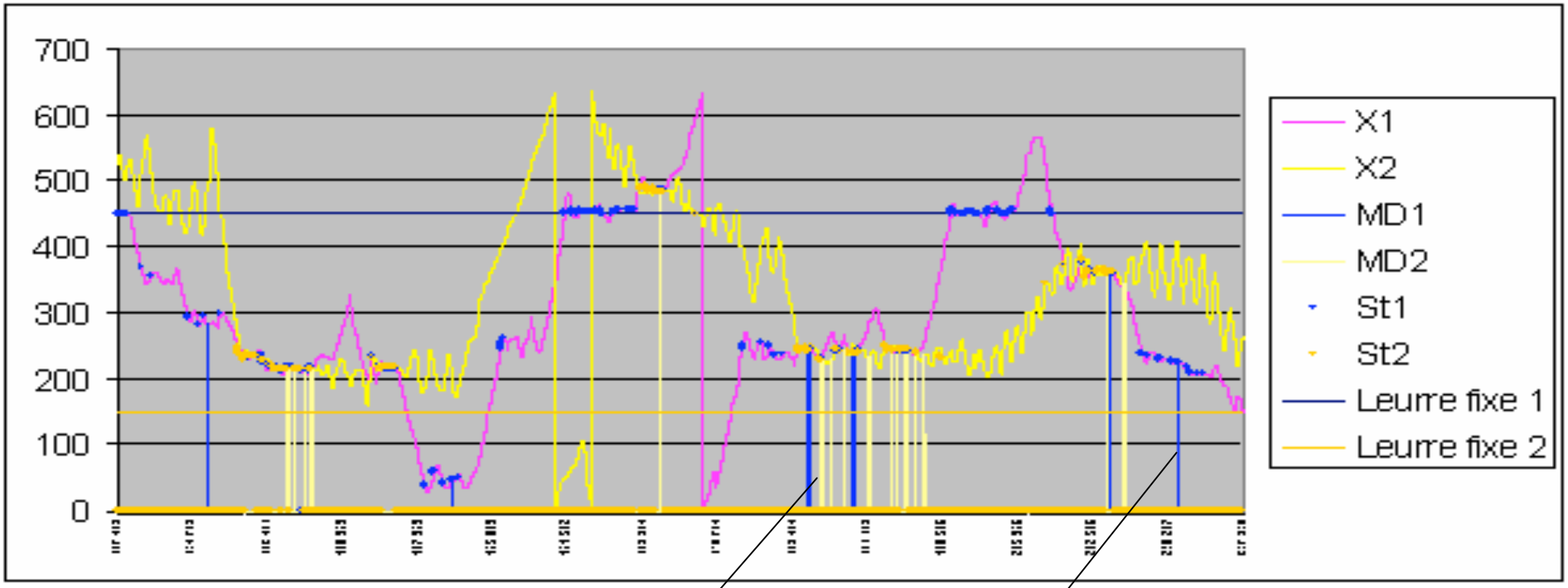
  … even though there was absolutely no difference in the stimuli themselves (simple all-or-none signals in all cases); and even though the structures of movement were absolutely identical.

- Relatively small proportion of clicks on the fixed object : participants' capacity to differentiate fixed and mobile objects

- But how they differentiate the receptor field?

- To understand we studied the perceptive trajectories…

Trajectories of the perceptual crossings



Clicks on the perceptual crossing

Clicks on the mobile object

Analysis

- The participants did not seem able to discriminate between stimuli due to the receptor field of the other participant and those due to the mobile object: The probability of a click was very similar in both cases.

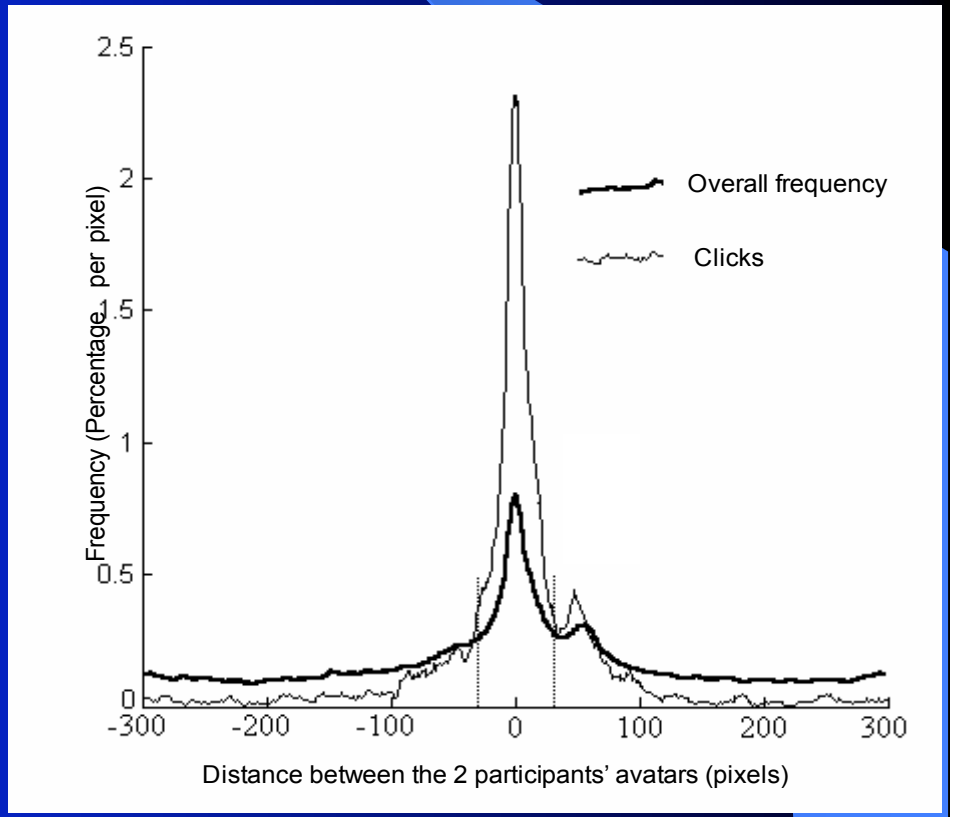
	Receptor field		Mobile object		Fixed object	
Percentage of clicks	65.9 %	± 3.9	23.0 %	± 10.4	11.0 %	± 8.9
Percentage of stimulation	52.2 %	± 15.2	15.2 %	± 6.2	32.7 %	± 11.8
Ratio clicks / stimulations	1.26		1.51		0.33	

- The large difference observed between clicks on the avatar and clicks on the mobile object (65.9% vs. 23.0%) must be attributed to the conjoint strategies of movement, which are such that stimulations associated with the mobile object were much less frequent than those due to the avatar (52.2% vs. 15.2%).

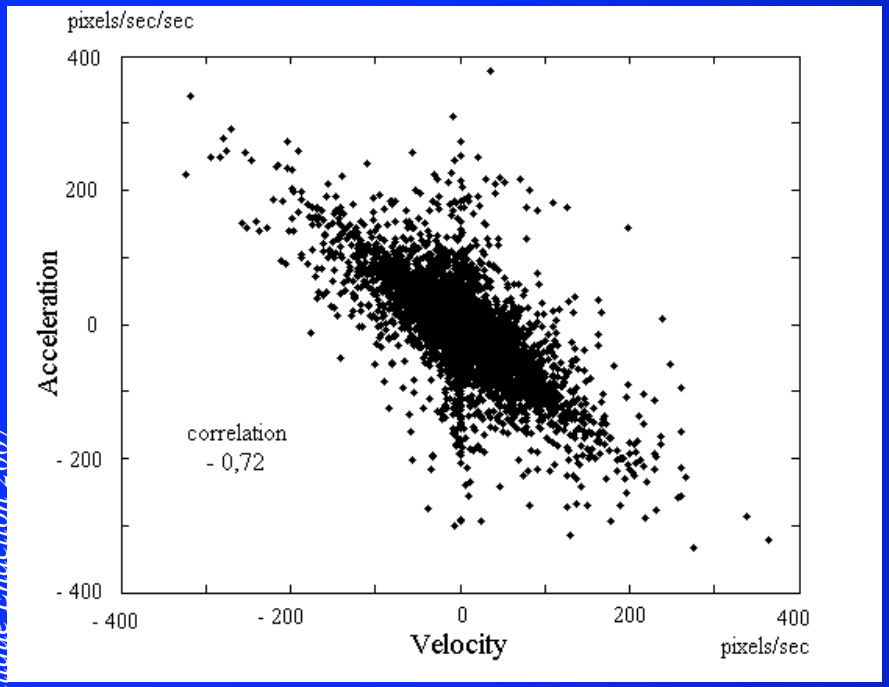
Attractor of the collective dynamic

- If the participants succeeded in the perceptual task, it is essentially because they succeeded in situating themselves in front of each other.

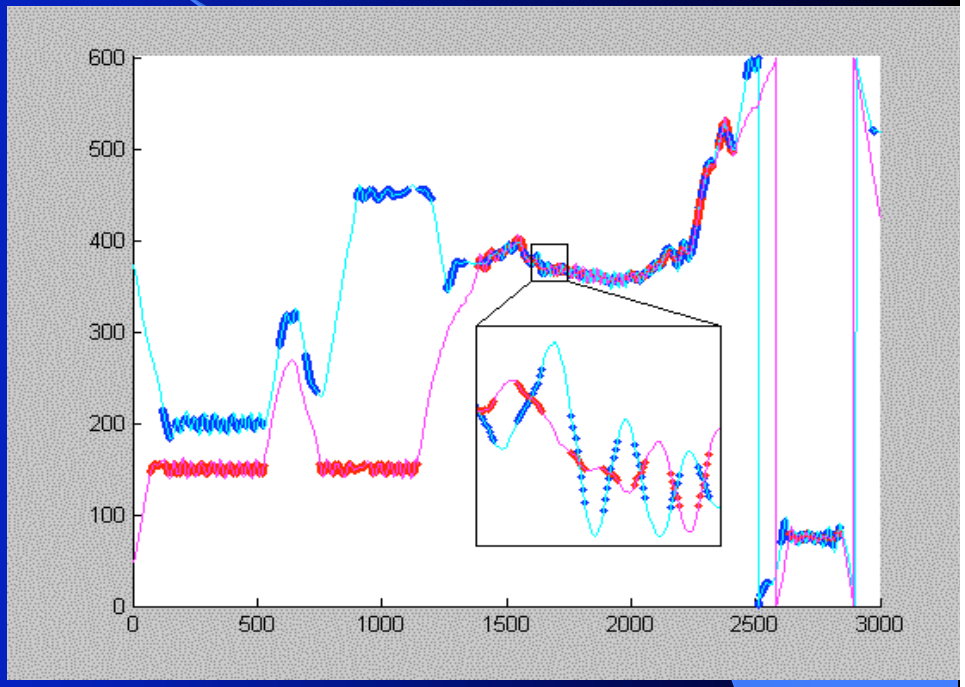
- The active perceptual activities attract each other; just as in everyday situations there is an attraction to the situation where two people catch each other's eye.



Perceptive strategies for an attractor of the collective dynamic



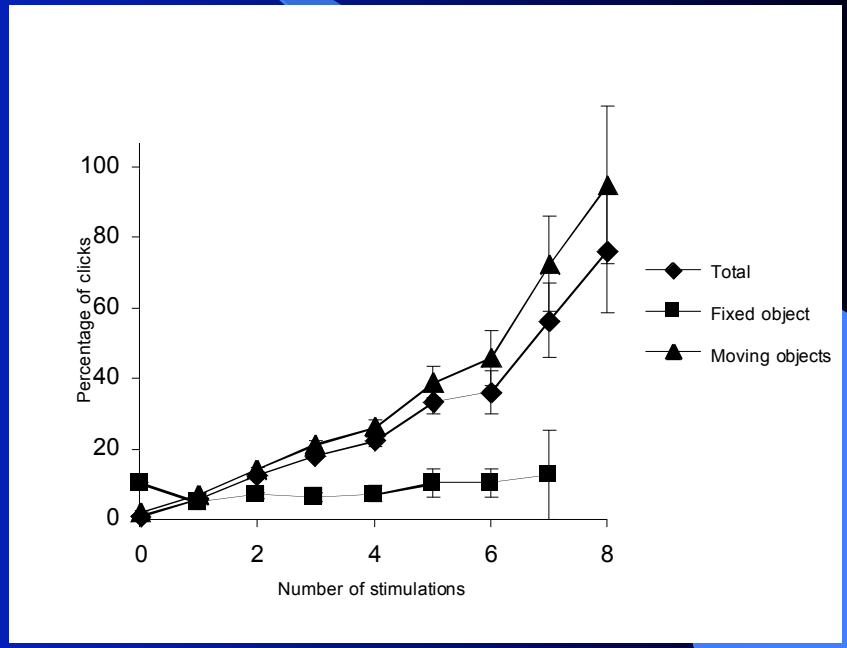
The mean acceleration during 1 second after losing contact with a source of stimulation, plotted as a function of the mean velocity during 1 second preceding this event: clear negative correlation, - 0,72.



Simulations: when a receptor field meets a stimulation we reverse his acceleration (modelisation carried out in our lab by John Stewart)

Individual strategy

- The attractor increases the probability that the stimulation is due to the presence of the other participant
- So, if subjects click more often when the number of stimulations increases, they will click correctly on the receptor field of the other participant.



Number of stimulation (in 2 s) before a clic

Theoretical discussion

- Perception of an object in a spatial location results from active, reversible exploration of this object (general form of the perceptual strategy consists of turning back whenever a sensory variation is encountered) : spatial determination of the fixed object.
- There is thus a « Wall of perception » : I cannot perceive an object which moves more quickly than my receptor field.
- Therefore, I cannot perceive the receptor field of my partner… and nevertheless I perceive it!
- In the perceptual crossing, the perceptive activities of the two partners are dependent between them and form an attractor which has no spatial stability.
- Thus, while maintaining their presence, the others' glance resists to spatial localization. It is something there, but which is not an object spatially given.
- Another perceiving subject is a thing that is at the same time present (there are variations of the stimuli) and that resist to its precise spatial determination.

Recognition of a perceptive intentionality

- What means the recognition of the presence of others?
  - The categorization of the stimuli? In this case, there is no recognition : for a given stimulus (from the mobile lure or from the receptor field of the partner) the probability of clicking is the same
  - The capacity to discriminate others actively, the know-how to find him specifically?
- Here, the discrimination is carried out by a *collective* dynamics of the perceptive trajectories
  - The difference between the receptor field of my partner and the mobile object is that only the first changes its behavior when my receptor field crosses it. Thus, the dynamics of the interactions reveals the sensitivity of the receptor field of the partner
  - The condition for the existence of an attractor is that the reaction of my partner is a perceptive activity directed towards me: a perceptive intentionality.
- The situation of perceptive crossing is perceived by each partner as the sign of the presence of a perceptive intentionality turned towards him.
- Behind the body-image (Körper) of my partner I perceive the intentionality of a perceiving body (Lieb) : I understand the interlacing between the Lieb and the Körper in others before in my own body

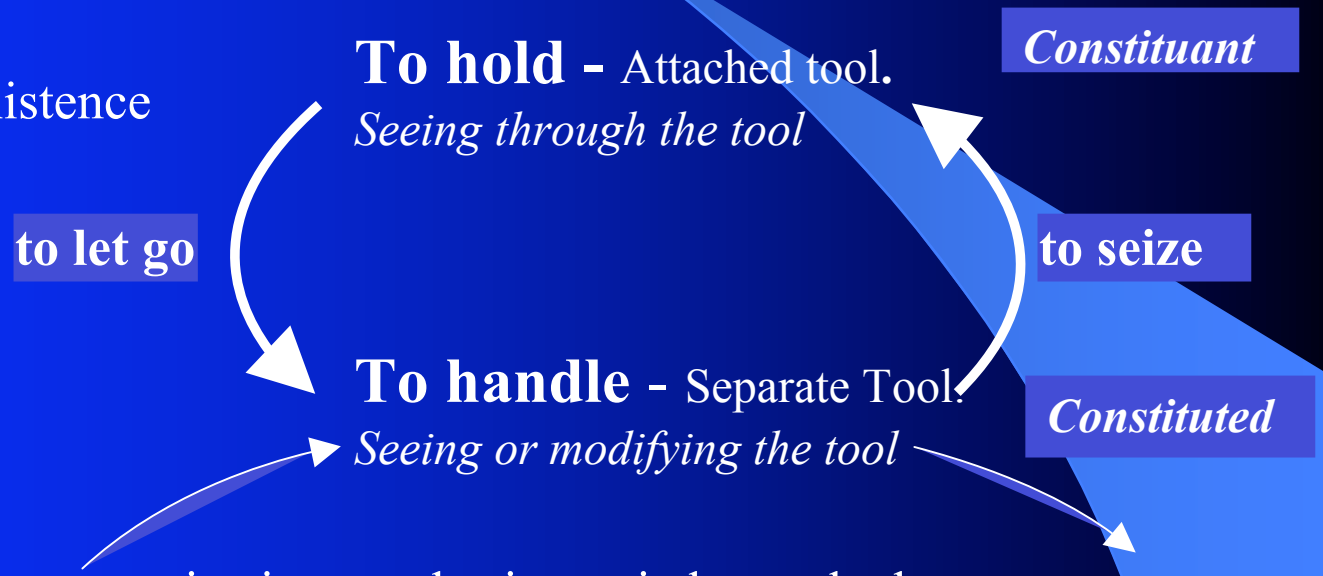
Technological and social consequences

- The situation of perceptual crossing is felt more richer and interesting than the perception of fixed form.
- Even with maximum sensory poverty, an emotional value can be attached to perceptions if there is a possibility of synchronization of the perceptive activities.

IV.3. Technical Communities

• Problem: one never perceives what one uses to perceive. Neither its retina, neither its ocular movements, neither its cerebral surface V1, nor its glasses...

• The two mode of existence of a tool:

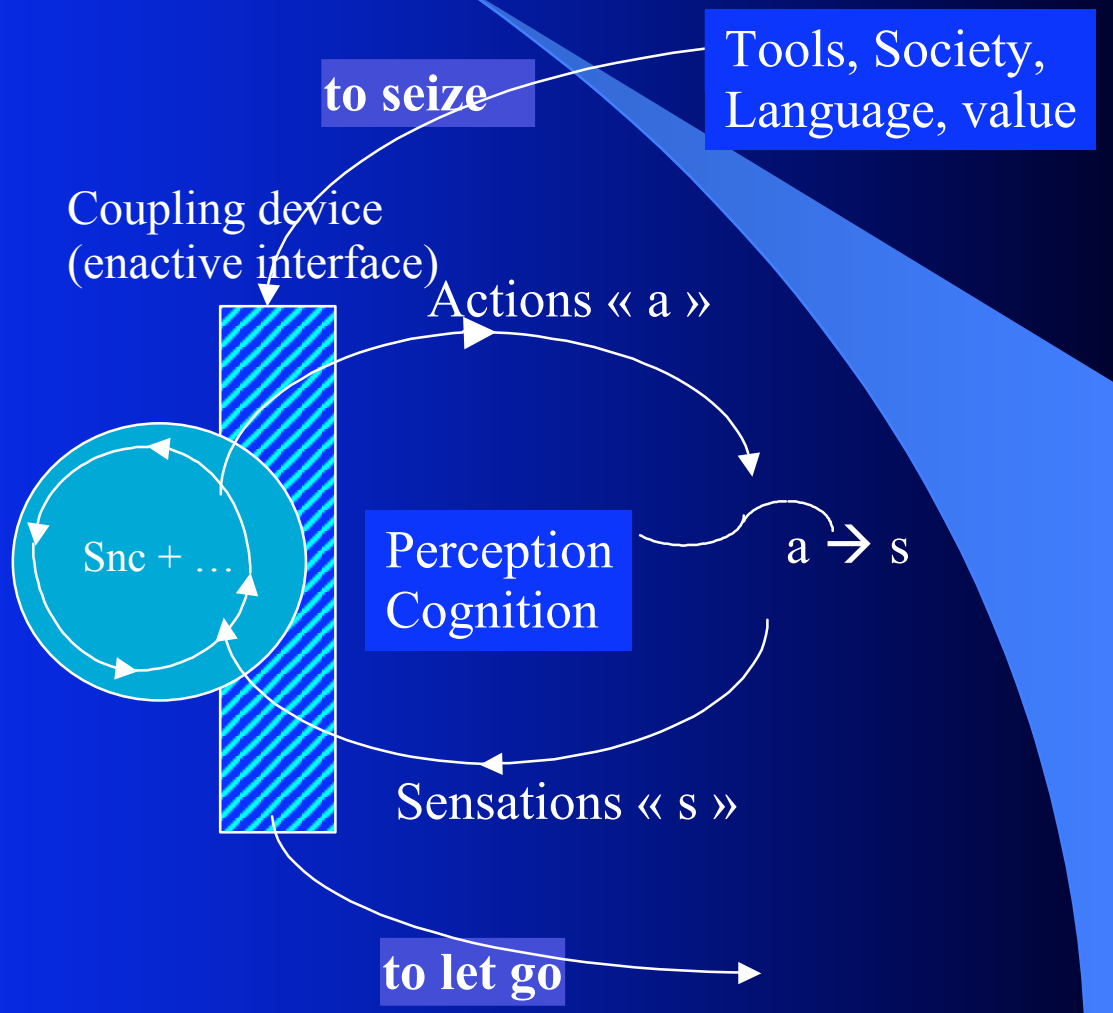


• But the problem is to recognize its prosthesis carried, attached.
• Through the perceptive crossings, I can assume my prosthesis as I assume my face.
• The mediation can be at the same time forgotten (because integrated) and expressive (because assumed)

Questions for the futur of enactive sciences

Beyond a « meta-dualism »…

- internalism and neurophenomenology
- externalism and sensorimotor constitution



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