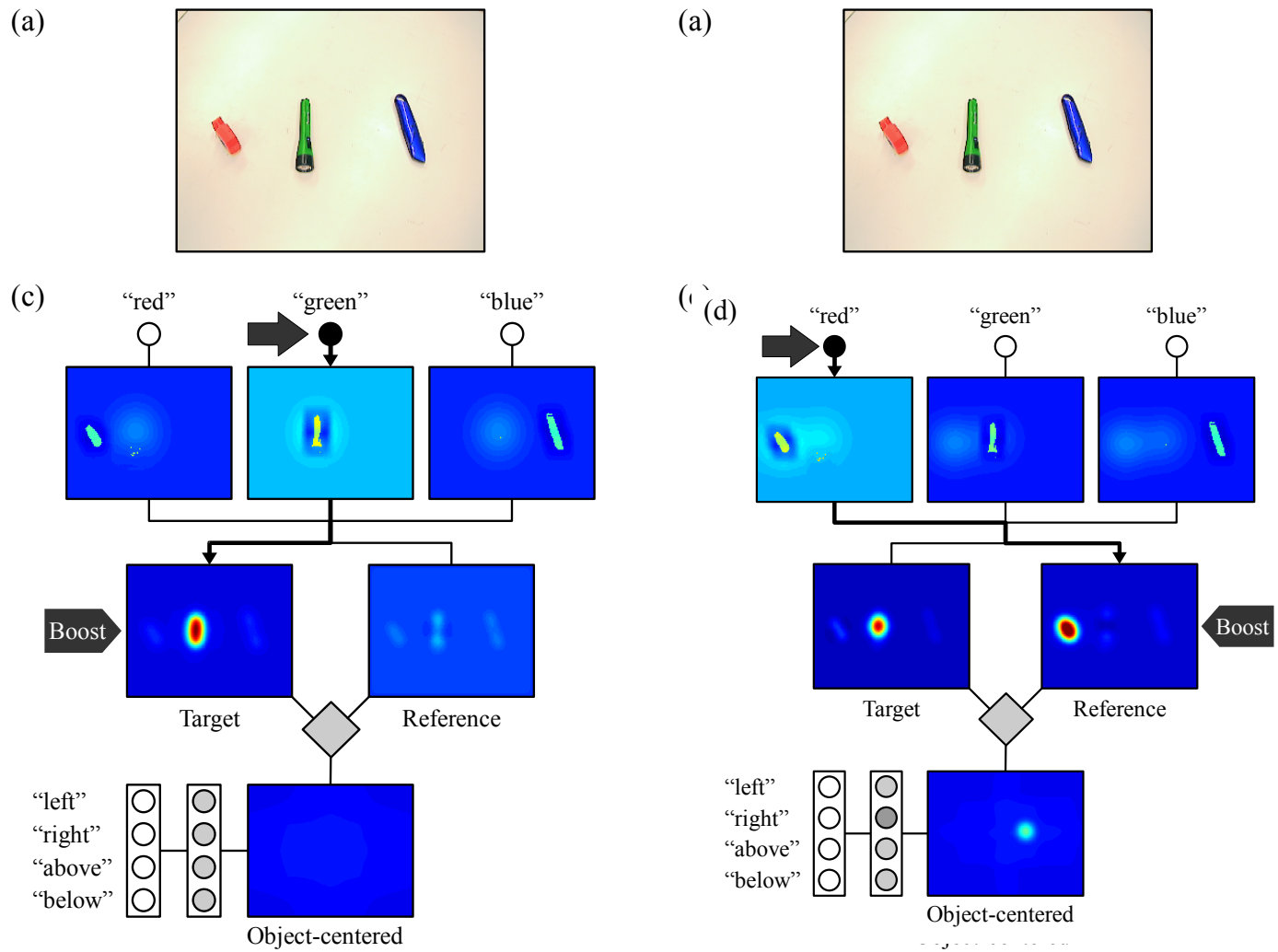
Sequential processing in DFT

Gregor Schöner

Sequence generation

- how would sequences of processing steps arise autonomously from within the DFT architecture?



[Lipinski et al: *JEP:LMC* (2011)]

Sequence generation

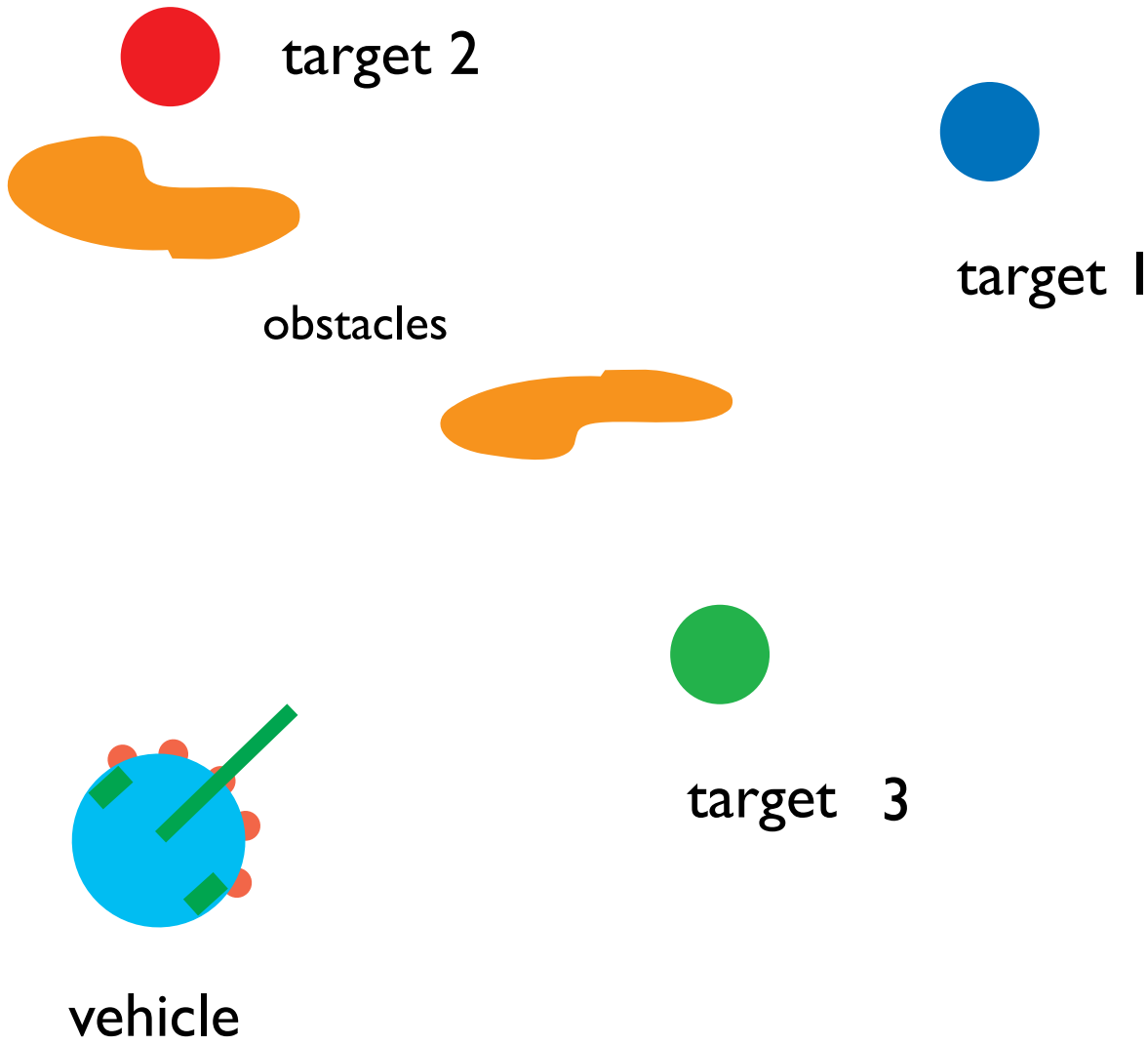
- in real life all actions consist of sequences of movements, perceptual and mental acts
  - often fixed by the logic of action
  - often highly automated: routines
- but also flexible:
  - serial order: arbitrary sequences

Challenge for sequence generation in DFT

- behaviors/representations are stable states
- in a sequence there is a need to switch out of one behavior to the next. How to overcome stability?
- answer: induce an instability

Illustration

- search for objects of a given color in given serial order
  1. blue
  2. red
  3. green

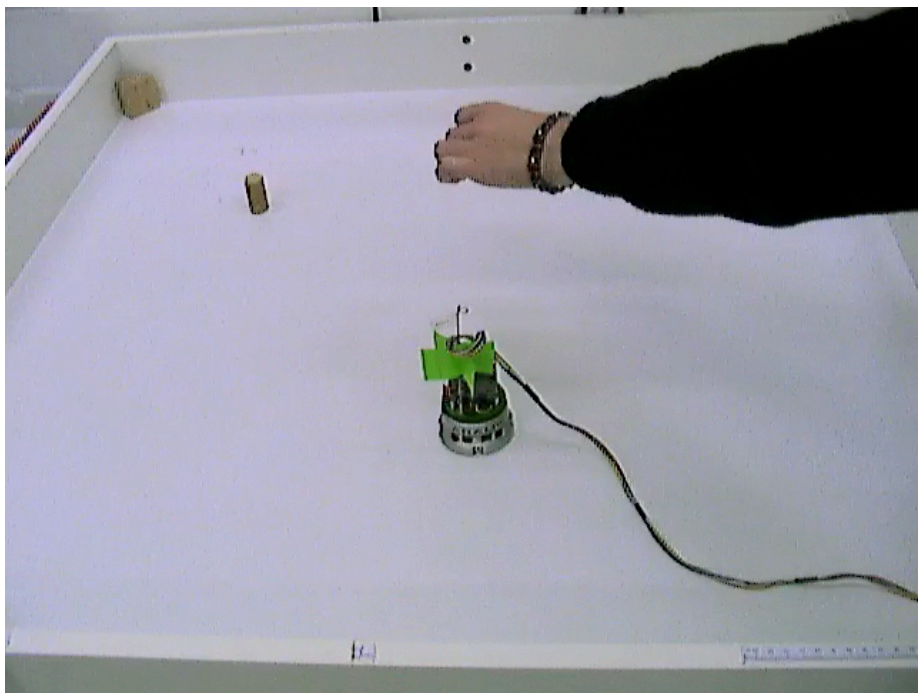


[Sandamirskaya, Schöner: *Neural Networks* 23:1163 (2010)]

Implementation as an imitation task

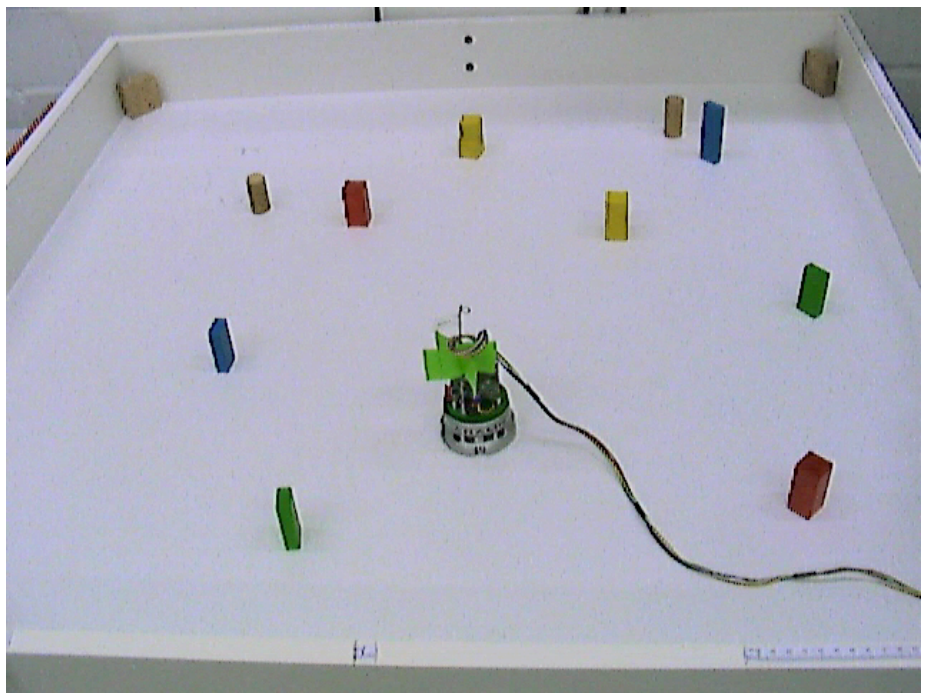
- learn a serially ordered sequence from a single demonstration

yellow-red-green-blue-red



- perform a serially ordered sequence with new timing

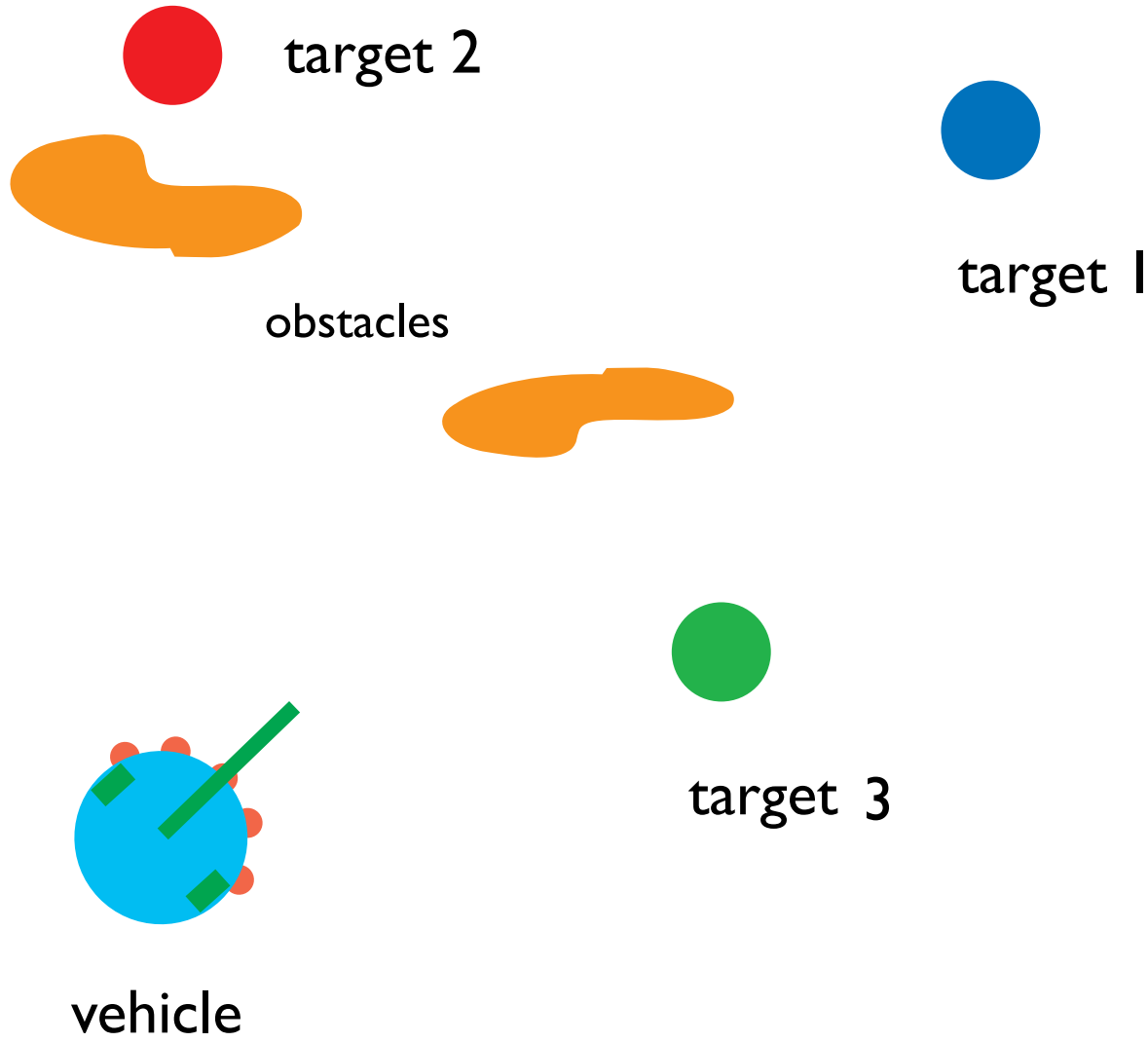
yellow-red-green-blue-red



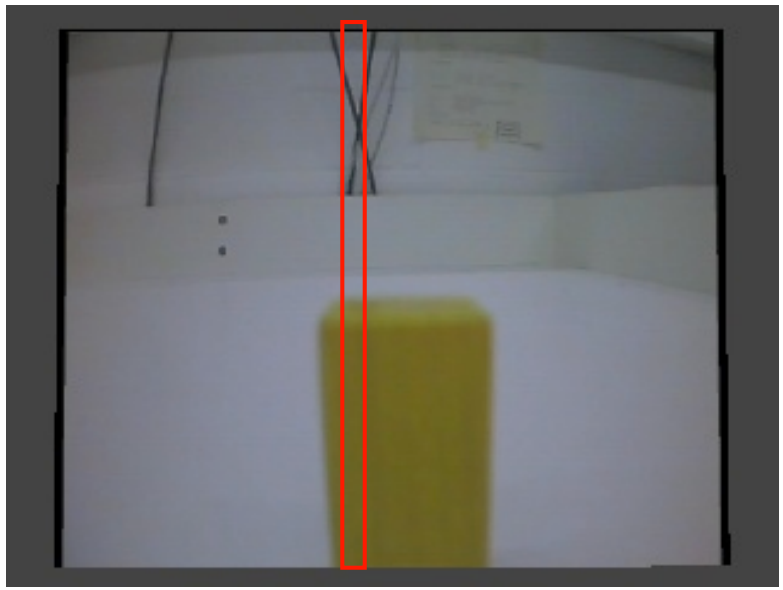
[Sandamirskaya, Schöner: Neural Networks 23:1163 (2010)]

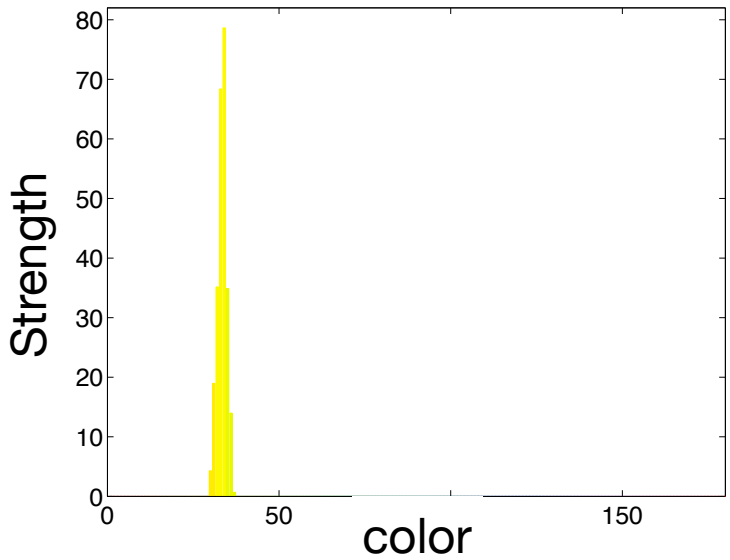
The problem of sequential processing

- each step entails a visual search for a target color



Camera image

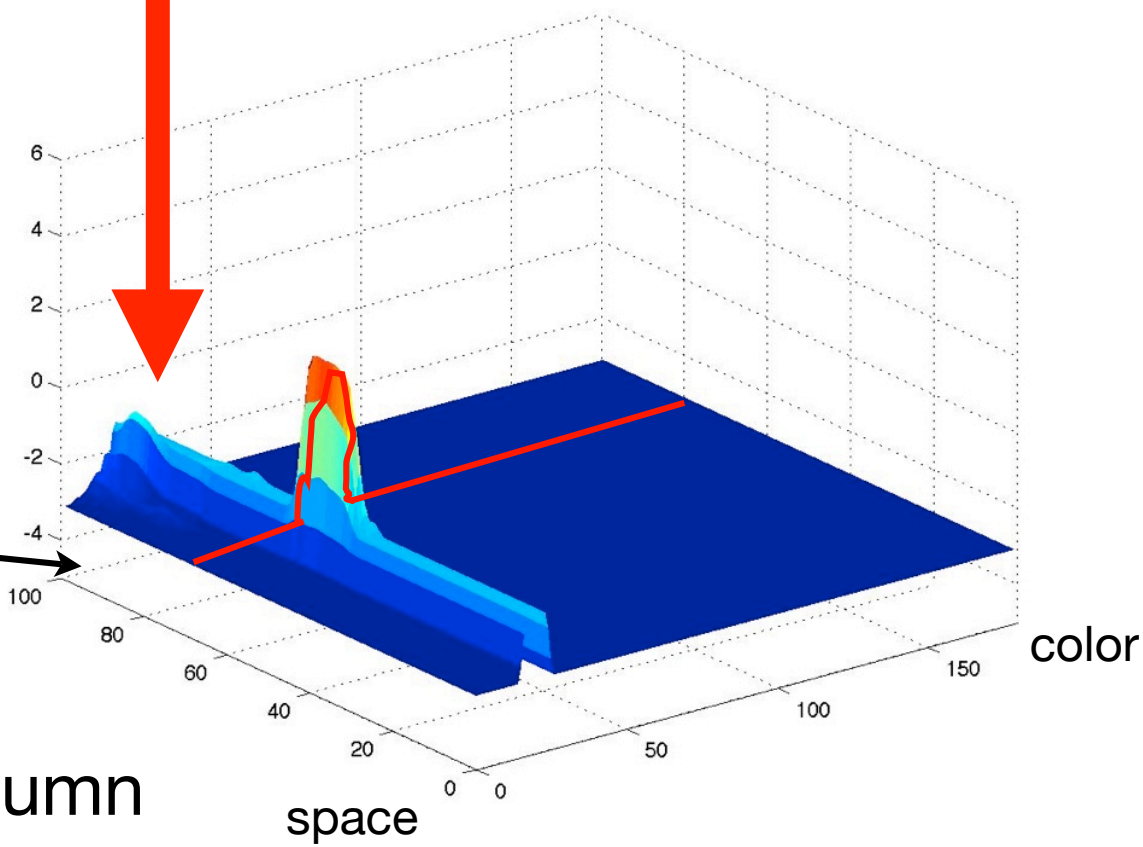




Color histogram of the column

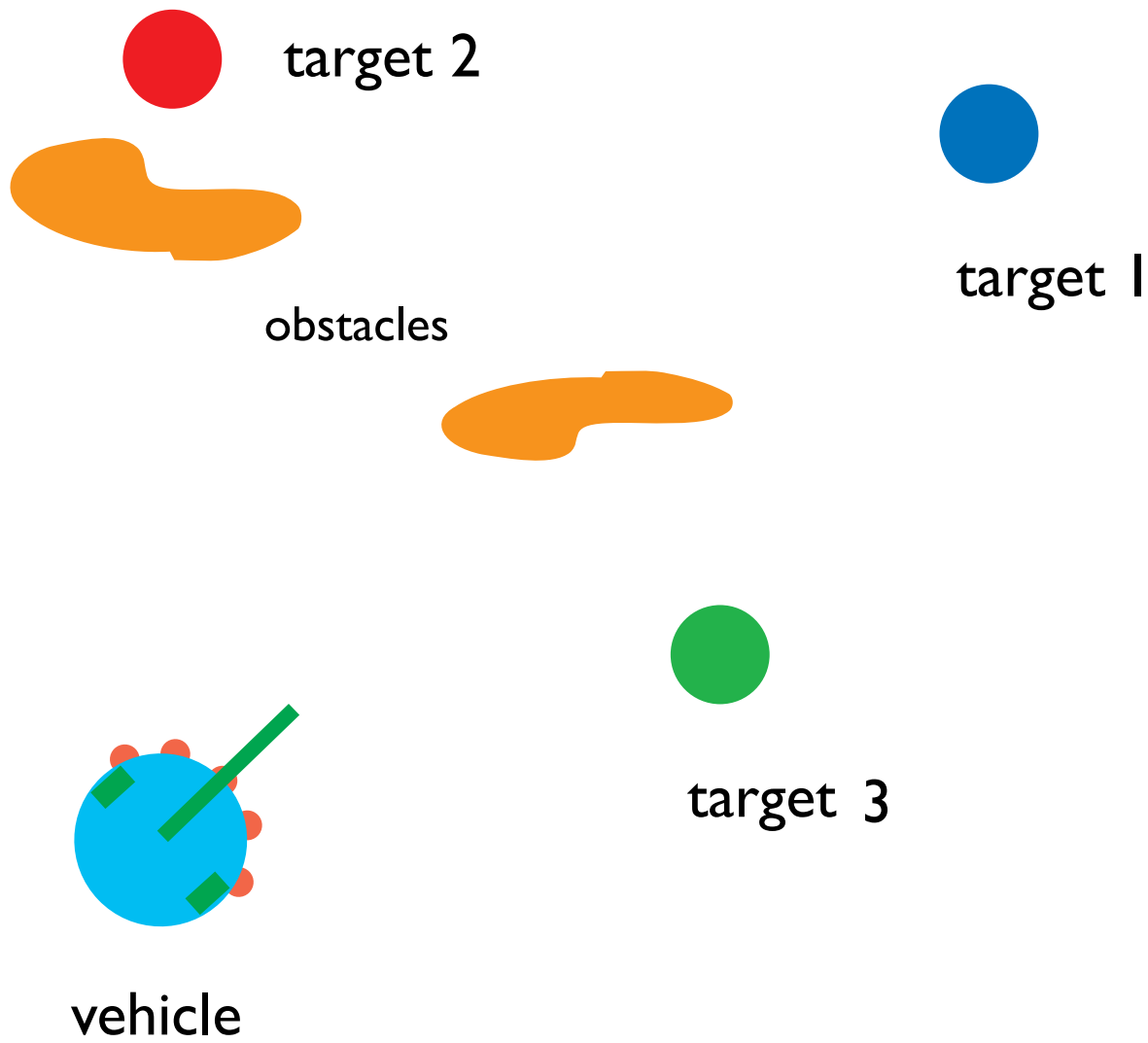
current target color

Color-space DF

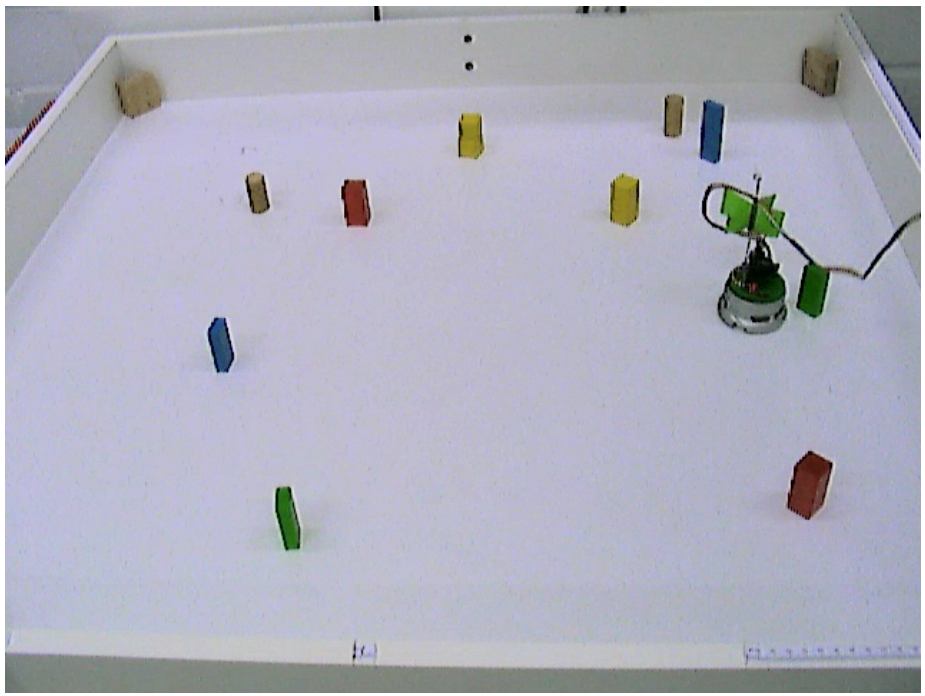


The problem of sequential processing

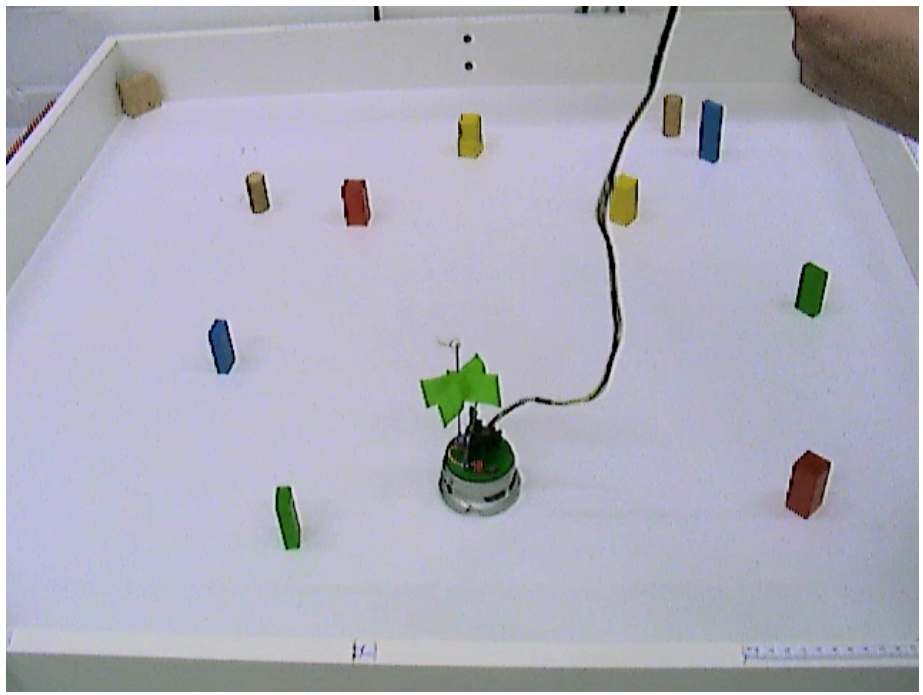
- the visual search takes a variable amount of time
- need to represent the target color by a stable peak that resists distractors



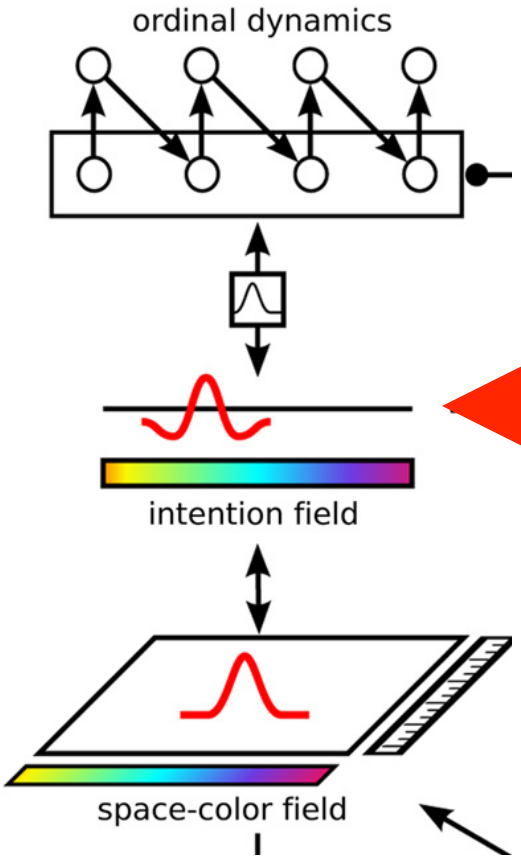
red a distractor



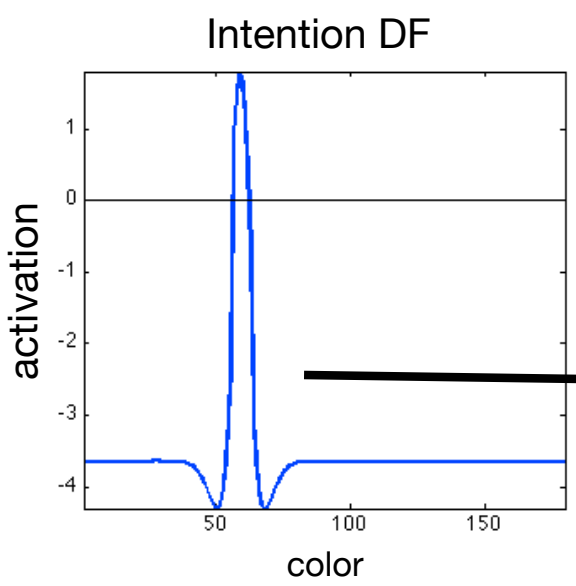
red a target

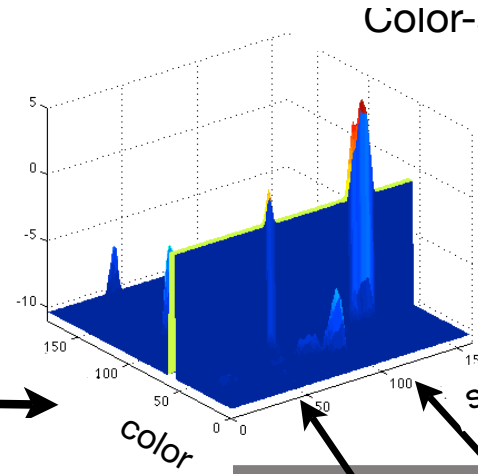


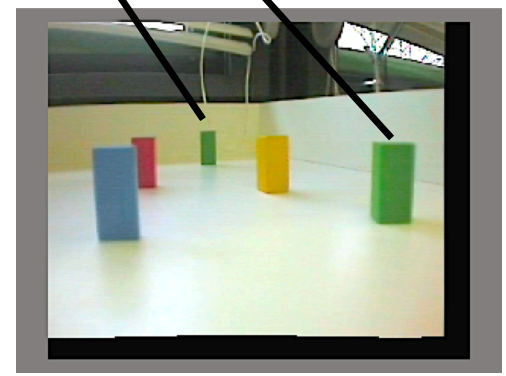
[Sandamirskaya, Schöner: Neural Networks 23:1163 (2010)]

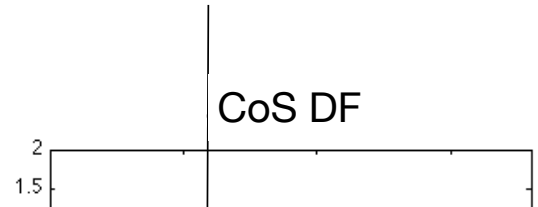


current target color



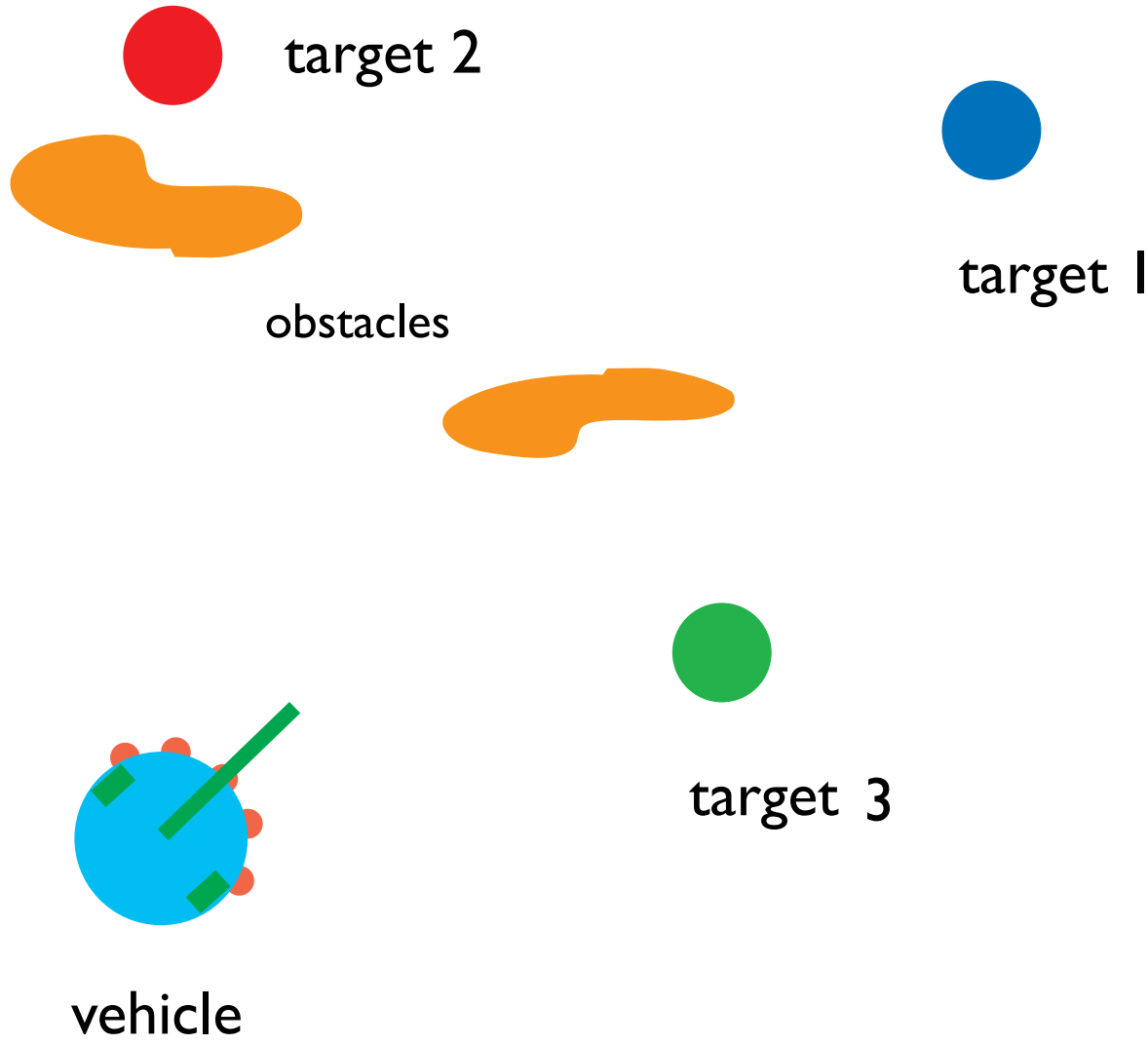




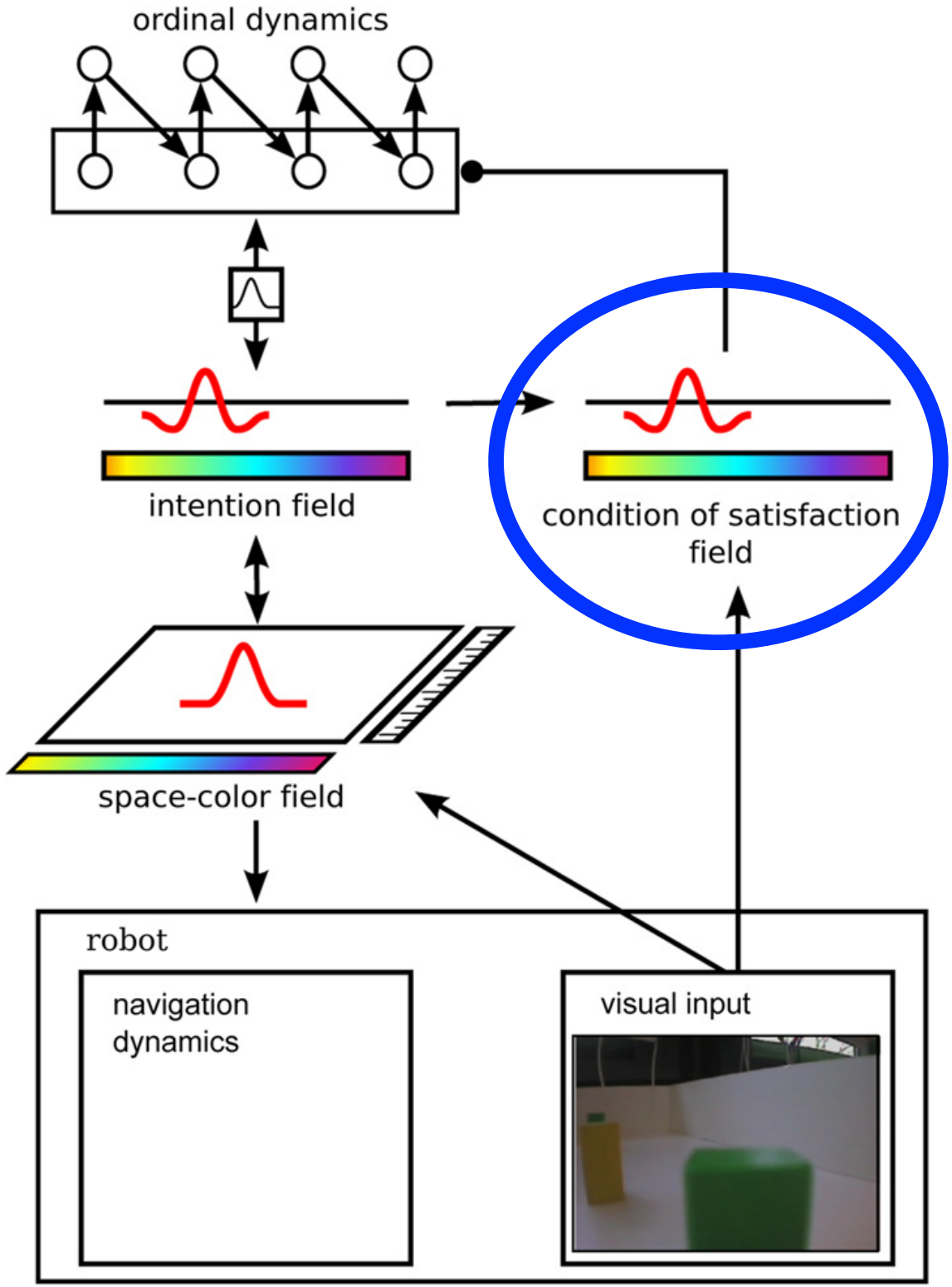


Neural dynamics of sequential processing

- when the target color is found, suppress the target color => instability
- switch to the next target color

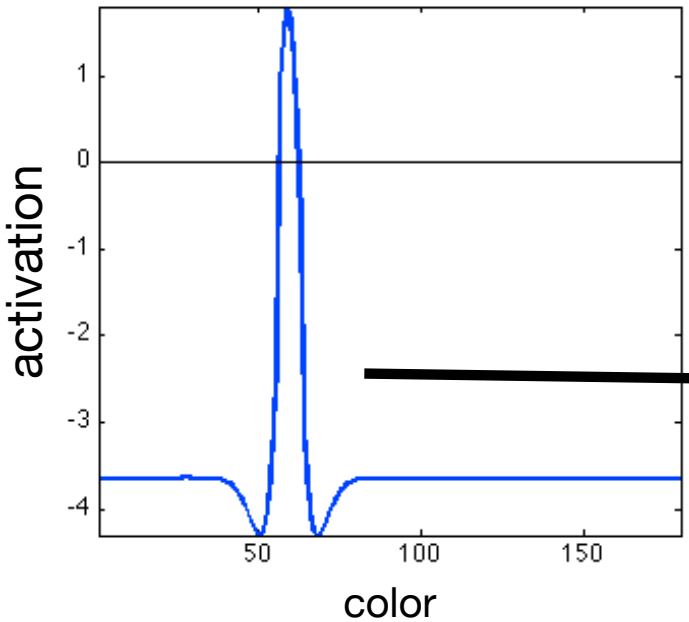


“Condition of Satisfaction” (CoS)

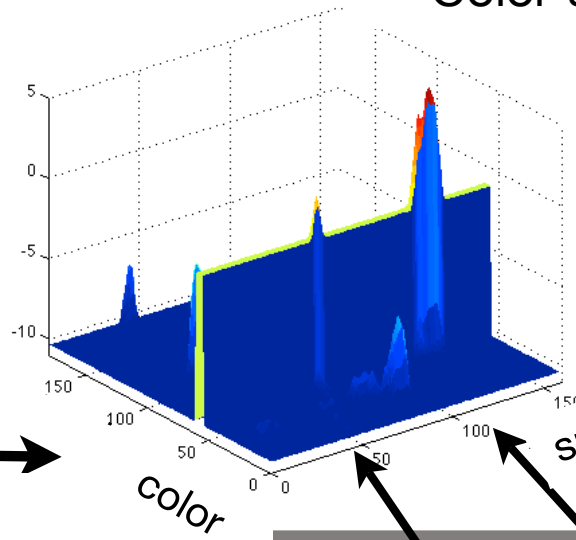


[Sandamirskaya, Schöner, 2010]

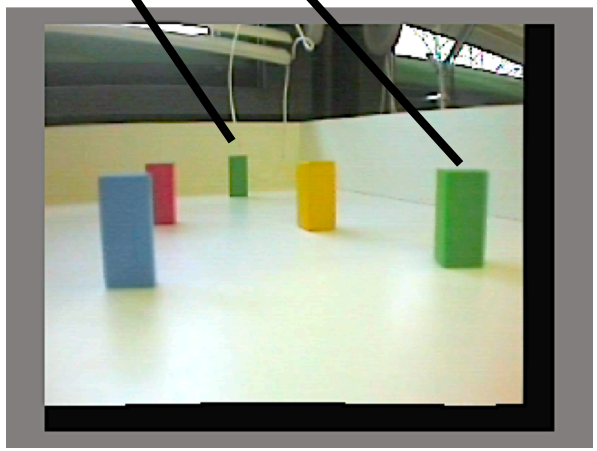
Intention DF



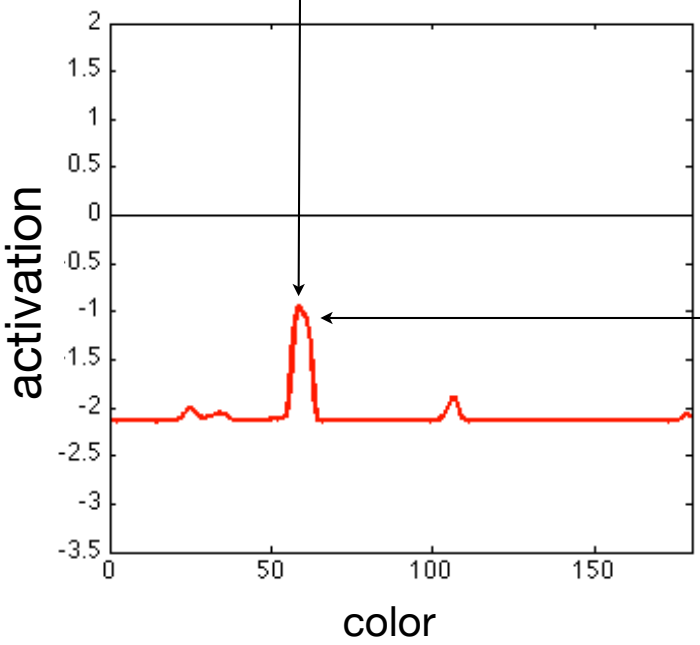
Color-space DF



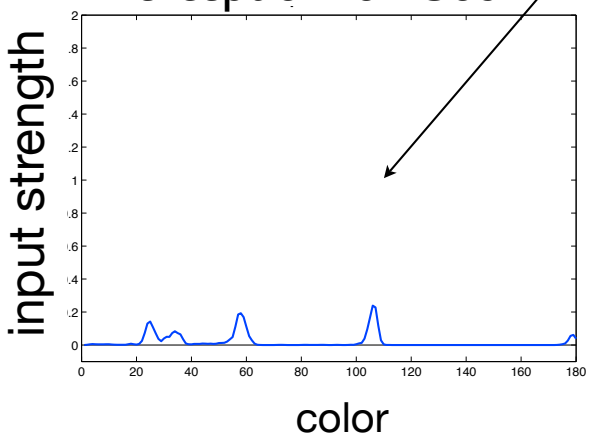
Camera image



CoS DF



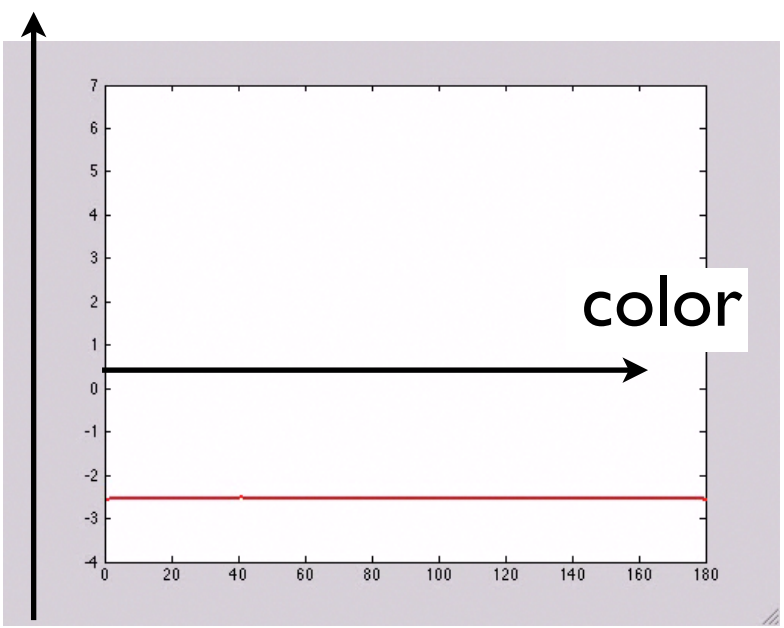
Perception for CoS



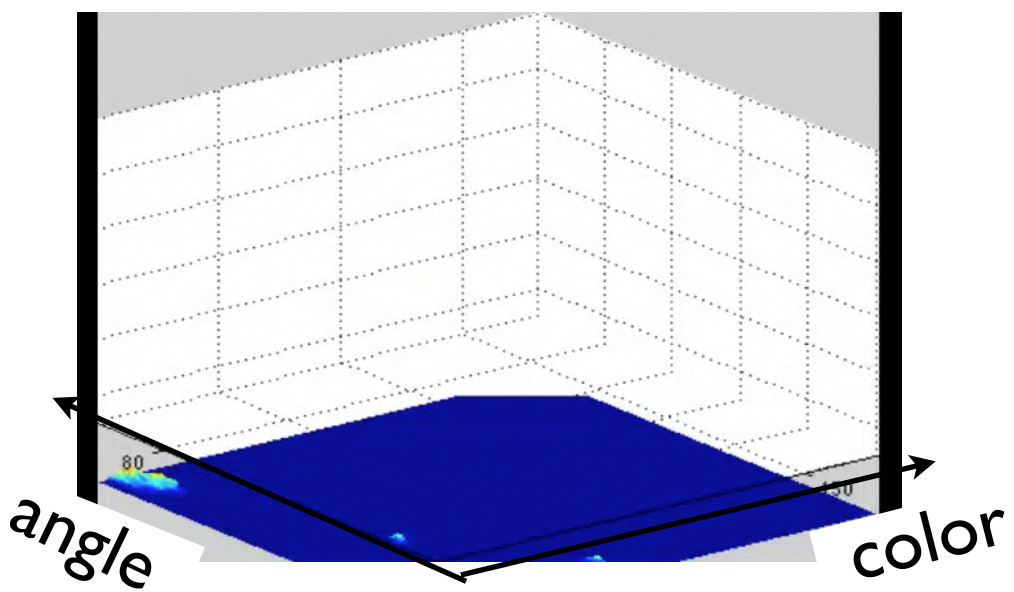
ordinal stack

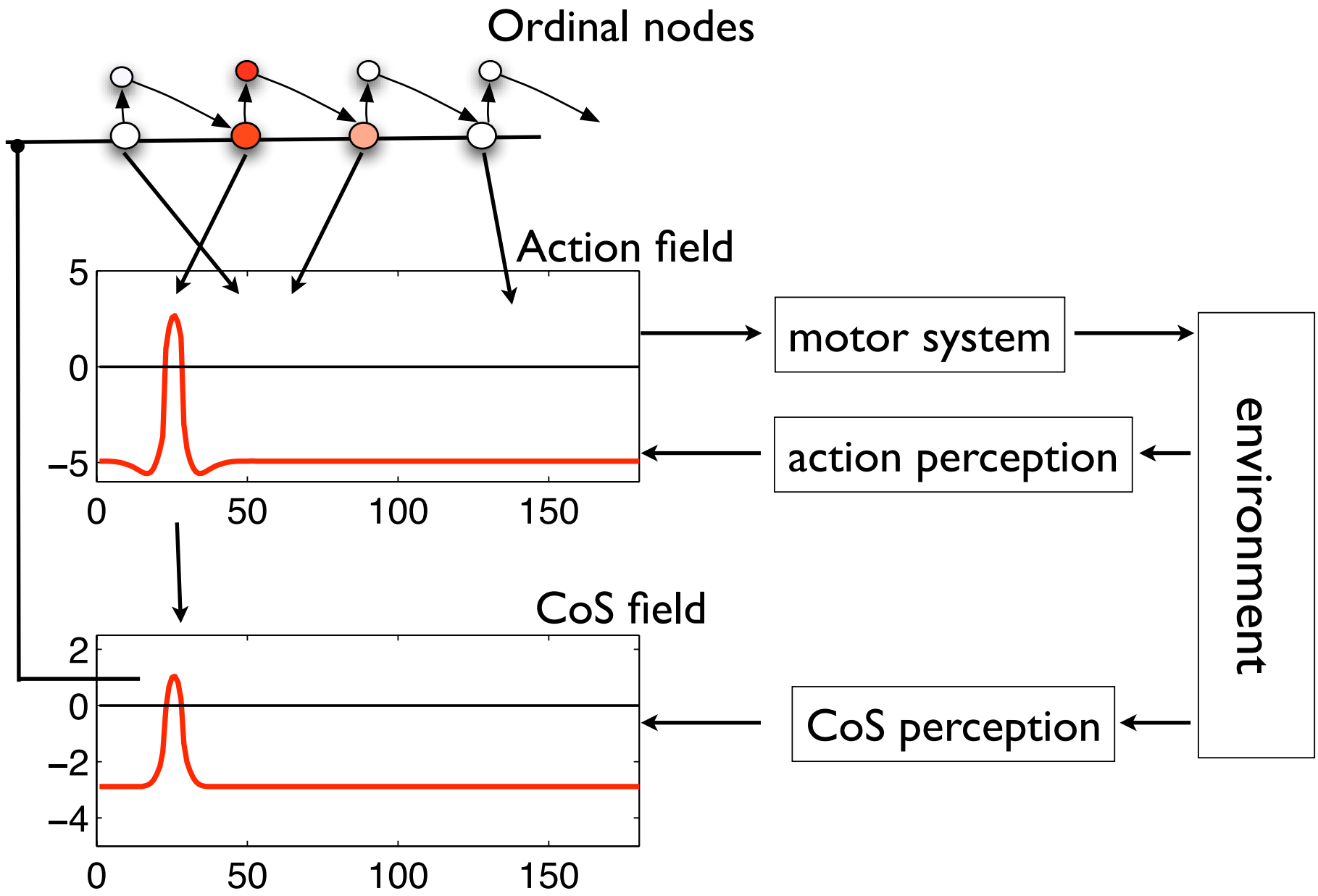
condition of satisfaction (CoS)

intentional state

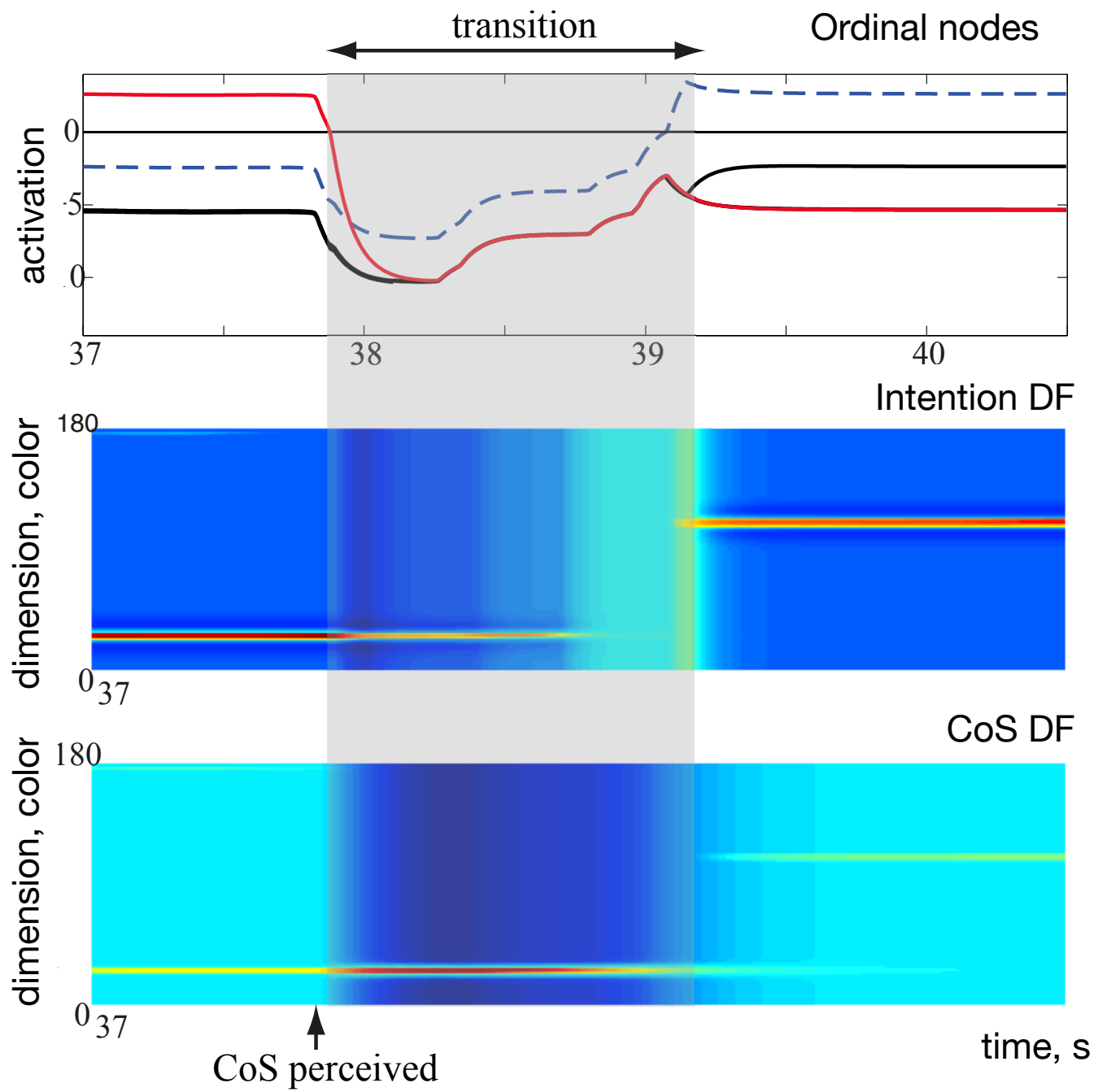


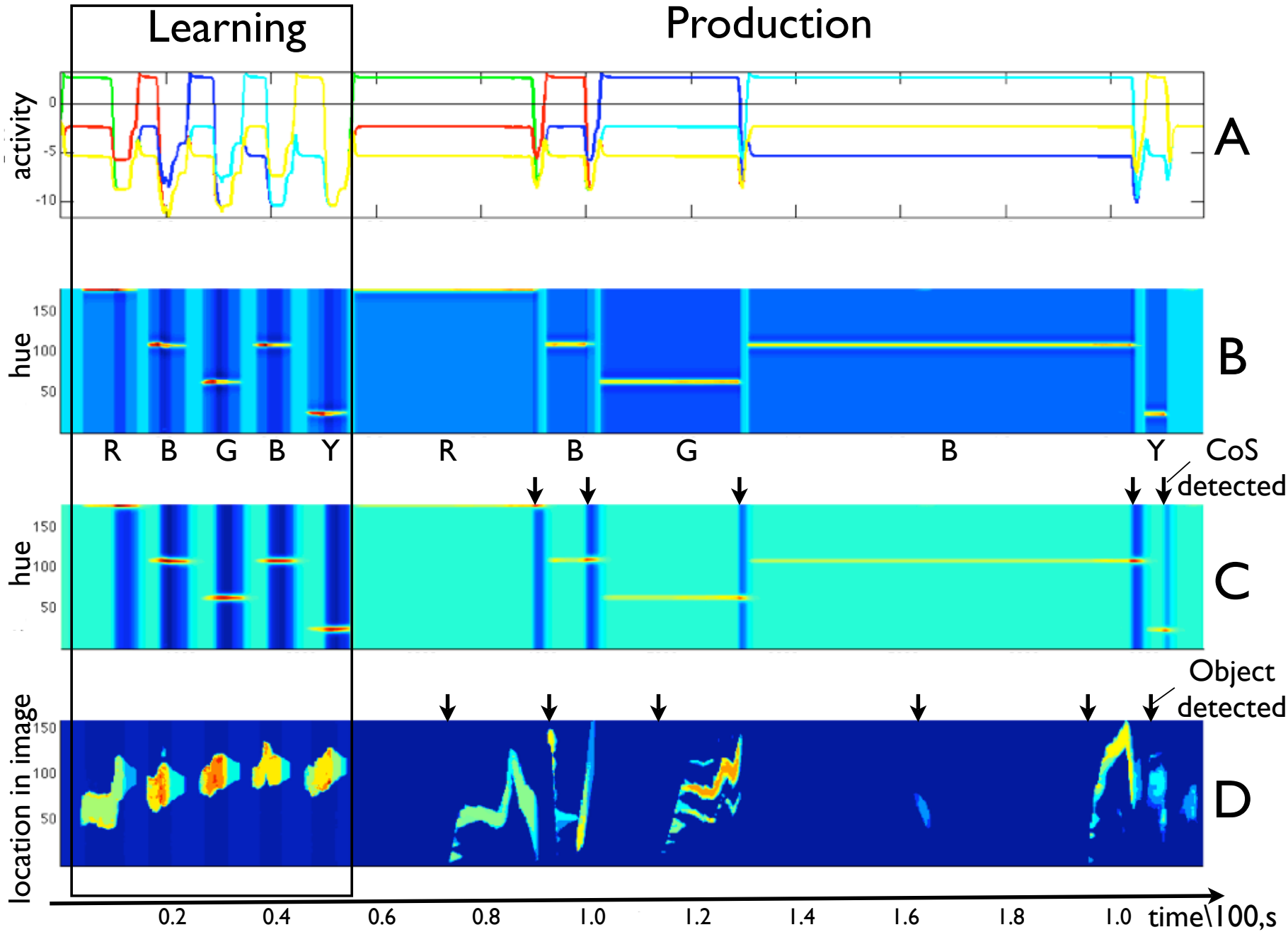
2D feature-space field





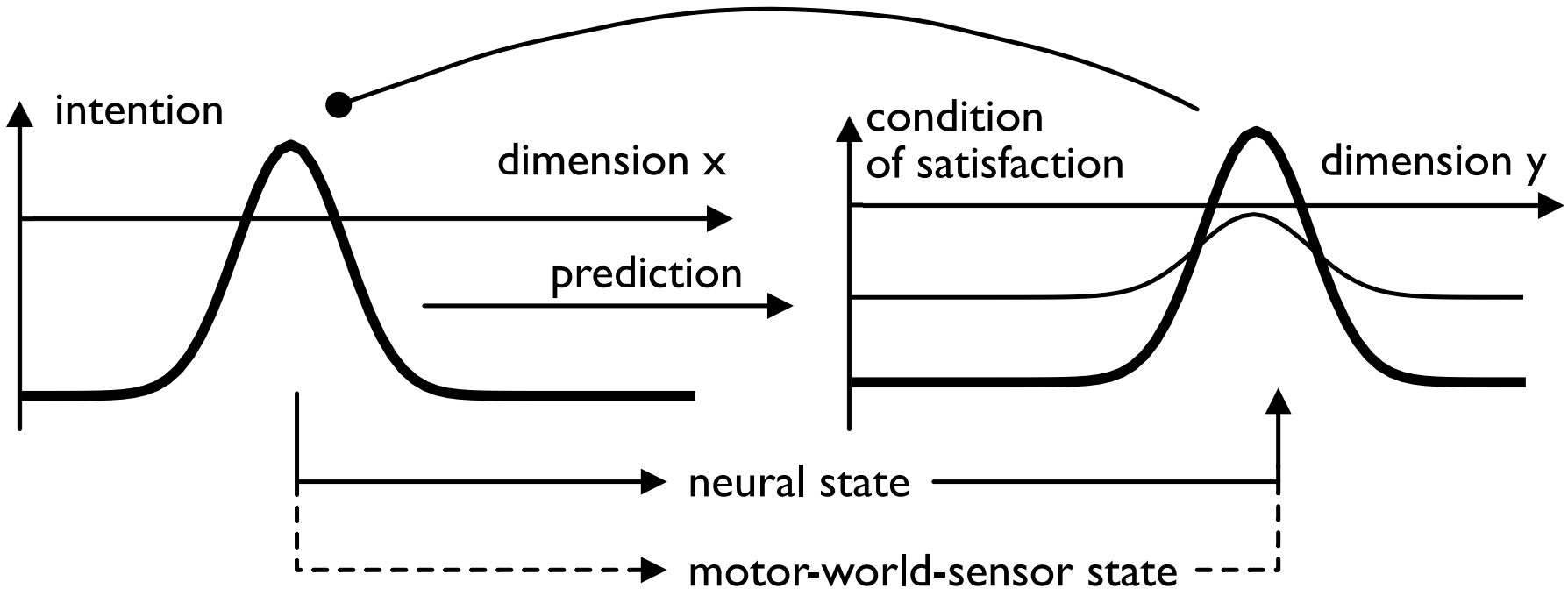
[Sandamirskaya, Schöner: Neural Networks 23:1163 (2010)]


transition
Ordinal nodes
activation
0
-5
0
37
38
39
40
Intention DF
dimension, color
180
0
37
CoS DF
dimension, color
180
0
37
CoS perceived
time, s



[Sandamirskaya, Schöner: *Neural Networks* 23:1163 (2010)]

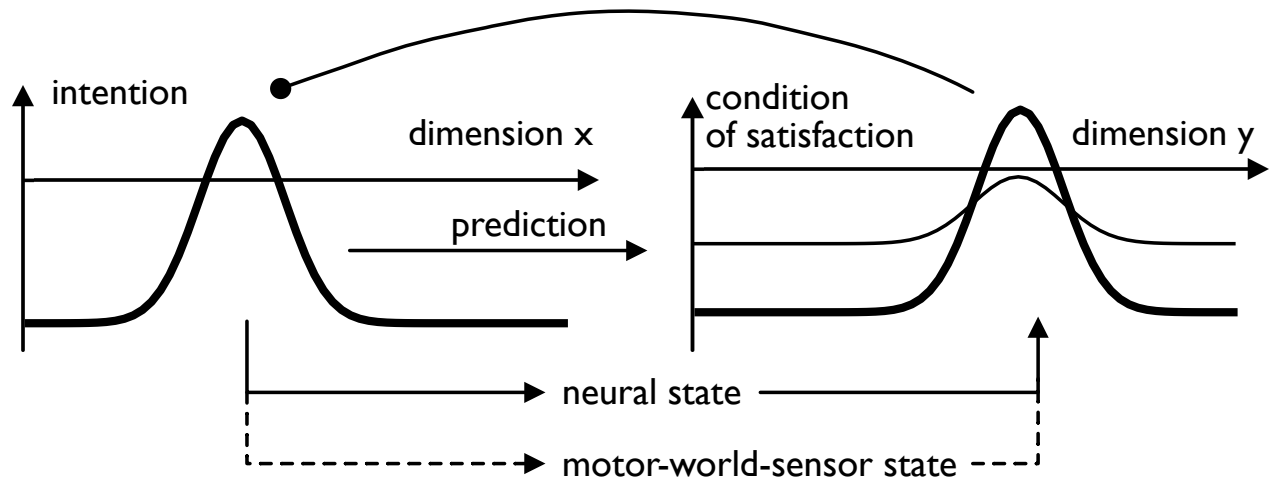
Generalization



[Sandamirskaya, Schöner, *Neural Networks* 2010]

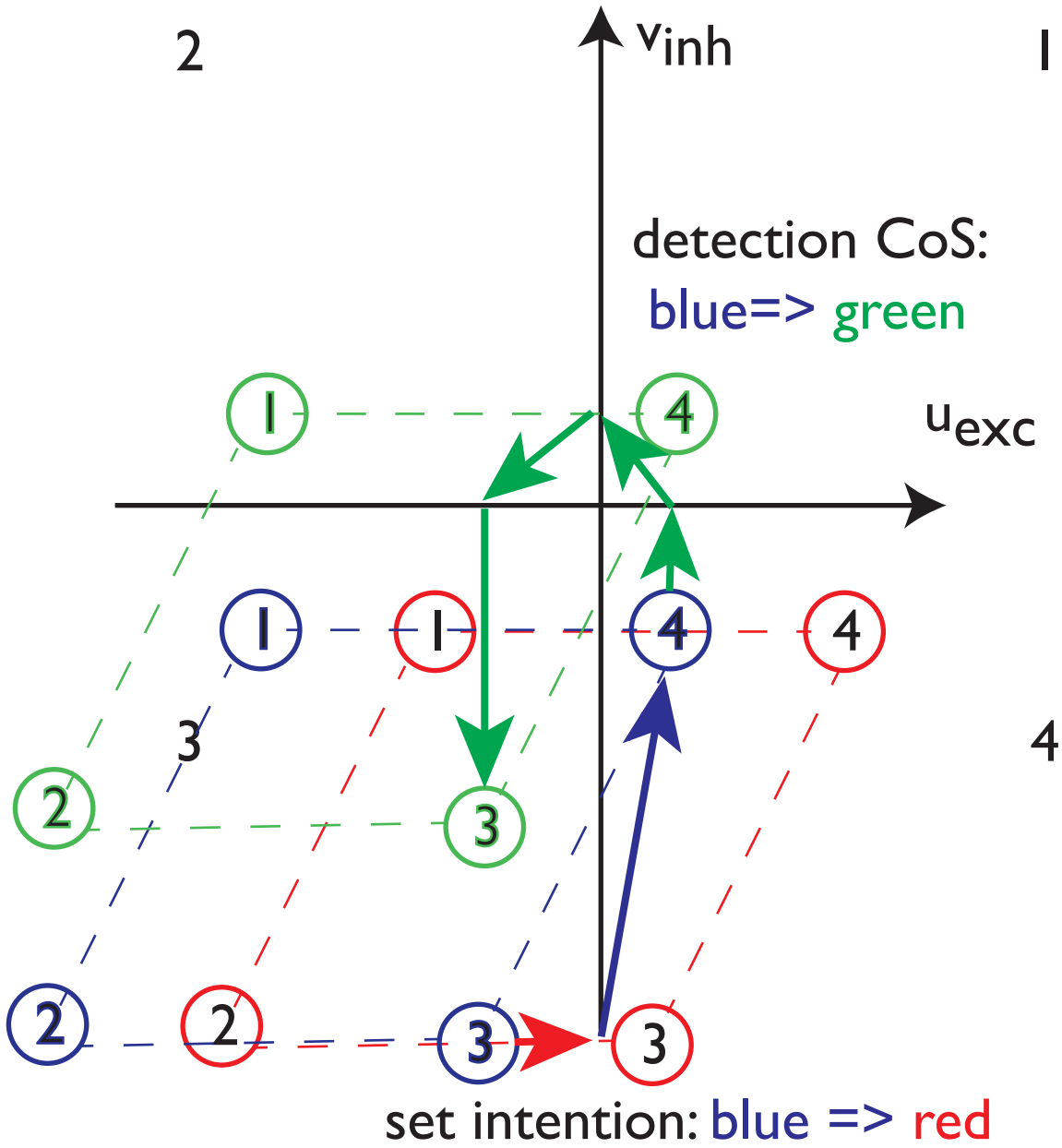
Condition of satisfaction

- detection instability in CoS as prediction and input match
- reverse detection in intention field
- reverse detection in CoS field
- => active transient



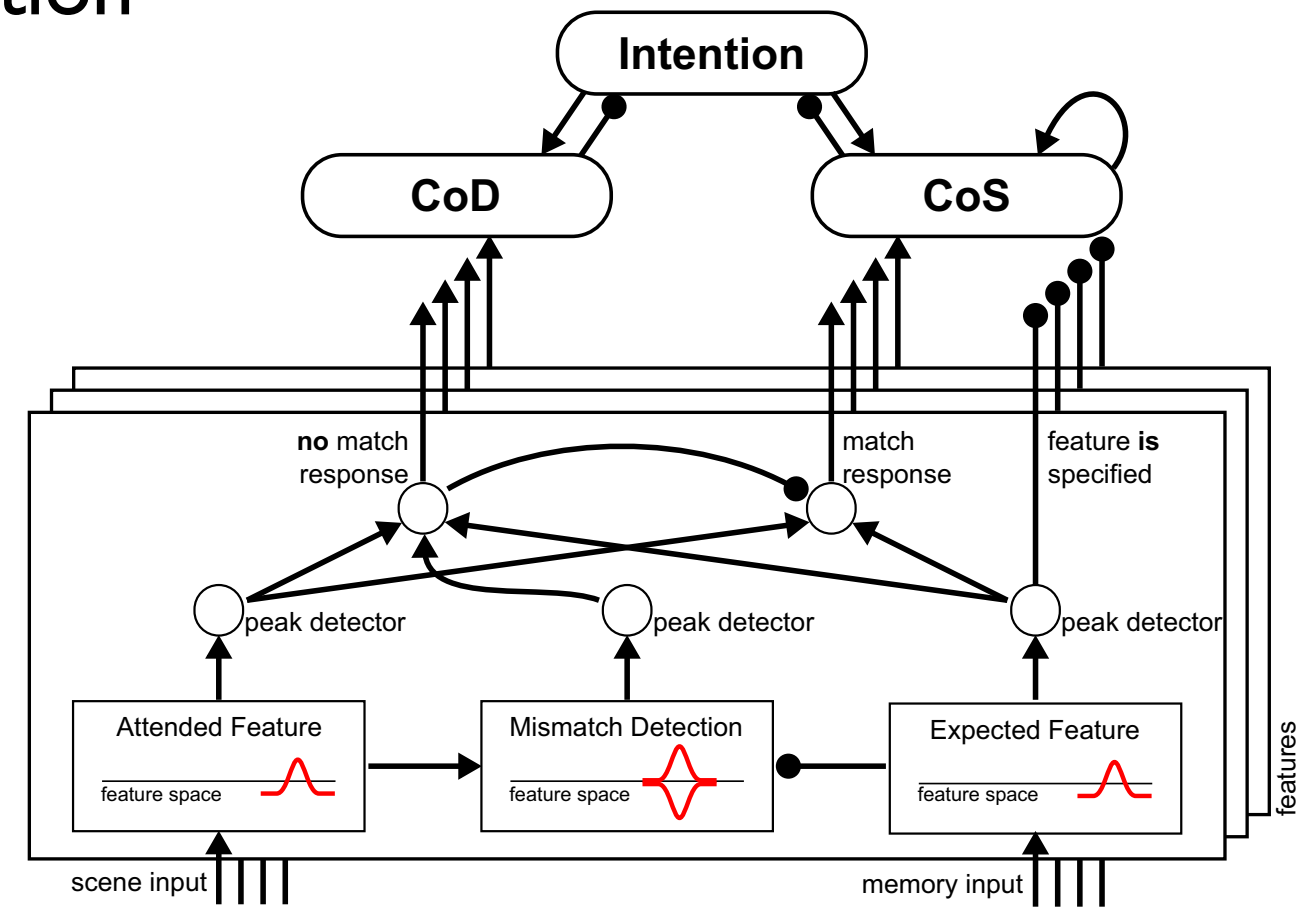
[Sandamirskaya, Schöner, *Neural Networks* 2010]

Active transient of the CoS



Match/mismatch detection

- the CoS mechanism is an instance of a more general class of neural dynamic mechanisms for match and mis-match detection

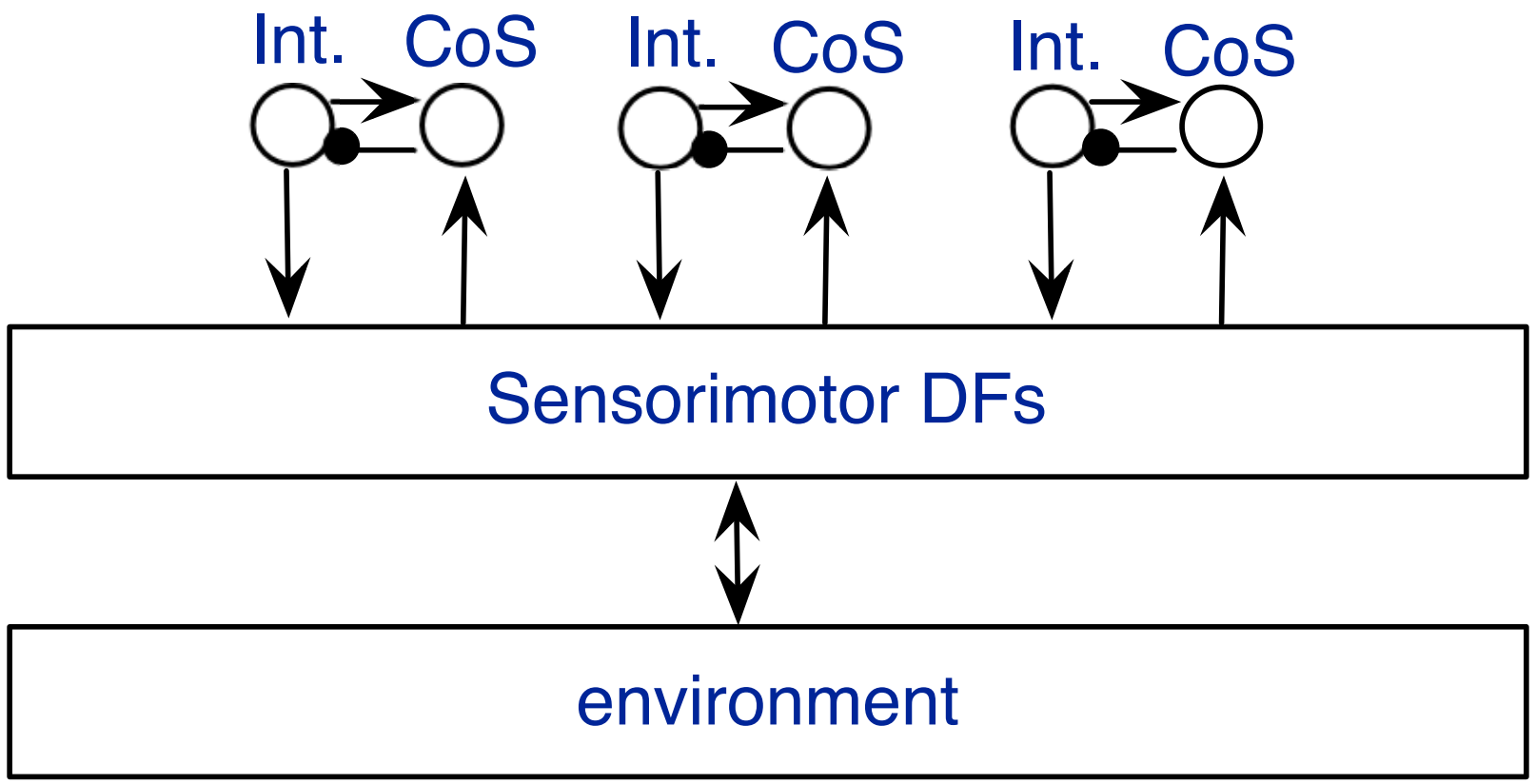


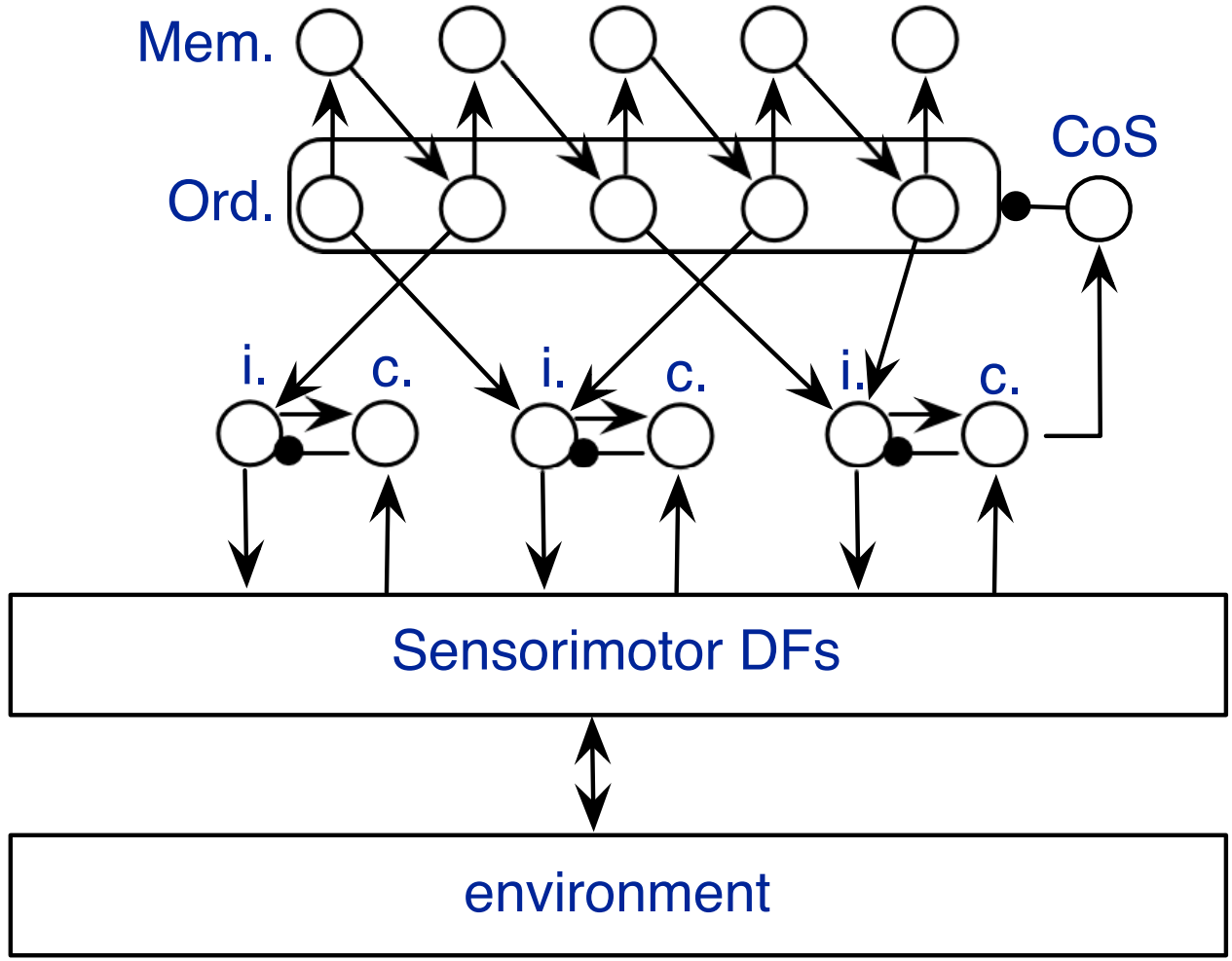
- (which develop older ideas by Grossberg and colleagues)

[Grieben et al, *PP&A* 2020]

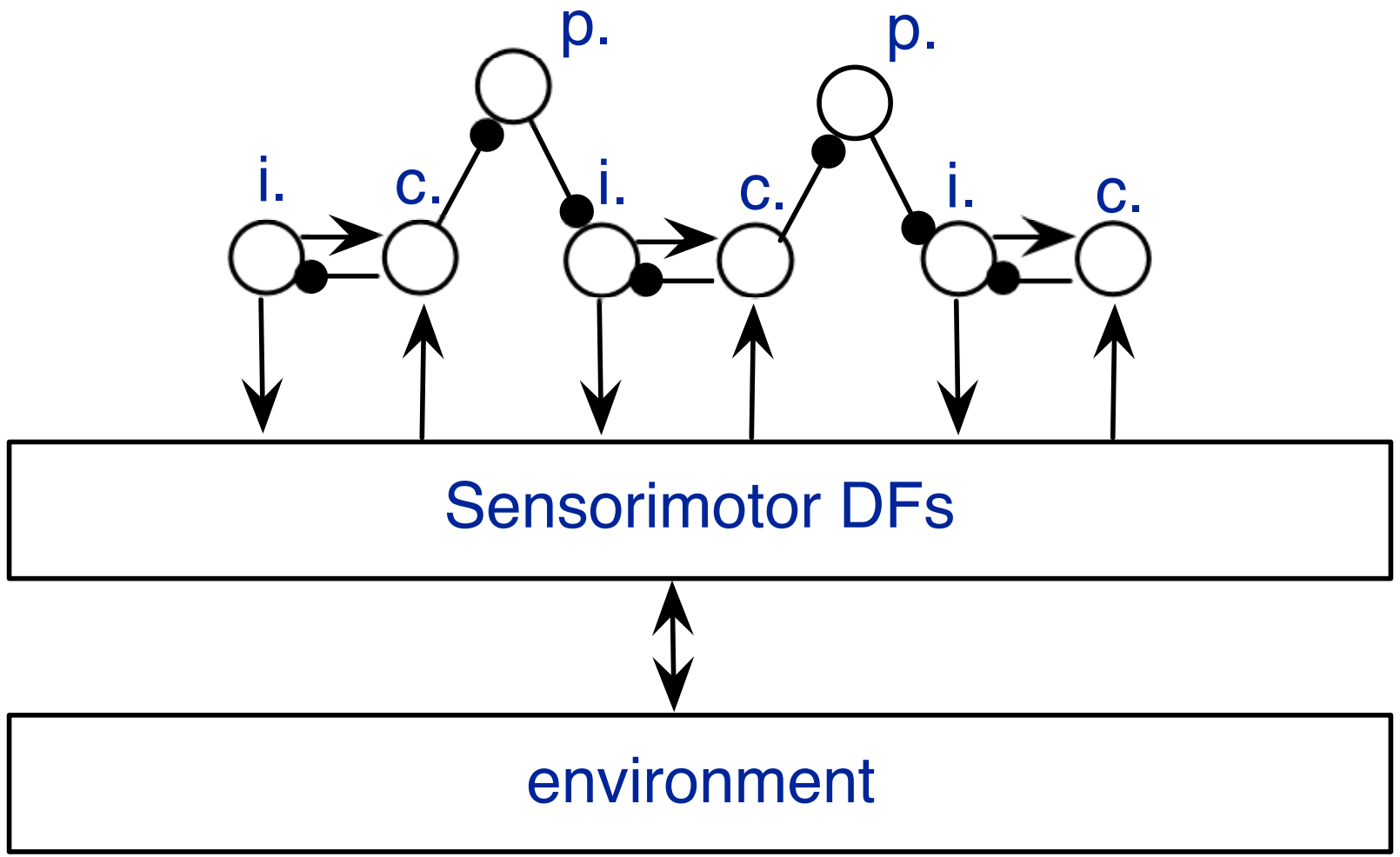
Match/mismatch detection

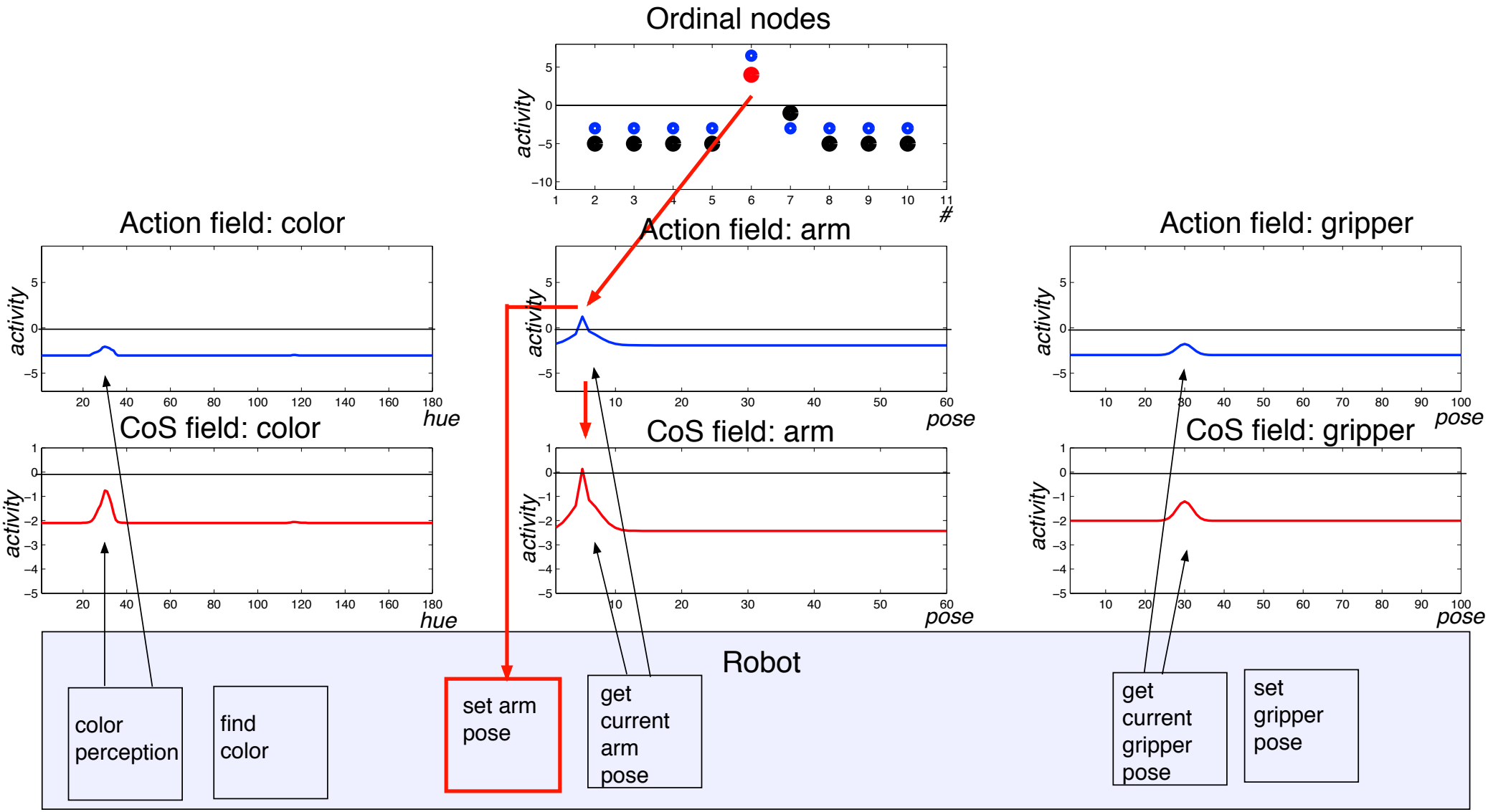
- see e.g. Chapter 6 by Johnson/Simmering of the DFT primer)
- => talks by Mathis Richter and Raul Grieben


Int.
CoS
Int.
CoS
Int.
CoS
Sensorimotor DFs
environment

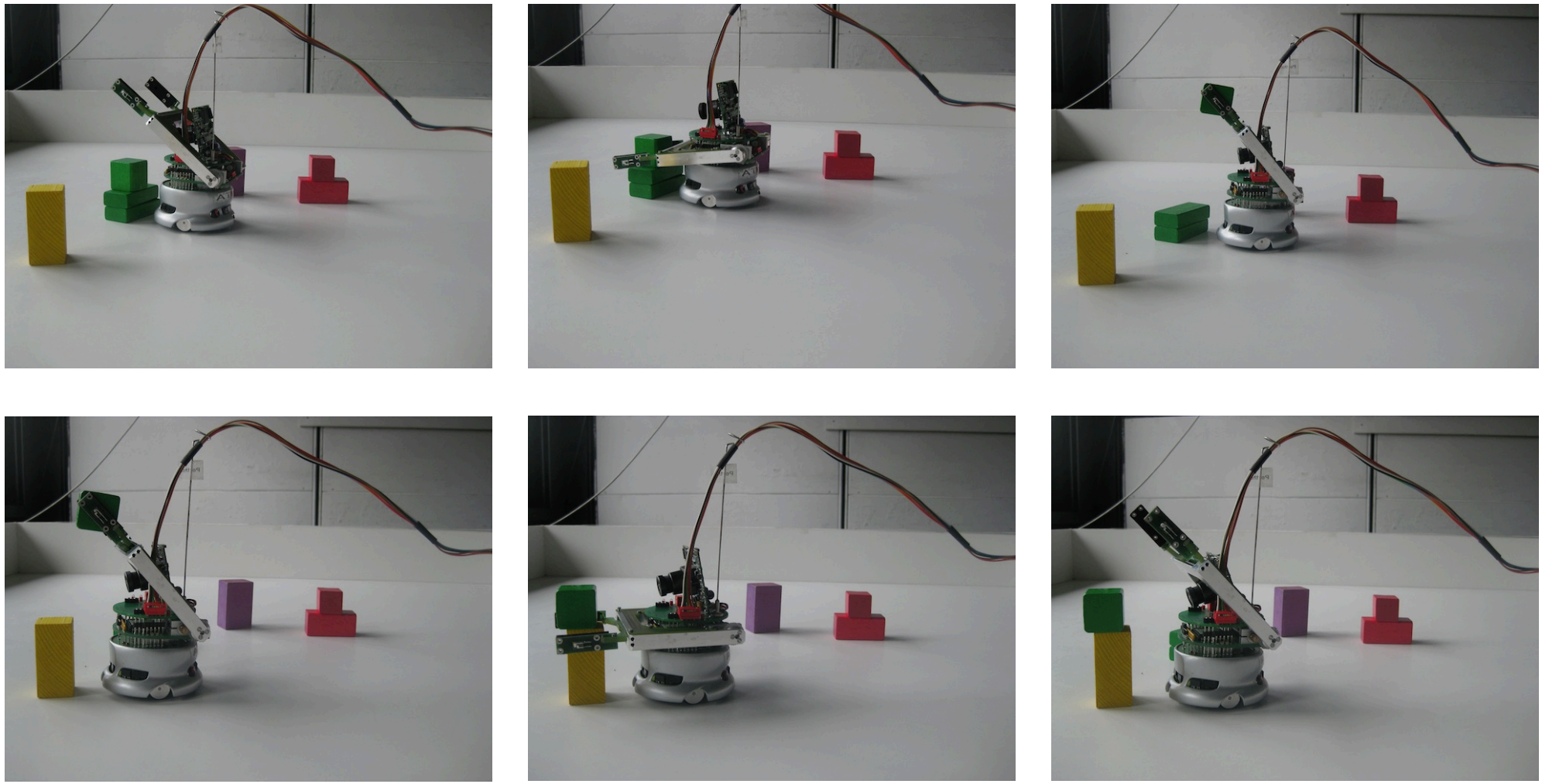

Mem.
Ord.
CoS
i.
c.
i.
c.
i.
c.
Sensorimotor DFs
environment

chaining



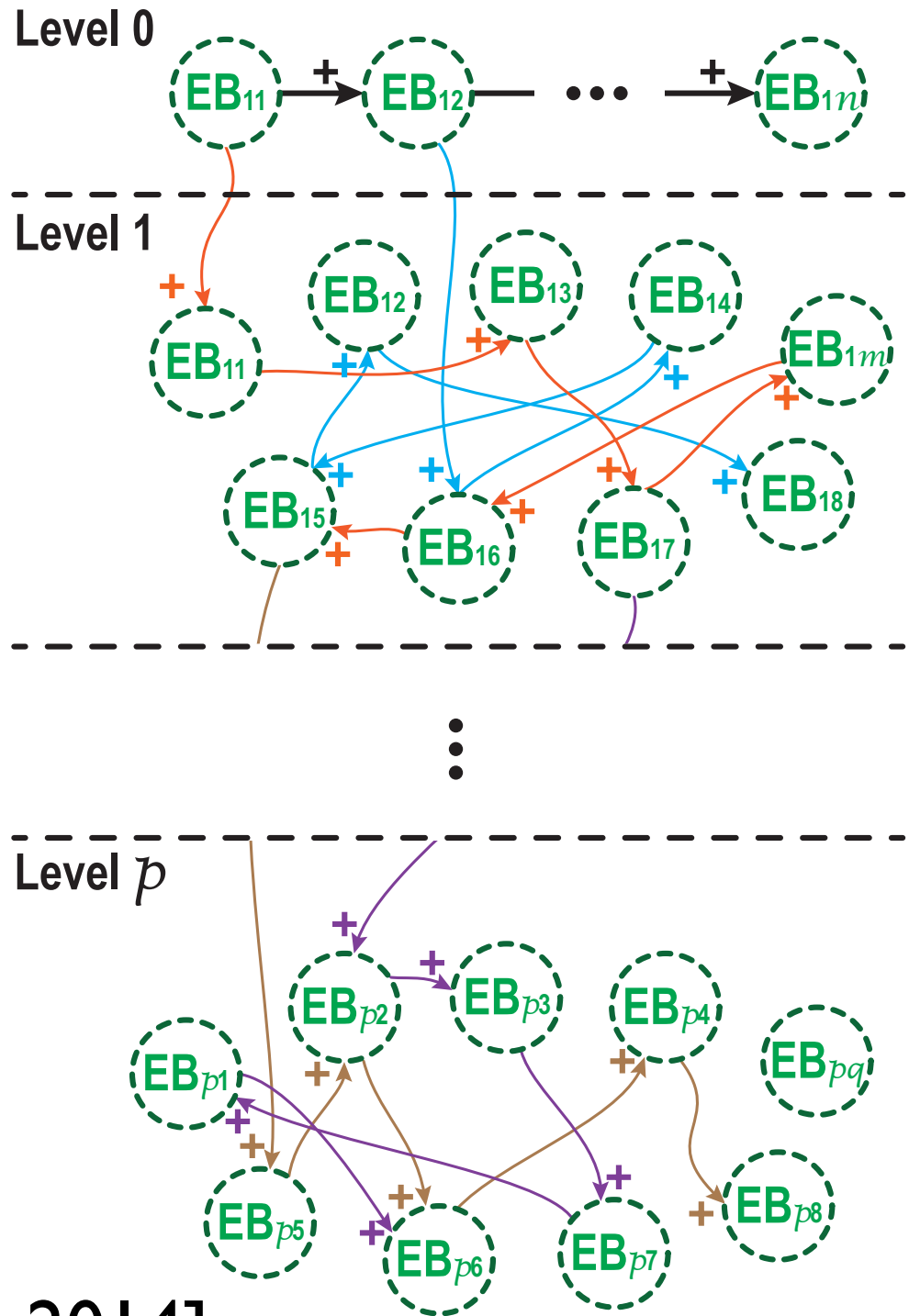


[Sandamirskaya, 2011]



[Sandamirskaya, 2011]

hierarchy



[Duran, Sandamirskaya, 2014]

Sequence generation

- sequence generation is critical to all DFT accounts for higher cognitive processes:
- => Raul Grieben on visual search
- => Mathis Richter and Daniel Sabinasz on on relational concepts
- => Jan Tekülve's tutorial on sequence generation and intentionality