Affordances and Robots
(The prescriptive way)

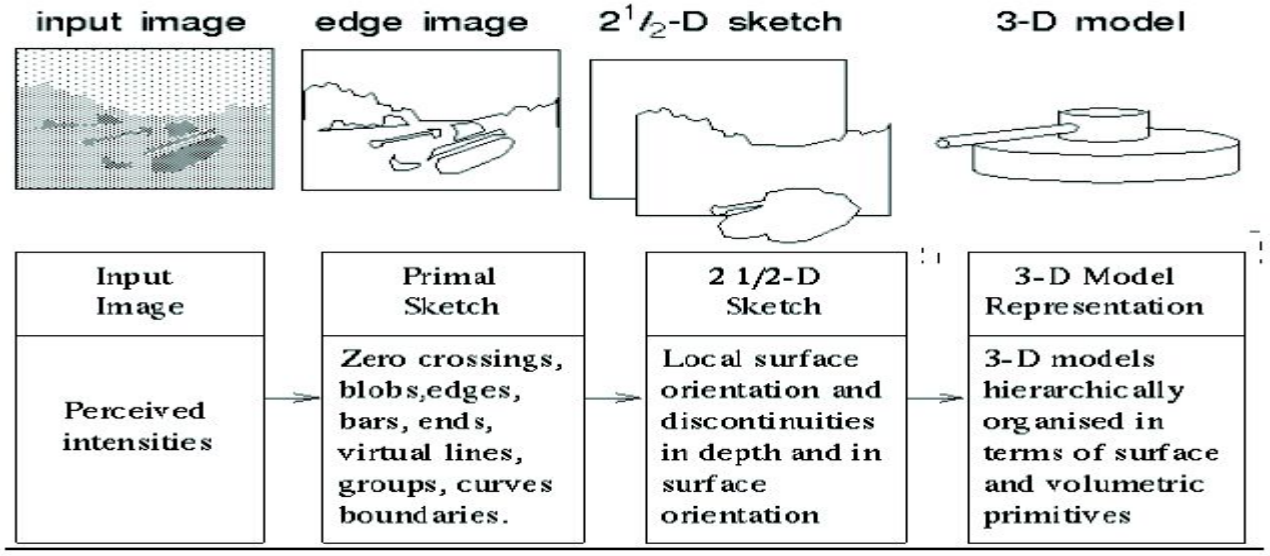
- Affordances from Ecological Psychology
- Affordances in Robotics

Readings

- Sahin, E., Cakmak, M., Dogar, M. R., Ugur, E., and Ucoluk, G. (2007). To afford or not to afford: A new formalization of affordances toward affordance-based robot control. Adaptive Behavior, 15(4), 447-472.
- Jamone, L., Ugur, E., Cangelosi, A., Fadiga, L., Bernardino, A., Piater, J. and Santos-Victor, J., 2016. Affordances in psychology, neuroscience and robotics: a survey. IEEE Transactions on Cognitive and Developmental Systems.

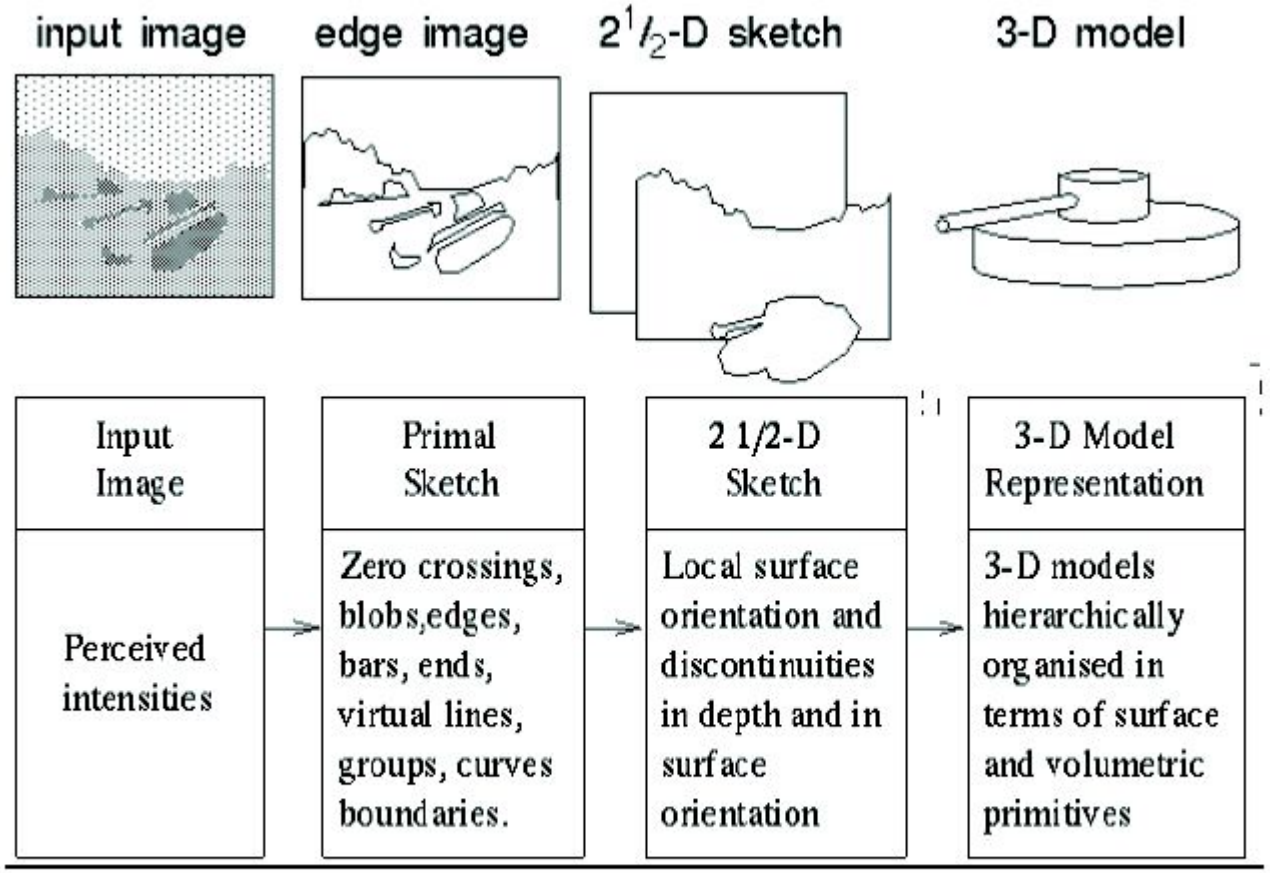
Traditional approach to visual perception in 70's

- Starting point of perception is the static pattern of light intensity on the retina
- Perception is indirect and mediated by other processes
- The outcome of the perception is the formation of an internal representation of objects in the environment



Stages of Visual Representation, David Marr, 1970s

Traditional approach to visual perception in 70's



Stages of Visual Representation, David Marr, 1970s

Traditional approach to visual perception in 70's

- In order to grasp a mug
  - Reconstruct the 3D model of the object from the retinal image
  - Recognize the object as a mug
  - Infer that the object is graspable thanks to the internal representations

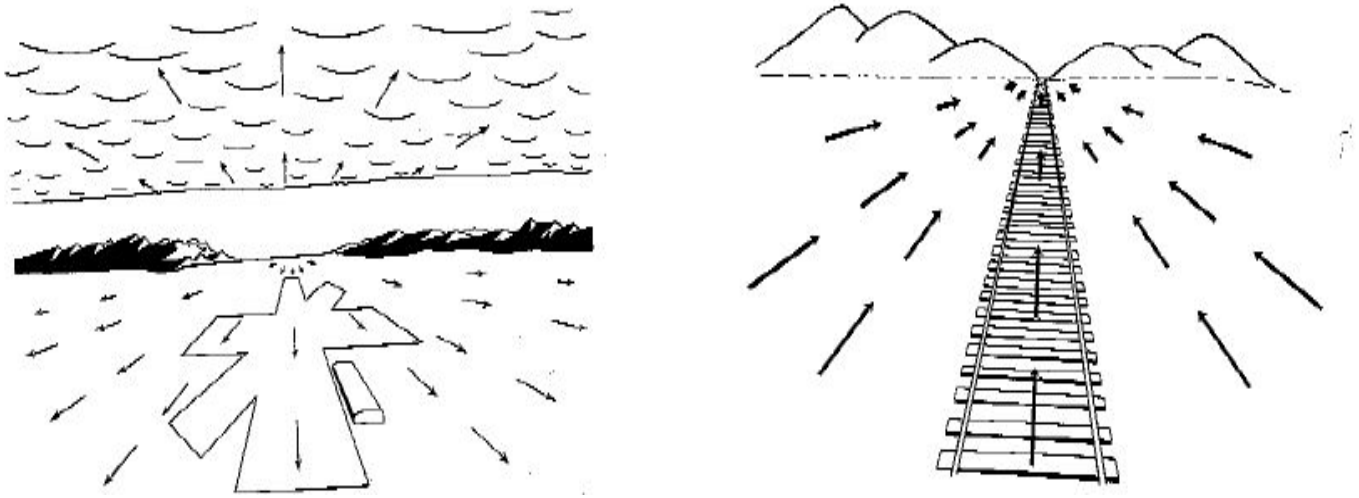
A radical approach

Each thing says what it is … a fruit says “Eat me”; water says “Drink me”; thunder says “Fear me”; and woman says “Love me”. (Koffka, 1935)

- Mug says “grasp me”

Optical variables/invariants

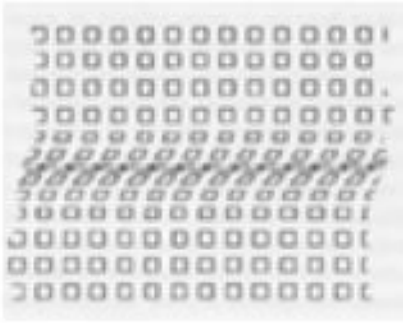
- **James Gibson**, During World War II, U.S. Army Air Force's Aviation Psychology Program.
- Visual aptitude tests for screening out pilot applicants
  - Tests in static images, e.g. depth perception
  - Perception of properties related to flying and landing
- Optical variables in the perceptual data that are meaningful.
- The optical center of expansion of the pilot's visual field. This center of expansion, indicates the direction of the glide and helping him to adjust landing behavior.



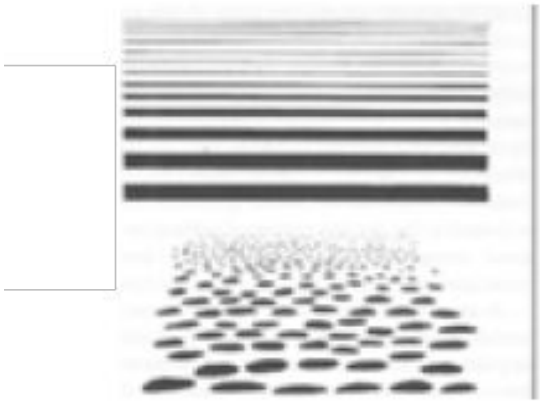
Transformational invariants

Optical variables/invariants

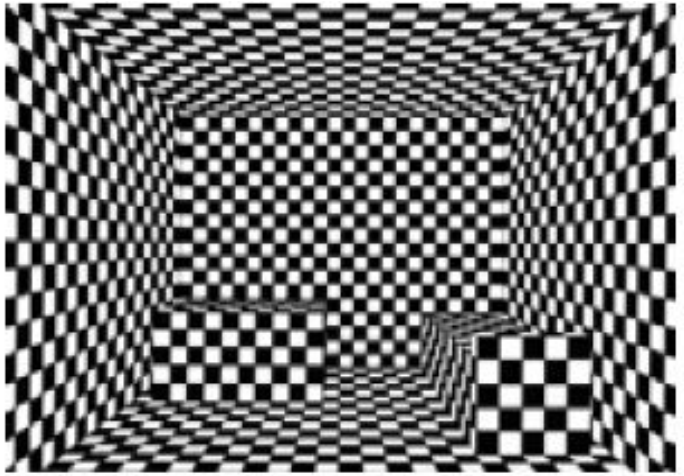
- Structured light carries information
  - e.g. light structured by texture



about shape



information about distance

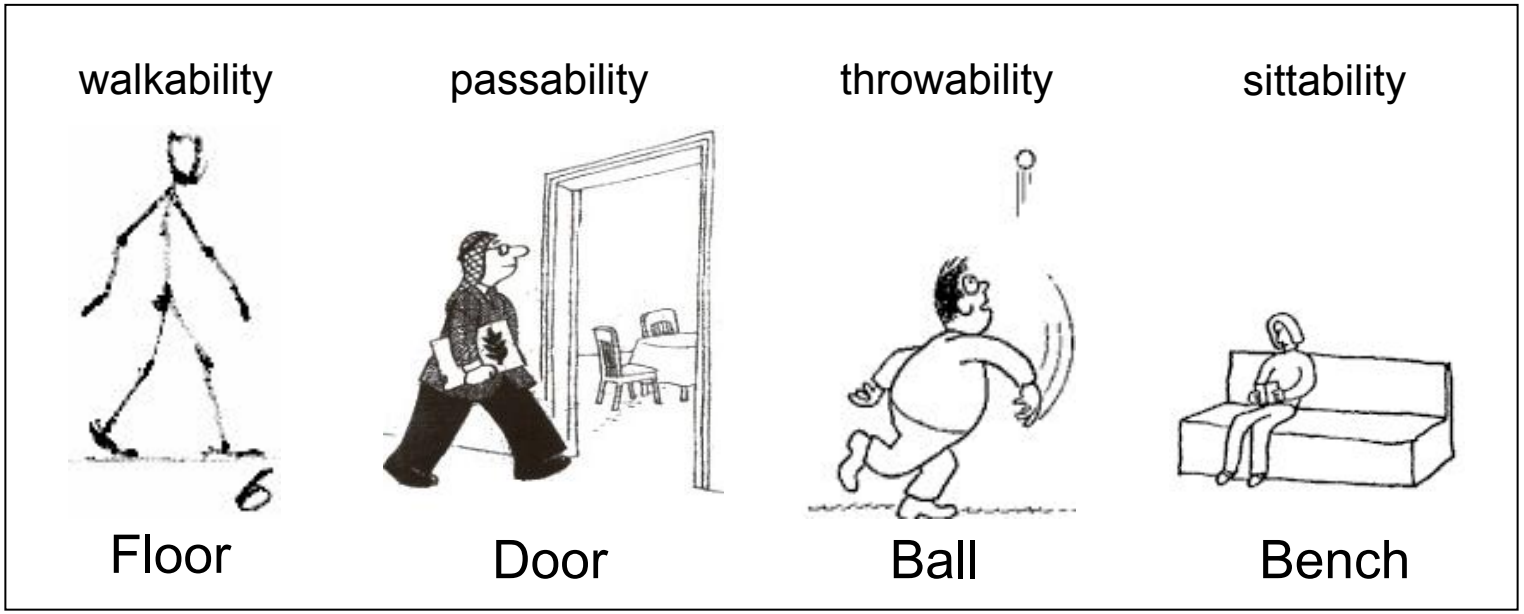


and general layout of objects in the environment

What is an affordance?

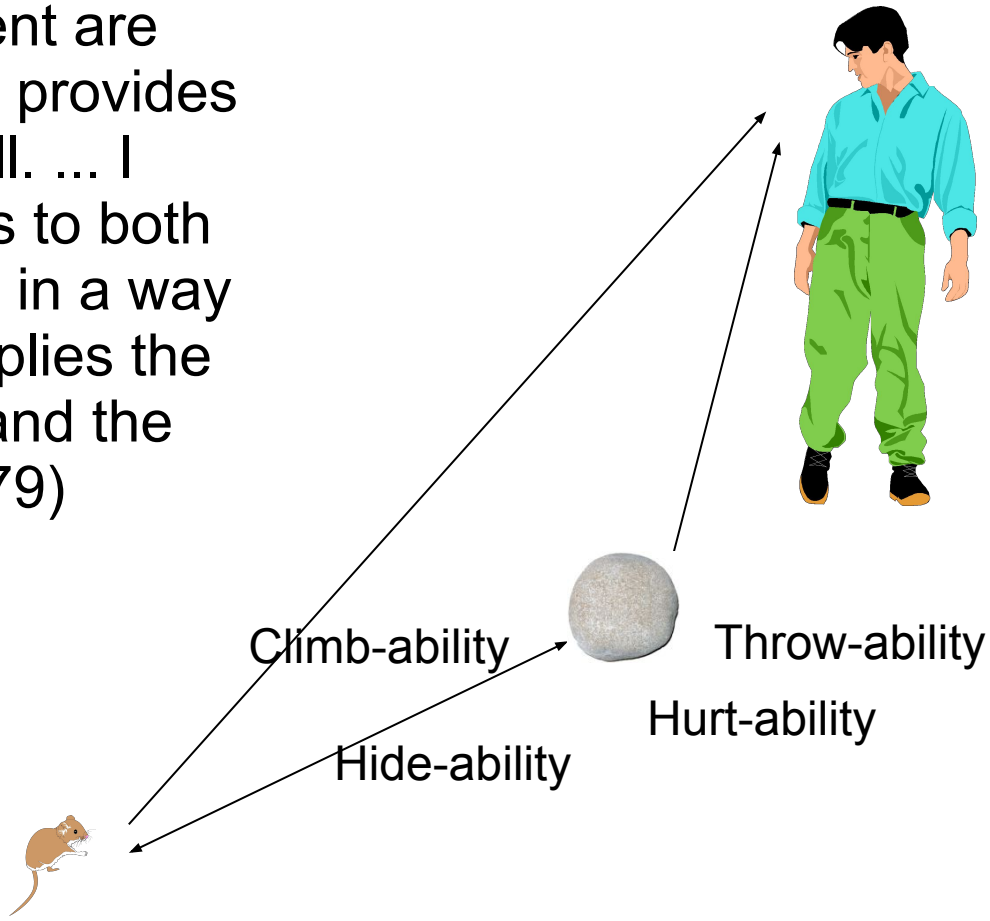
J.J. Gibson (1904–1979)

- "Affordances are action possibilities that the environment offers to an animal interacting with it"
- The organisms do not need to recognize the objects in order to act on them.
  - Direct perception.

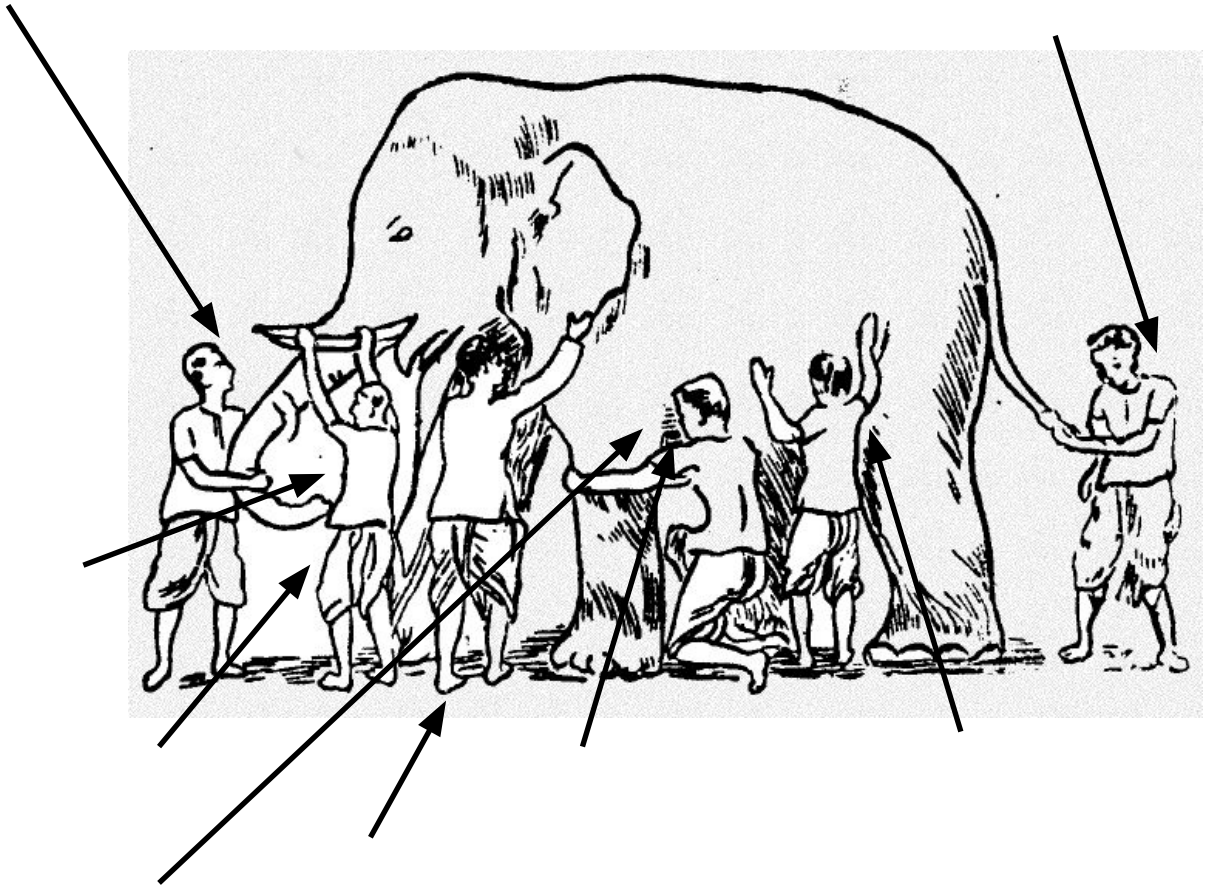


Affordances are defined in animal-environment system

"The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. ... I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment." (J. J. Gibson, 1979)



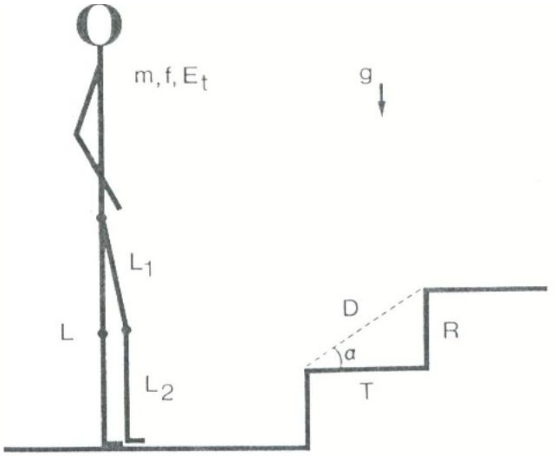
Affordances as an elephant

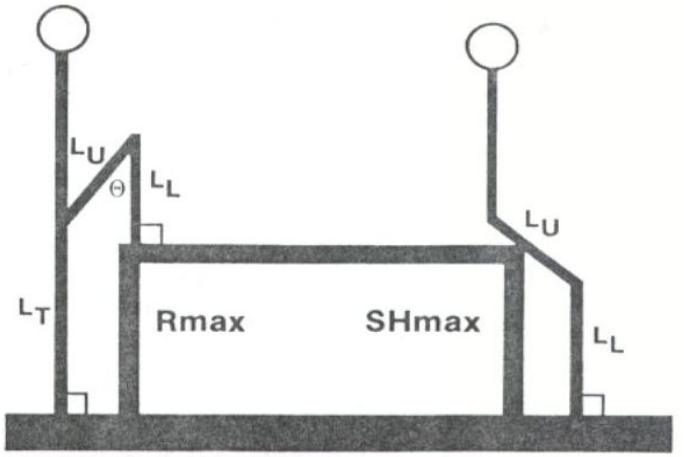


- expressed in verbose descriptions.
- evolved over time
- in contrast to the background of contemporary ideas.
- were often blended with his work on visual perception

Experiments in Ecological Psychology

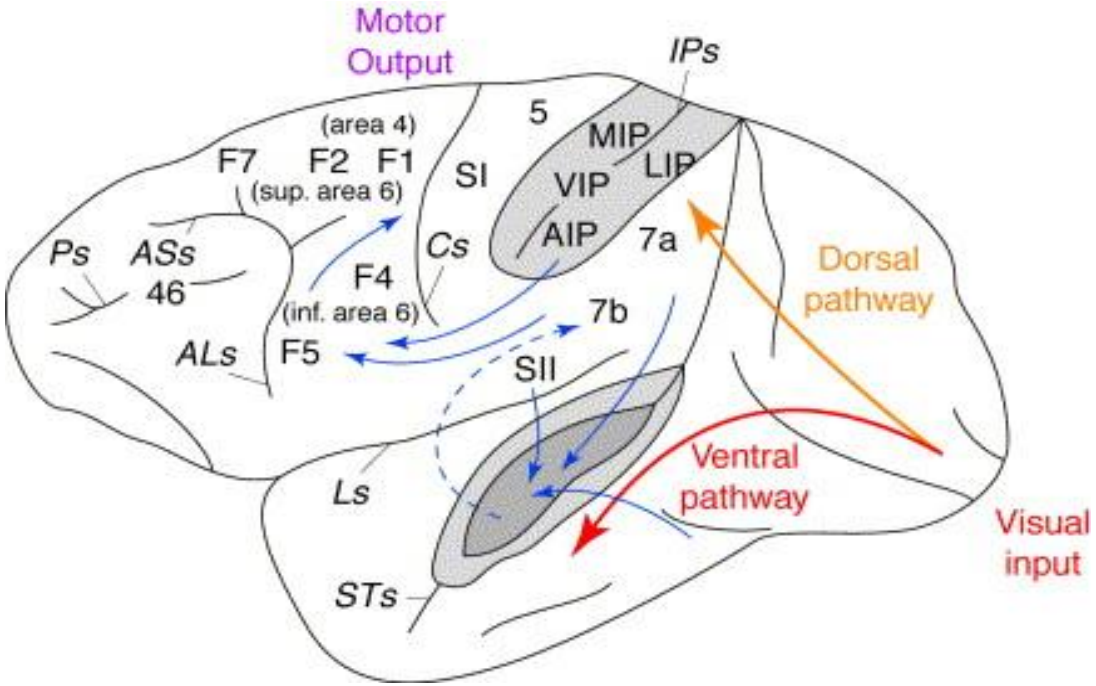
- Affordance ratios
- Warren's (1984) stair-climbing experiments
  - Claims that affordances are perceived in terms of intrinsic or body-scaled metrics
  - Identified critical points and optimal points which are perceivable, constant dimensionless ratios, called pi
- Intrinsic nature of affordance perception: eyeheight
  - Walking through aperture (Warren and Whang; 1987)
  - Sitting and climbing to various surfaces (Mark;1987)





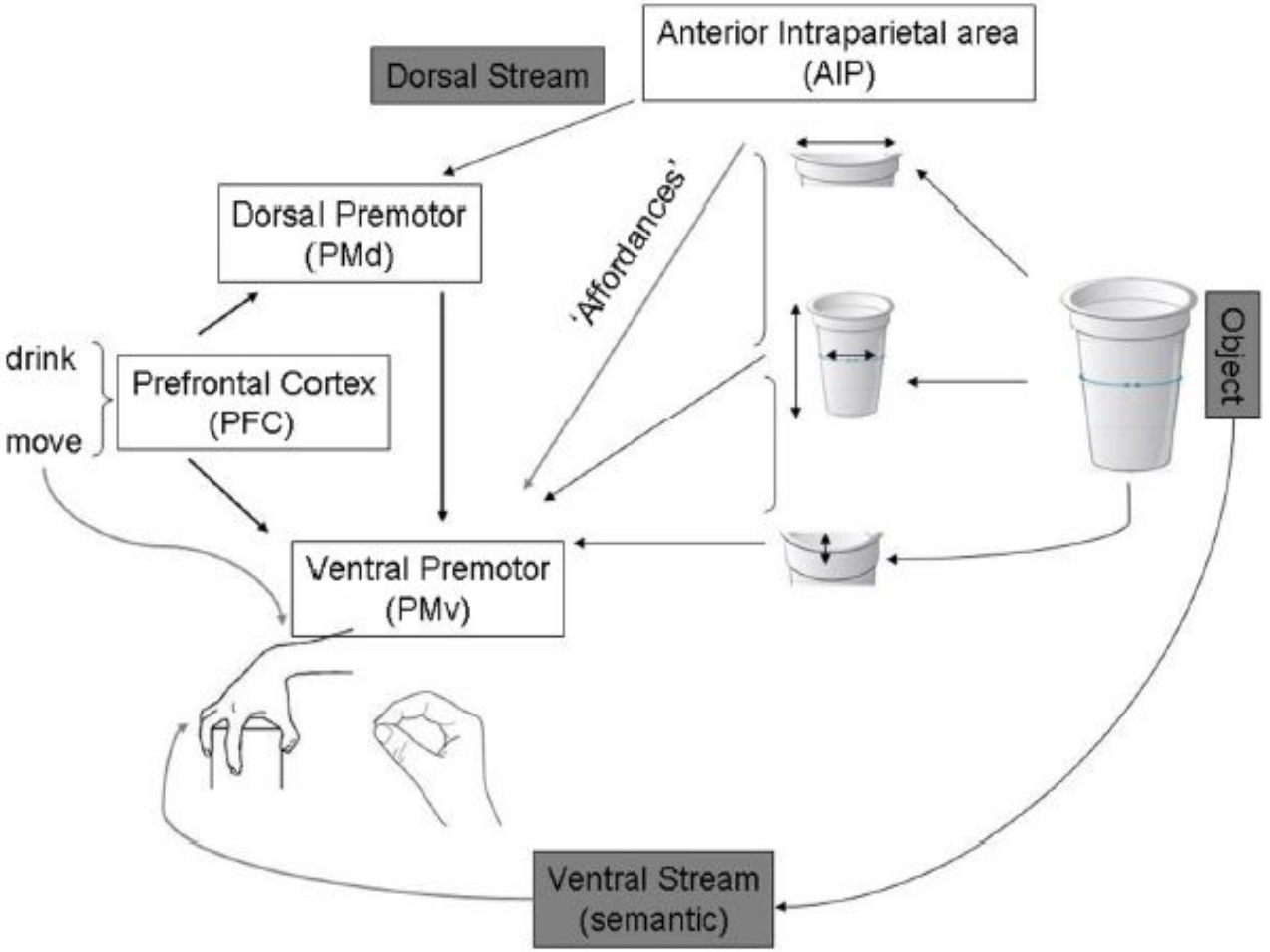
Evidence from Neurophsiology

- Dorsal system for information pickup -- AFFORDANCE
- Ventral system for high-level tasks like identification.
- The patient without a ventral system is able to successfully avoid from the obstacles or insert mails into slots in correct orientation.
- However the same patient does not recognize those objects.



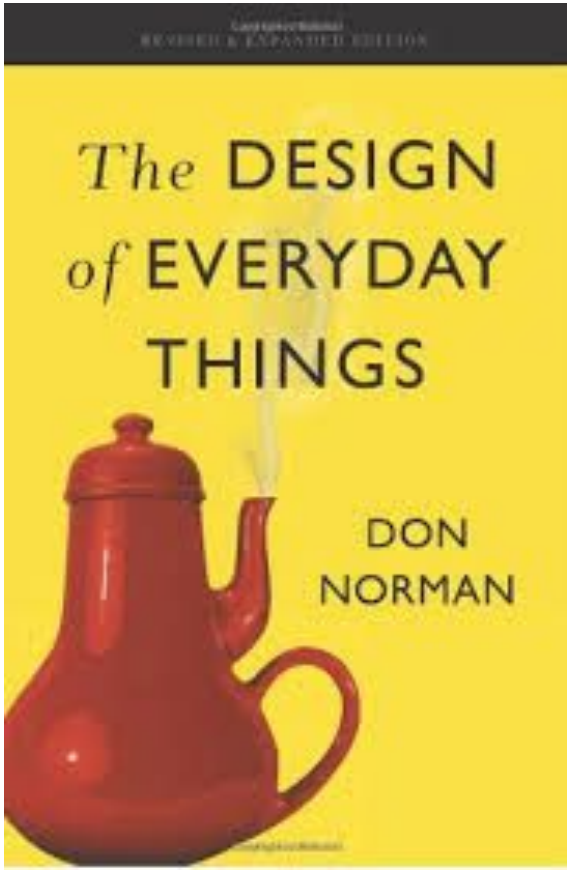
Evidence from Neurophsiology

- A computational model



Affordances in Human Computer Interaction

- Plates (on doors) are for *pushing*.
- Knobs are for *turning*.
- Slots are for *inserting* things into.
- Balls are for *throwing* or *bouncing*.
- “When affordances are taken advantage of, the user knows what to do just by looking; no picture, label, or instruction needed.”



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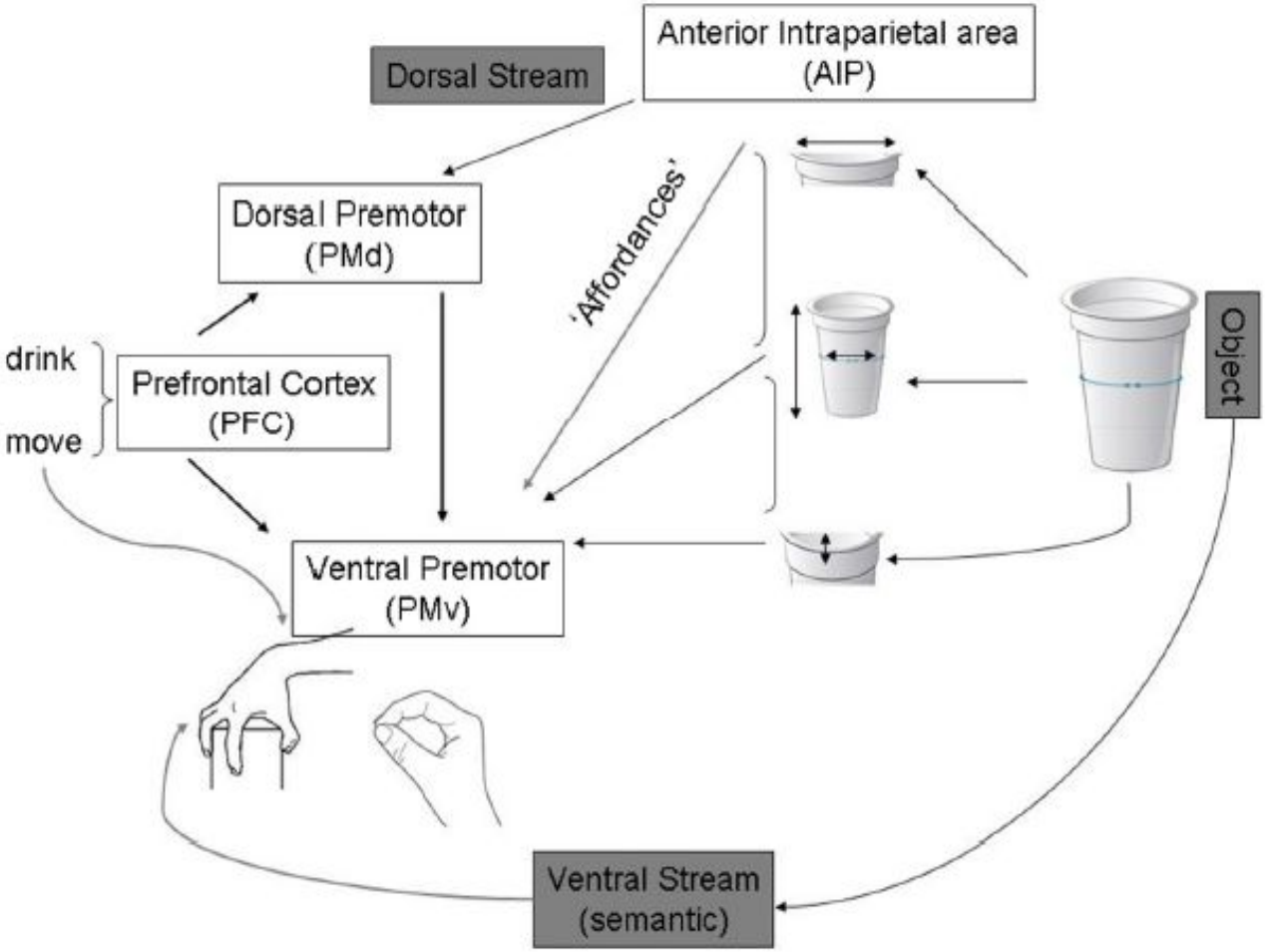


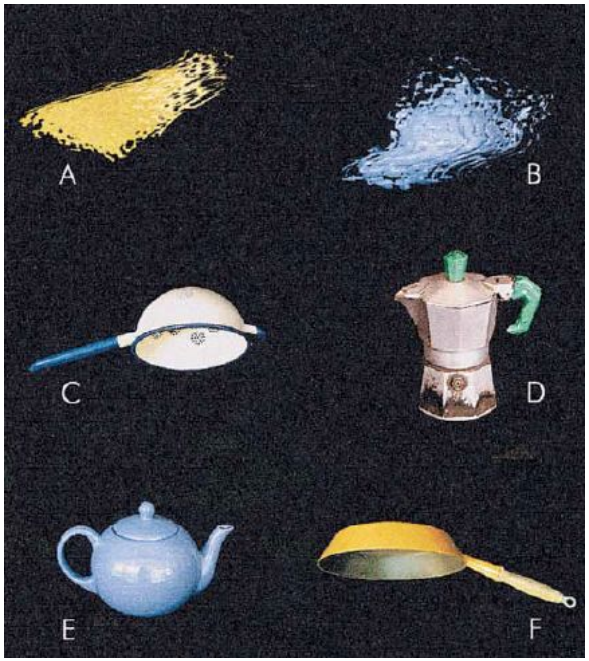
PERGAMON

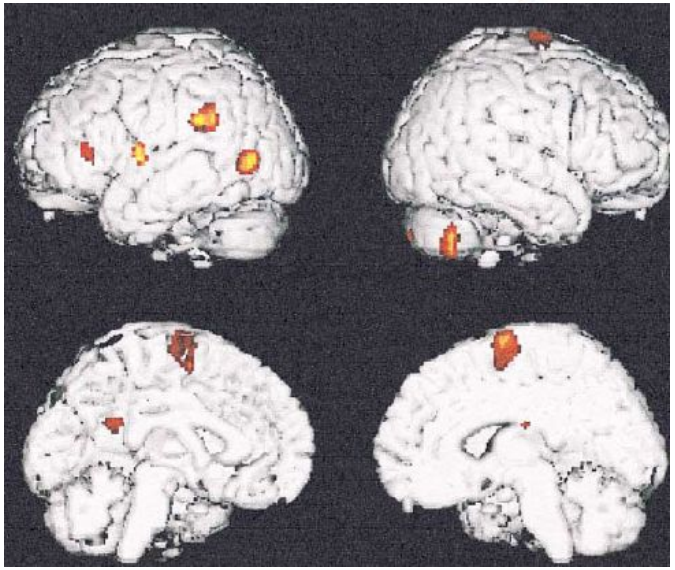
Neuropsychologia 40 (2002) 212–222

www.elsevier.com/locate/neuropsychologia

Does visual perception of object afford action? Evidence from a neuroimaging study

J. Grèzes [a], J. Decety [a,b,*]

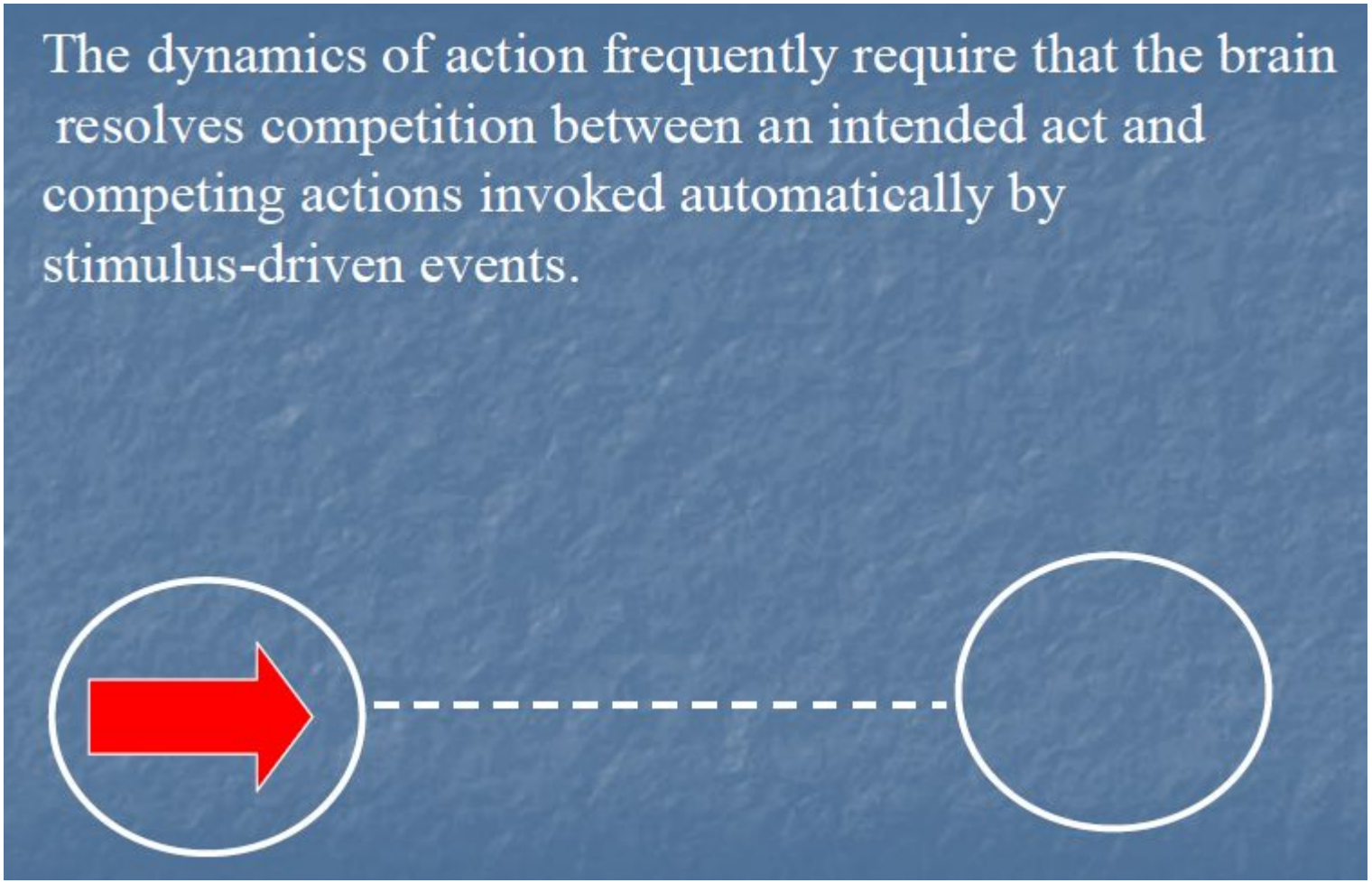




- PET
- tasks: judge orientation, motor imaginary, verbalize
- parietal and premotor activati
- The lack of involvement of the ventral stream

- Upright–inverted cond., a graspable tool, keyboard response, left or right hand depending on orientation
- motor imagery cond, imagine grasping and using obj, click left/right depending on horizontal orientation
- silent object naming task, silently name each object, then to make a keyboard response with the left or the right

Alignment paradigm



http://thesciencenetwork.org/media/videos/335/Powerpoint.pdf

Alignment paradigm

Objects with handles form an interesting subclass of manipulable artifacts because actions may be automatically invoked on one or the other side of the body, depending on the position of the handle.

But if we wish, we can apply a left-handed grasp to the beer mug, despite the habitual action invoked by the handle on the right.

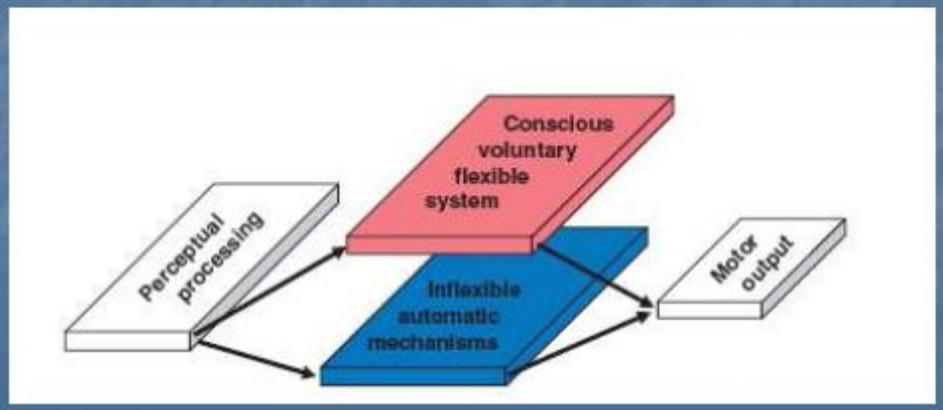
http://thesciencenetwork.org/media/videos/335/Powerpoint.pdf

Under what task conditions are motor affordances automatically evoked?

Possibility 1 (*See* $\rightarrow Act_{automatic}$): Perception of a manipulable object automatically triggers motor-based representations which then compete with the intentions of the observer.

Possibility 2 (*Motor Intention* $\rightarrow$ *See* $\rightarrow Act_{automatic}$): Objects do not inevitably afford actions during perception.

Rather, motor intentions play a crucial role in determining whether perception generates habitual actions.



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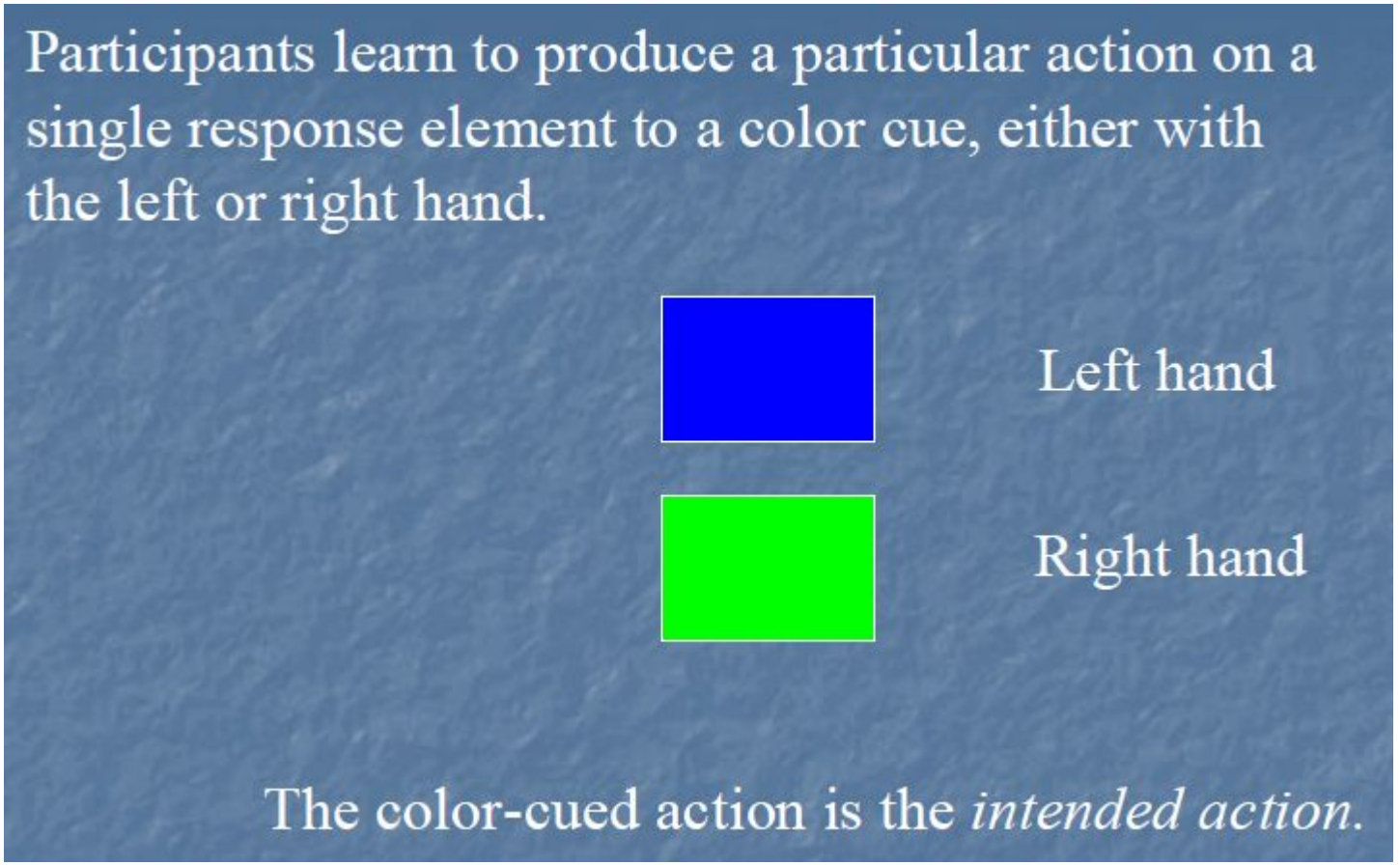

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Alignment paradigm

After training, the color cue is presented in the context of a handled object, with the handle facing left or right.

We assume the irrelevant handled object automatically evokes hand action representations.

Competition: The arm producing the intended action conflicts with the side matching the evoked action.

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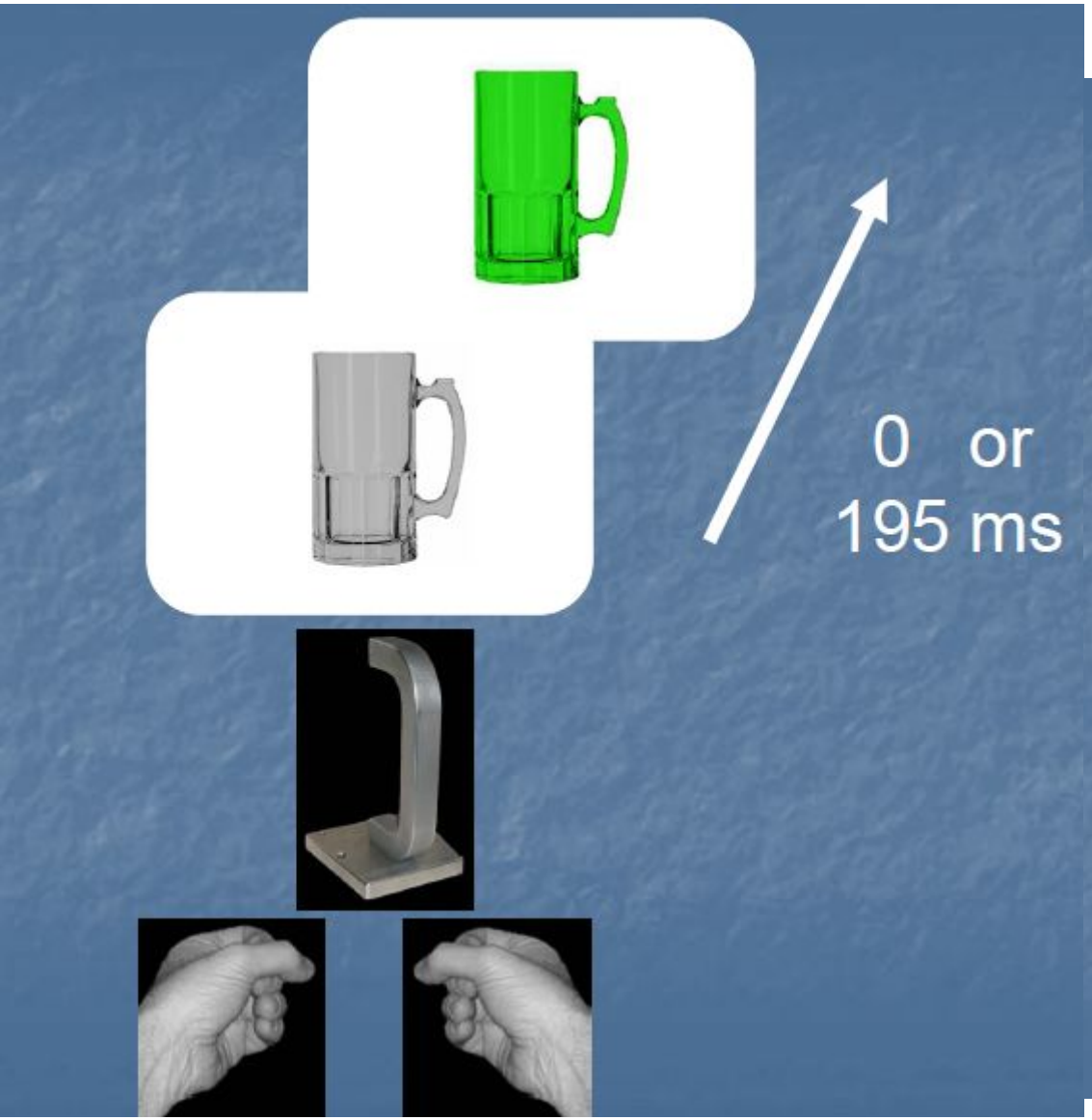
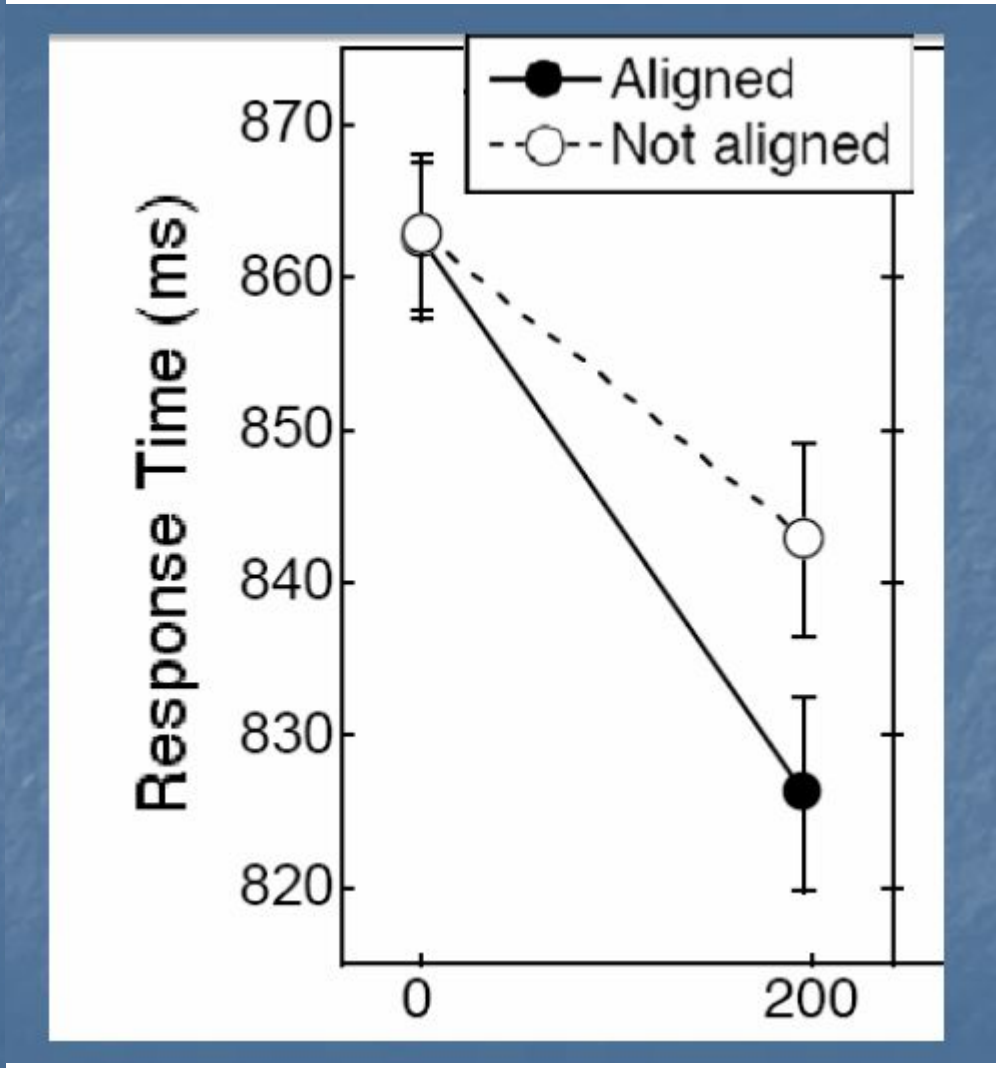
Alignment paradigm





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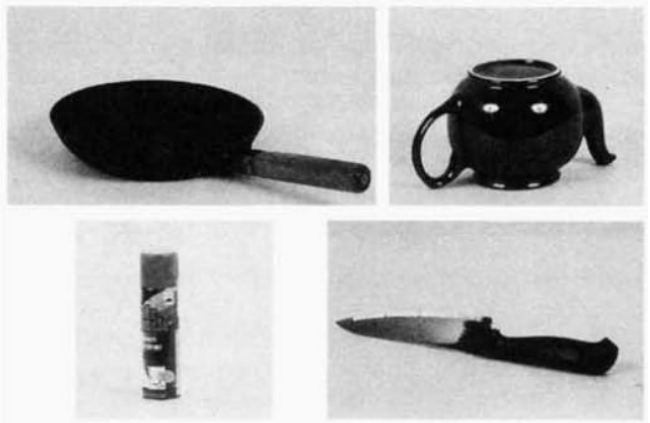
Journal of Experimental Psychology:
Human Perception and Performance
1998, Vol. 24, No. 3, 830–846

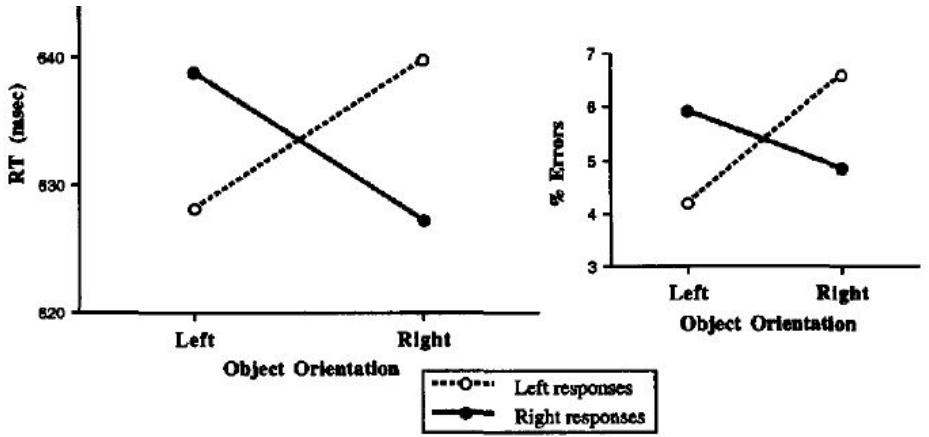
0096-1523/98/$3.00

On the Relations Between Seen Objects and Components of Potential Actions

Mike Tucker and Rob Ellis

- a stimulus-response compatibility paradigm
  - assigning left responses to left stimuli and right responses to right stimuli results in shorter response latencies than does the reverse mapping
- **stimuli**: photographs of common graspable objects
- **task**: as fast as possible whether each object was upright or inverted.
- the **hypothesis** that more than location-based response codes could be activated automatically by visual objects—in particular, that the actions the object affords are automatically potentiated

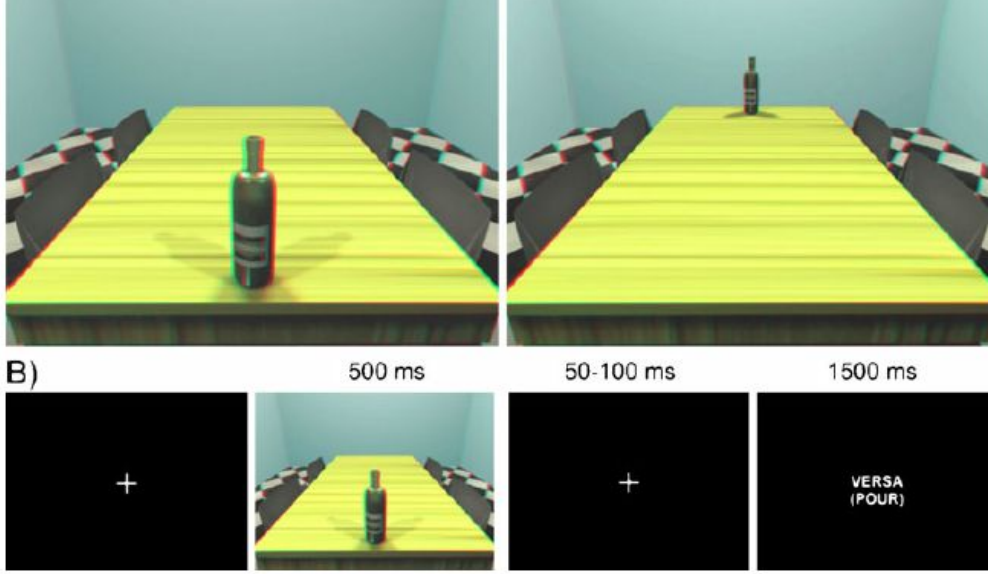




Psychon Bull Rev (2011) 18:302–308
DOI 10.3758/s13423-011-0054-4

When objects are close to me: Affordances in the peripersonal space

Marcello Costantini · Ettore Ambrosini · Claudia Scorolli · Anna M. Borghi



- 3-D pictures of objects located in peripersonal versus extrapersonal space
- Immediately after, they were presented with function, manipulation, or observation verbs (e.g., “to drink,” “to grasp,” “to look at”)
- judge whether the verb was compatible with the presented object.
- both function and manipulation verbs, participants were faster when objects were presented in reachable space
- the fastest response times were recorded when participants read function verbs while objects were presented in the accessible space.

Journal of Experimental Psychology:
Human Perception and Performance
2010, Vol. 36, No. 2, 341–358

0096-1523/10/$12.00 DOI: 10.1037/a0017606

Grasping Beer Mugs: On the Dynamics of Alignment Effects Induced by Handled Objects

Daniel N. Bub and Michael E. J. Masson
University of Victoria

- Left or right handled 3D mugs
- placed in peripersonal or extrapersonal spaces,
- the reaction time in response to a left-/right-hand grasp command is measured

https://tinyurl.com/yb3fxppc

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