
nysci

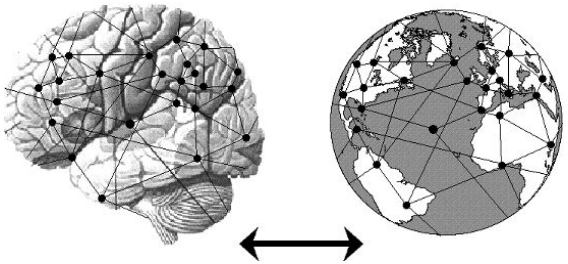
Enaction:

Embodied Interfaces for Learning

IPAM Workshop II: Cultural Analytics & User Experience

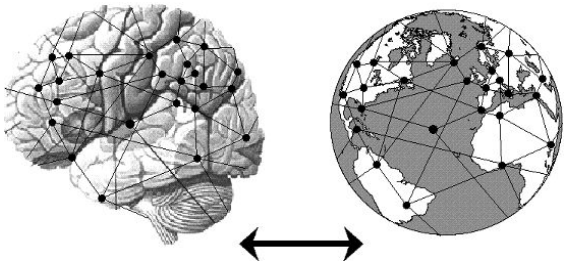
Stephen Uzzo, Chief Scientist *suzzo@nyscience.org*

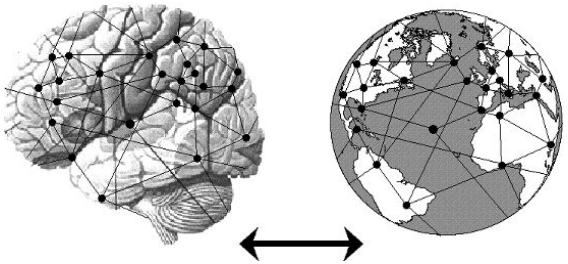
Enaction



- Origins
- Differs significantly from computational model
- Interfaces to learning
- Cyberlearning
- Learning analytics

A Little Arithmetic





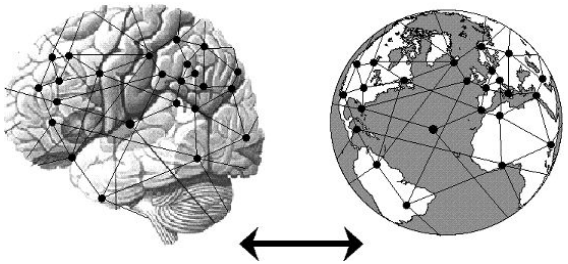
A Little Arithmetic

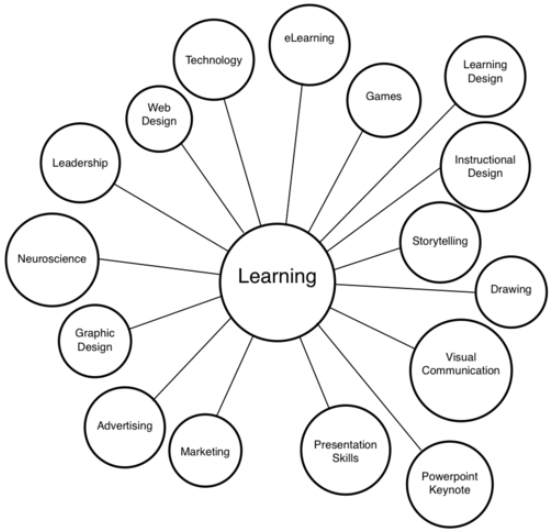
Add the following numbers

661, 42,117, 155, 1,420, 77 and 2,539

Computational Model for Cognition

CRUM vs. Enaction

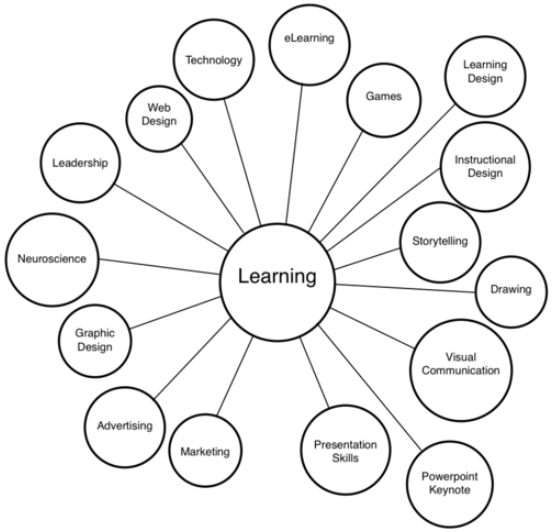




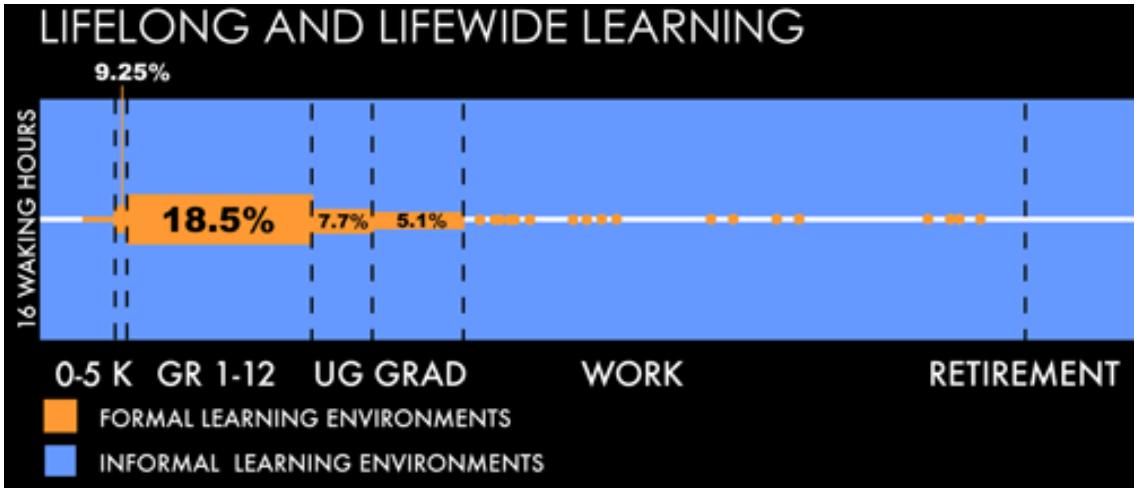
New York Hall of Science

"To bring the excitement and understanding of science to children, families and teachers by galvanizing their curiosity and providing creative, participatory ways to learn"

Lifelong Learning



The context of this kind of learning is OUTSIDE the classroom (Falk & Dierking)



LIFE Center: Stevens, Bransford. & Stevens, 2005

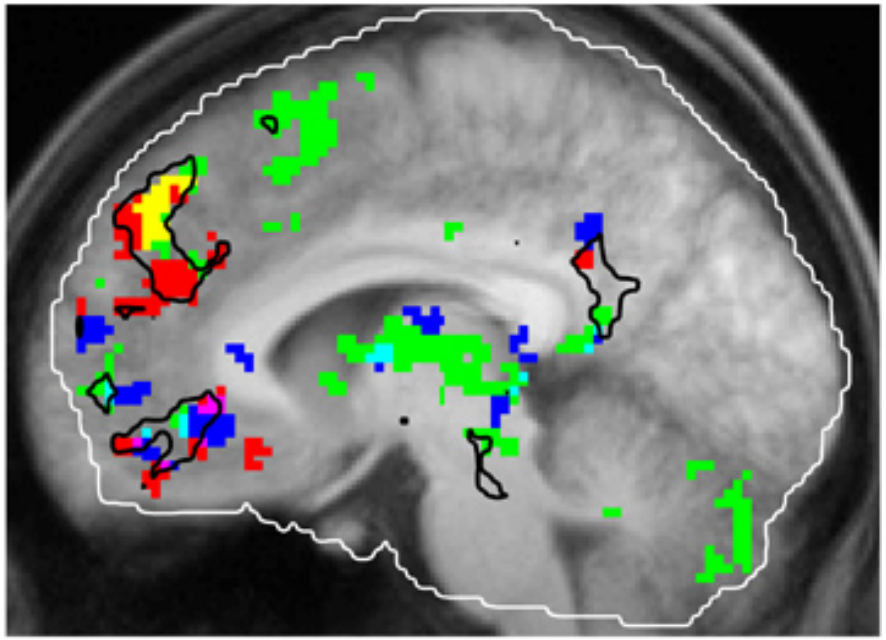
Definitions: Brain Vs. Mind

"I think, therefore everything is"

NIH

The Brain: 20th Century

The Brain: 20th Century

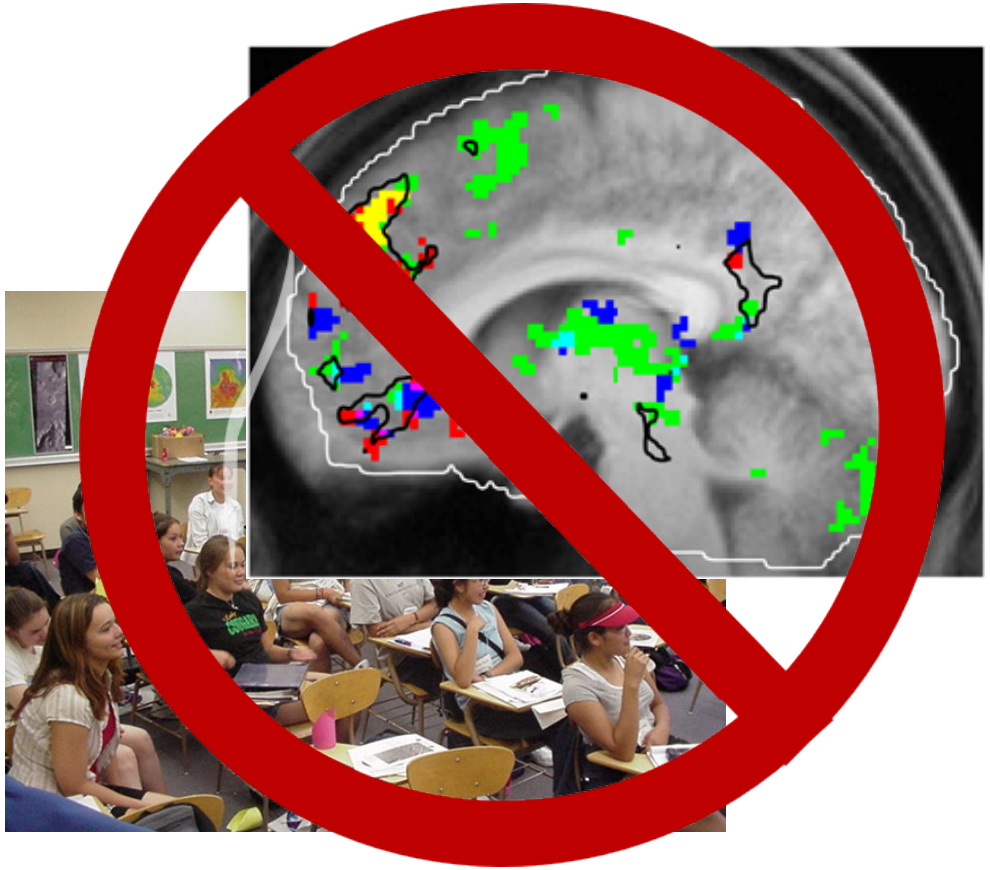


Petr Janata/UC Davis

The Brain: 20th Century

Creative Commons 3.0

The Brain: 20th Century

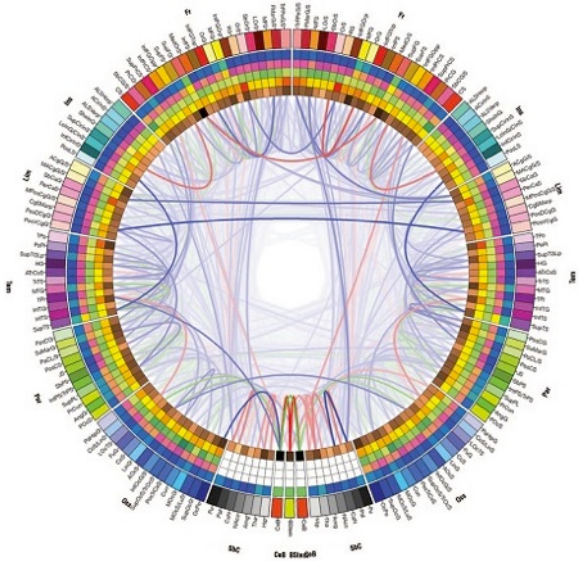


The Brain: 20th Century

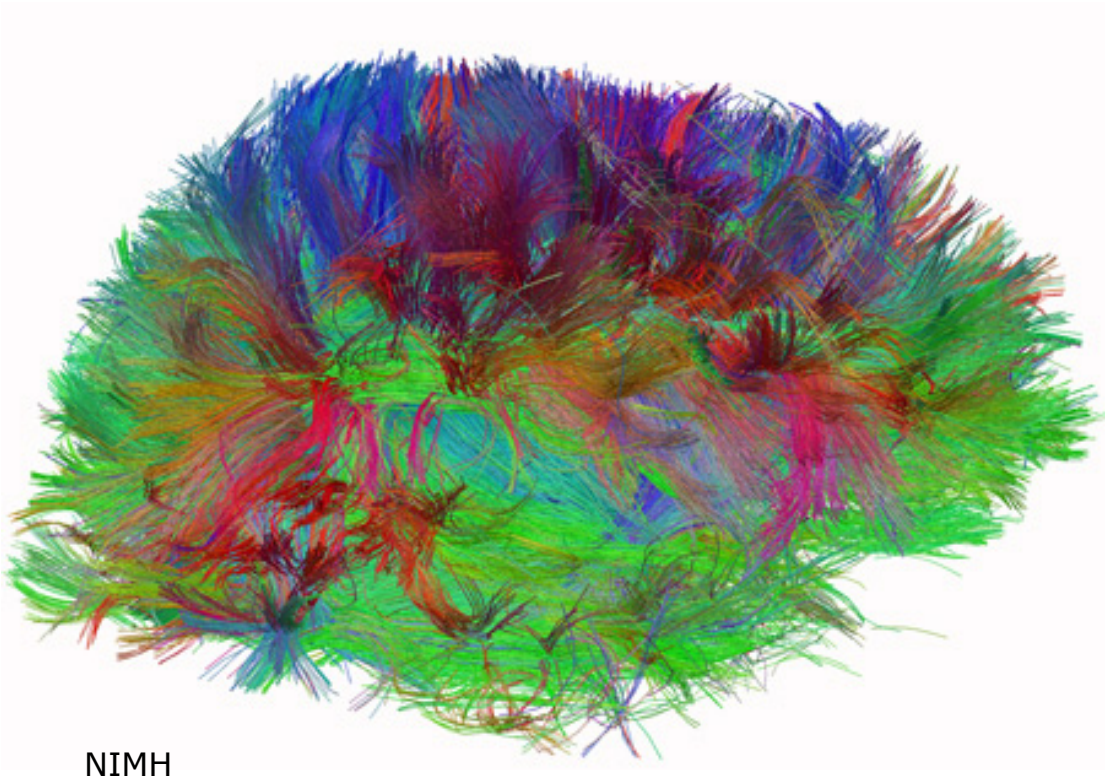
=

Argonne National Laboratory

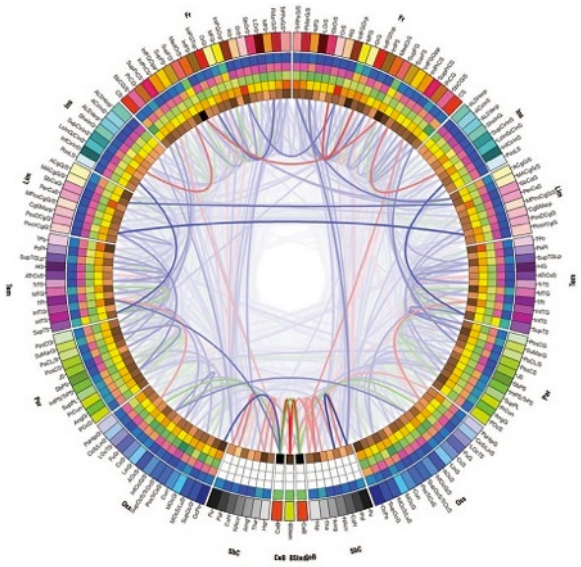
The Human Connectome Project



John Van Horn - PLoS One



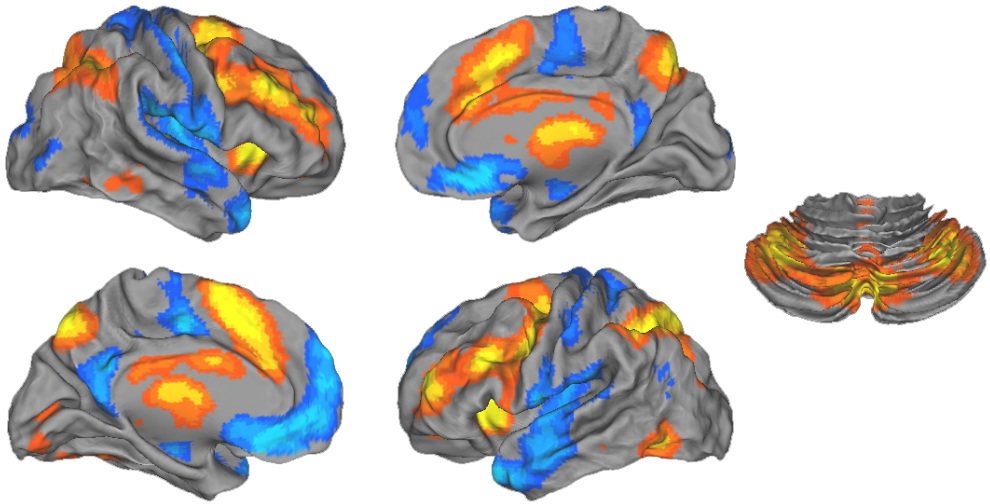
NIMH



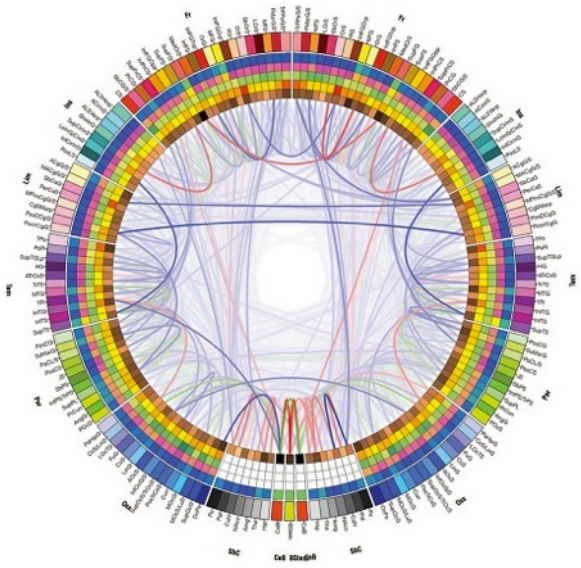
Biology of Cognition

Role of large-scale networks

- Default Mode Network
- Central Executive Network
- Salience Network (Menon & Uddin)

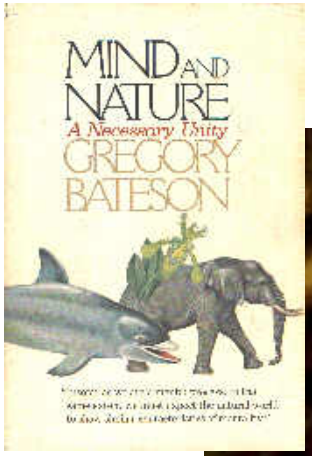


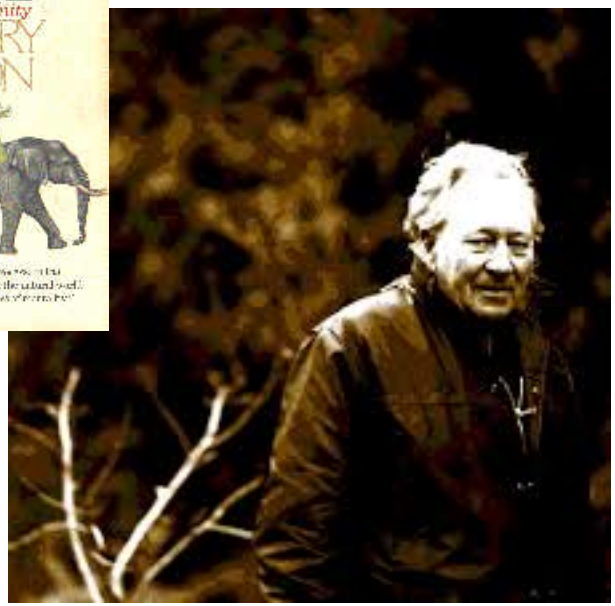
NIH



Biology of Cognition

Brain-Mind-Environment (Bateson)





Extending the Mind

How do the brain and nervous system interact with the environment?

The Cognitive Niche (Tooby and DeVore; Cosmides and Tooby, and; Pinker)

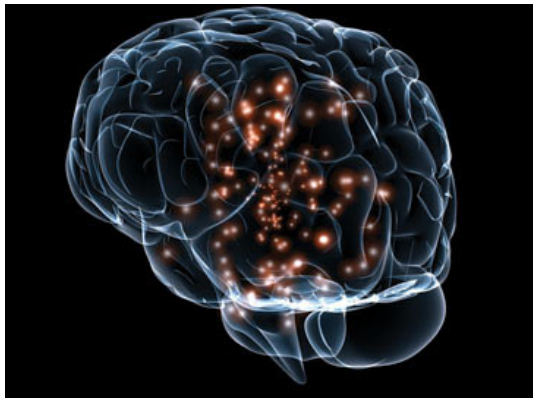
BirdPhotos.com

LaStrad, 2010

Extending the Mind

Niche Construction (Iriki & Taoka)

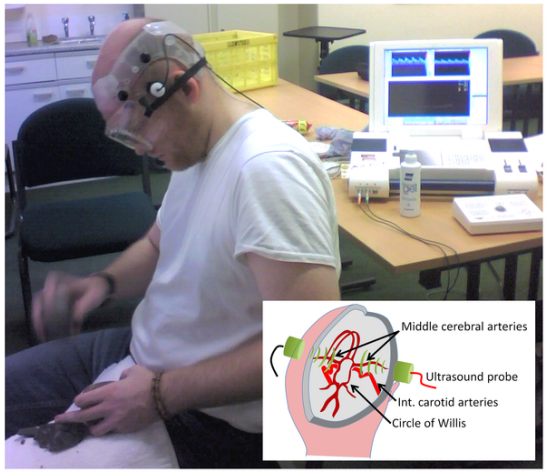
The “Socio-Cognitive Niche” (Whiten and Erdal)



NIH

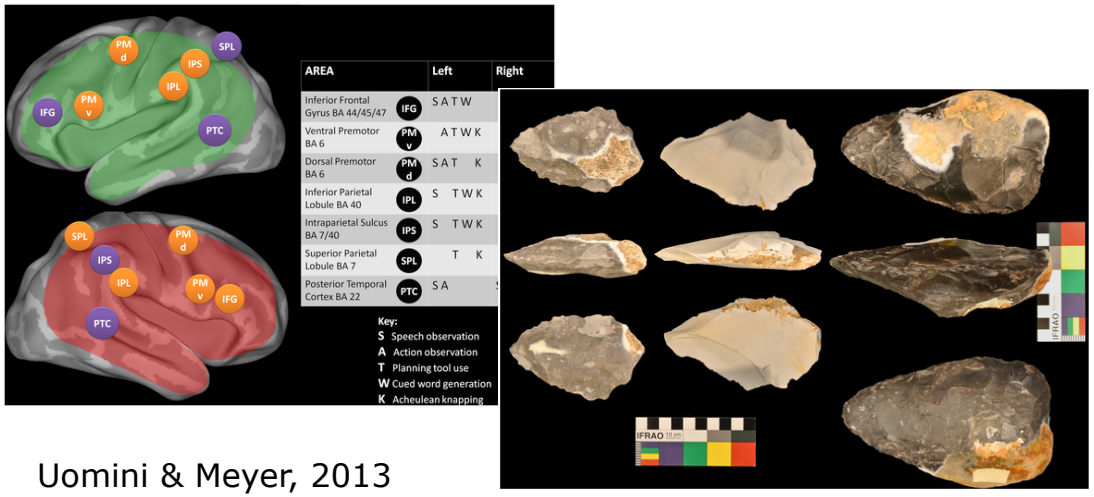
National Geographic

Extending the Mind

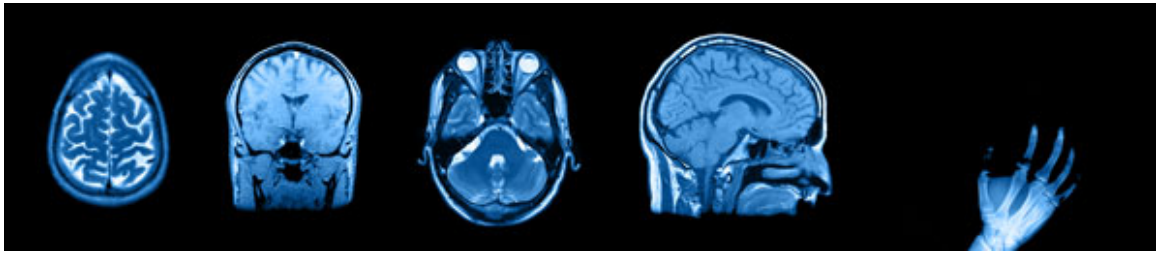


Uomini & Meyer, 2013

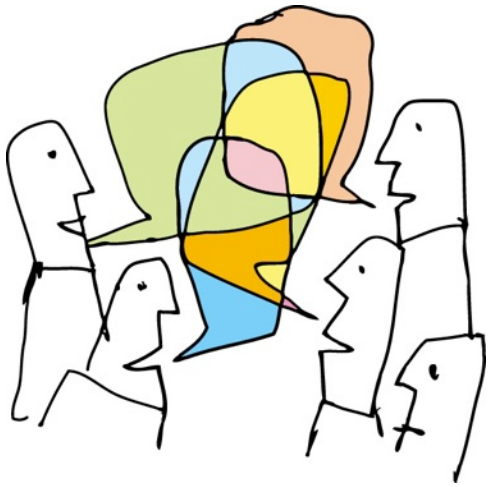
Unifying language and doing (Uomini and Meyer)



Uomini & Meyer, 2013

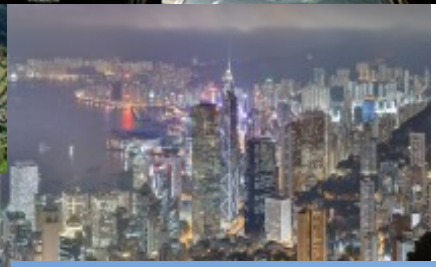


Extending the Mind



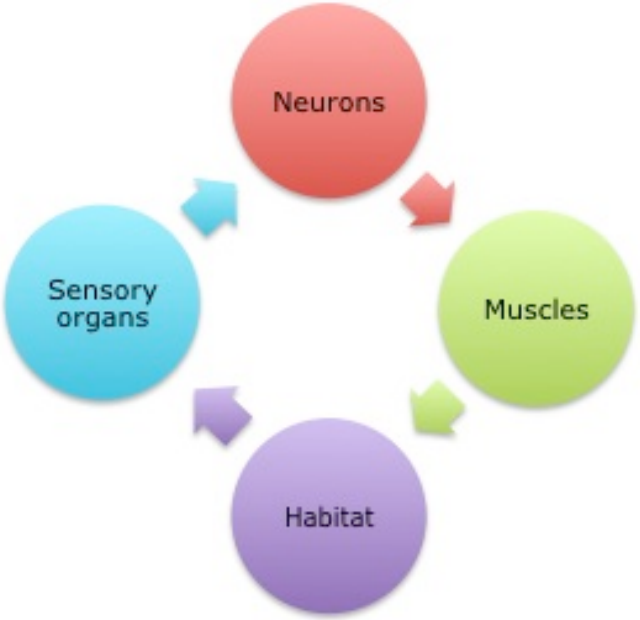
Recursive representation of interactions within consensual space (Maturana)

Extending the Mind



Enaction

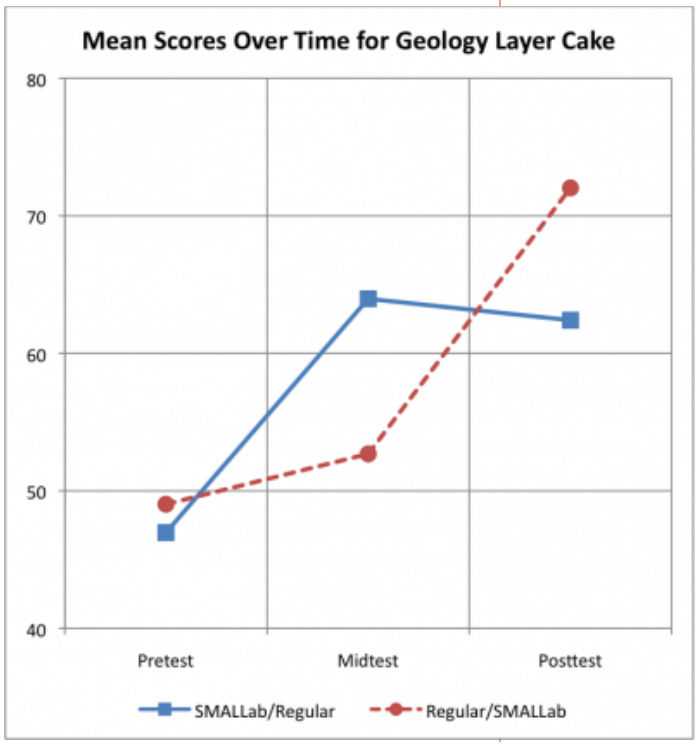
Perception-action networks are building blocks for learning: organism and environment are one complex system. The mind is the medium among the brain and environment/ society

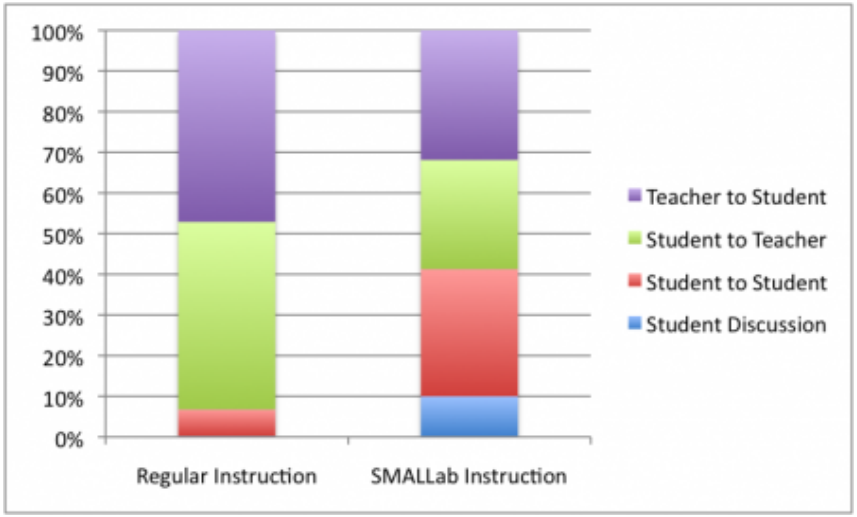


Enaction

Enactive Learning in Practice

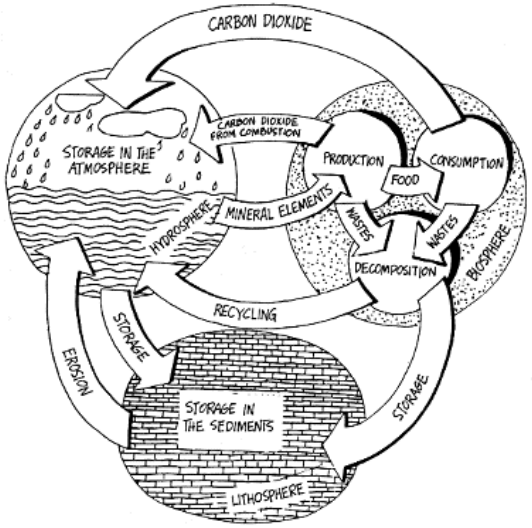
Empirical Research.





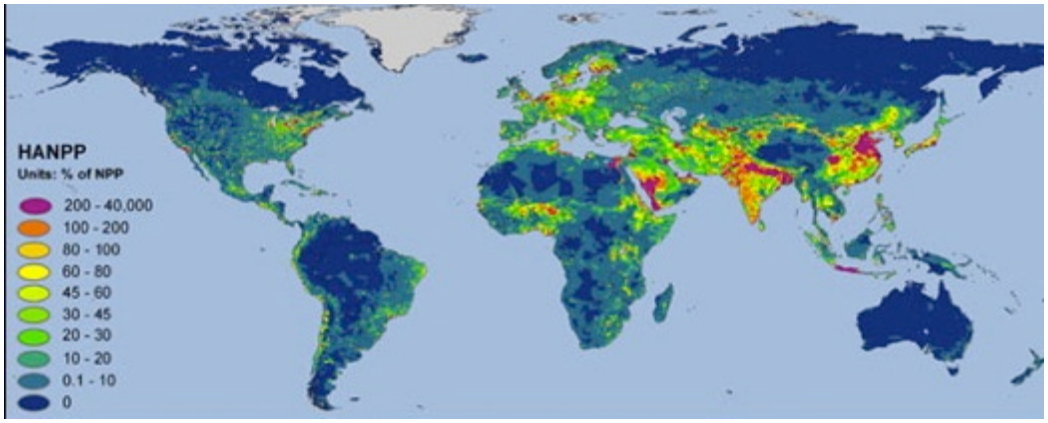
Birchfield & Johnson-Glenberg, 2010

Complex Systems at Multiple Scales



Joel de Rosnay, 1979

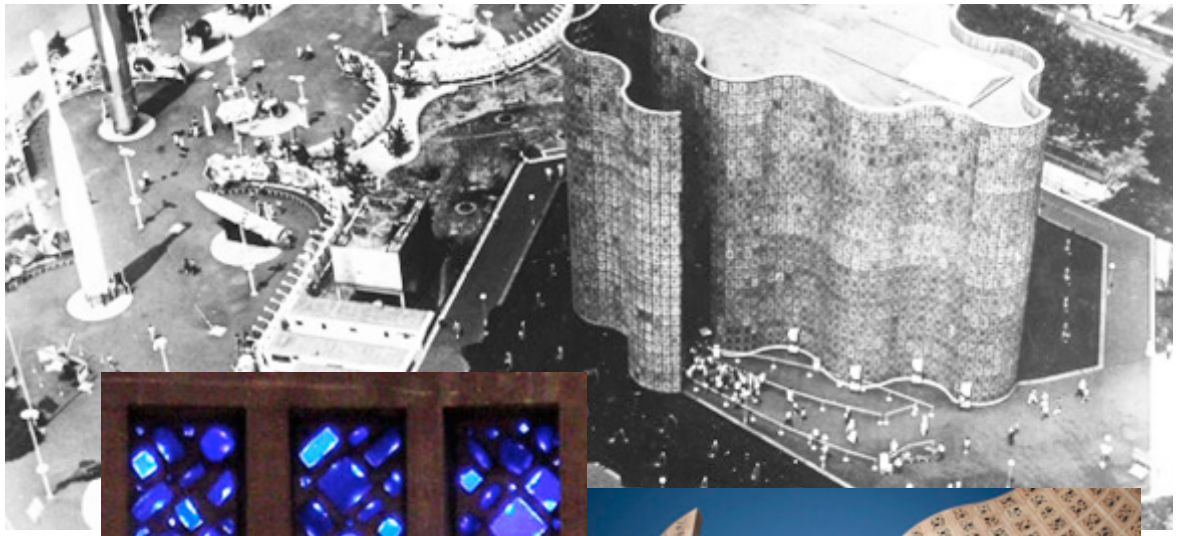
- *Immerse visitors in complex interconnected systems and provide them with agency to affect and understand those systems*
- *Balance among stocks and flows*
- *Positive/negative feedback*
- *Causal chains*

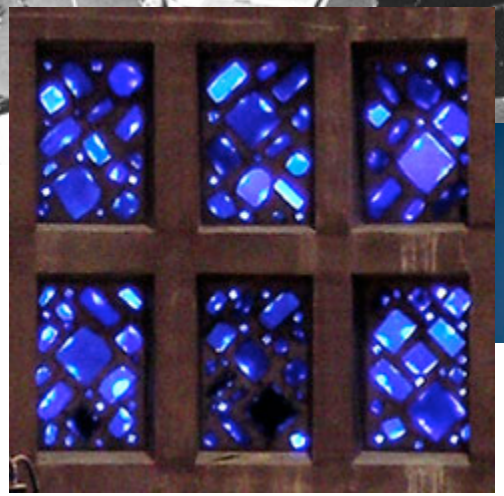


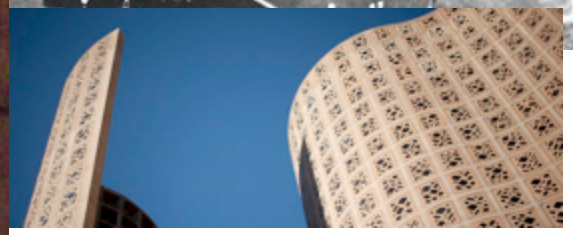
Imhoff, et al, 2004

The Venue: Great Hall

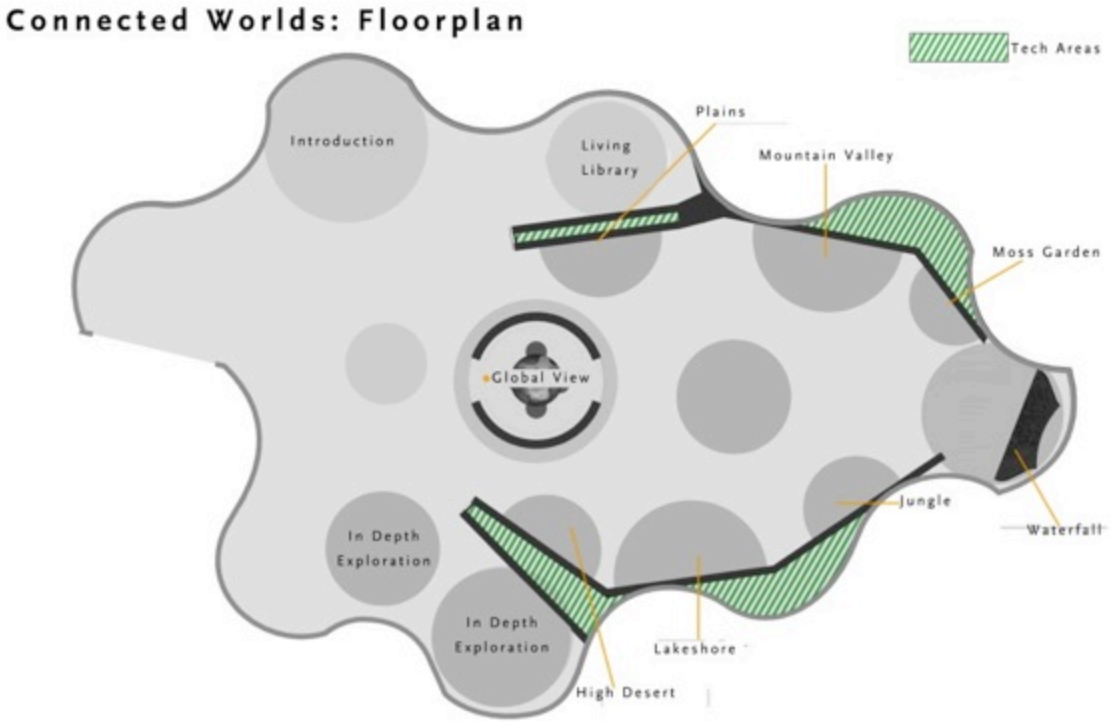
- *Dalle de verre historic structure*







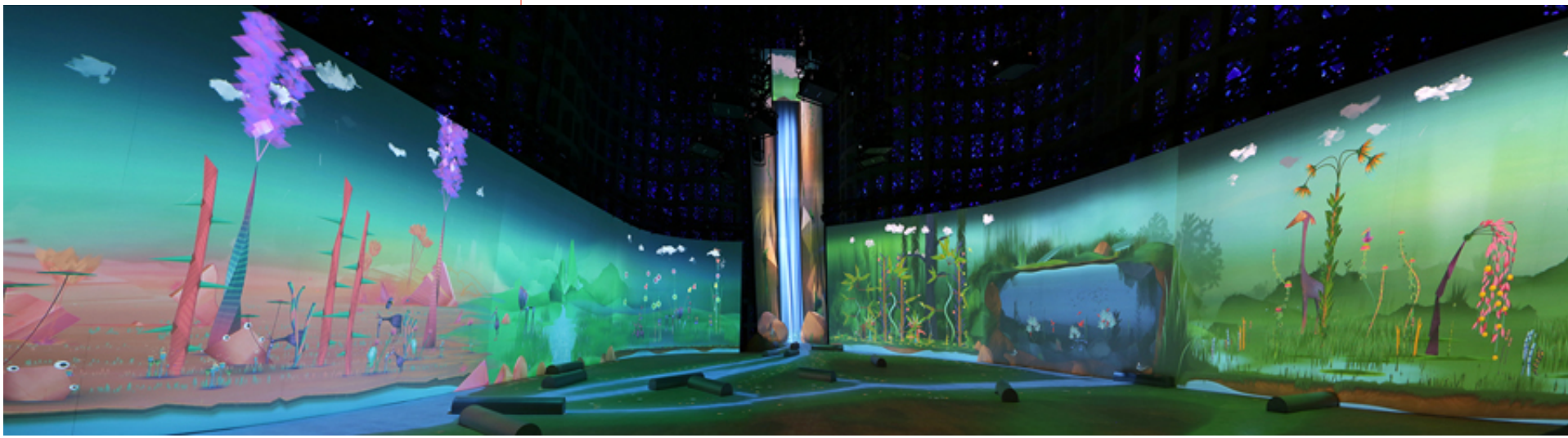
Immersive CGI
Gestural/Sensing/Tracking



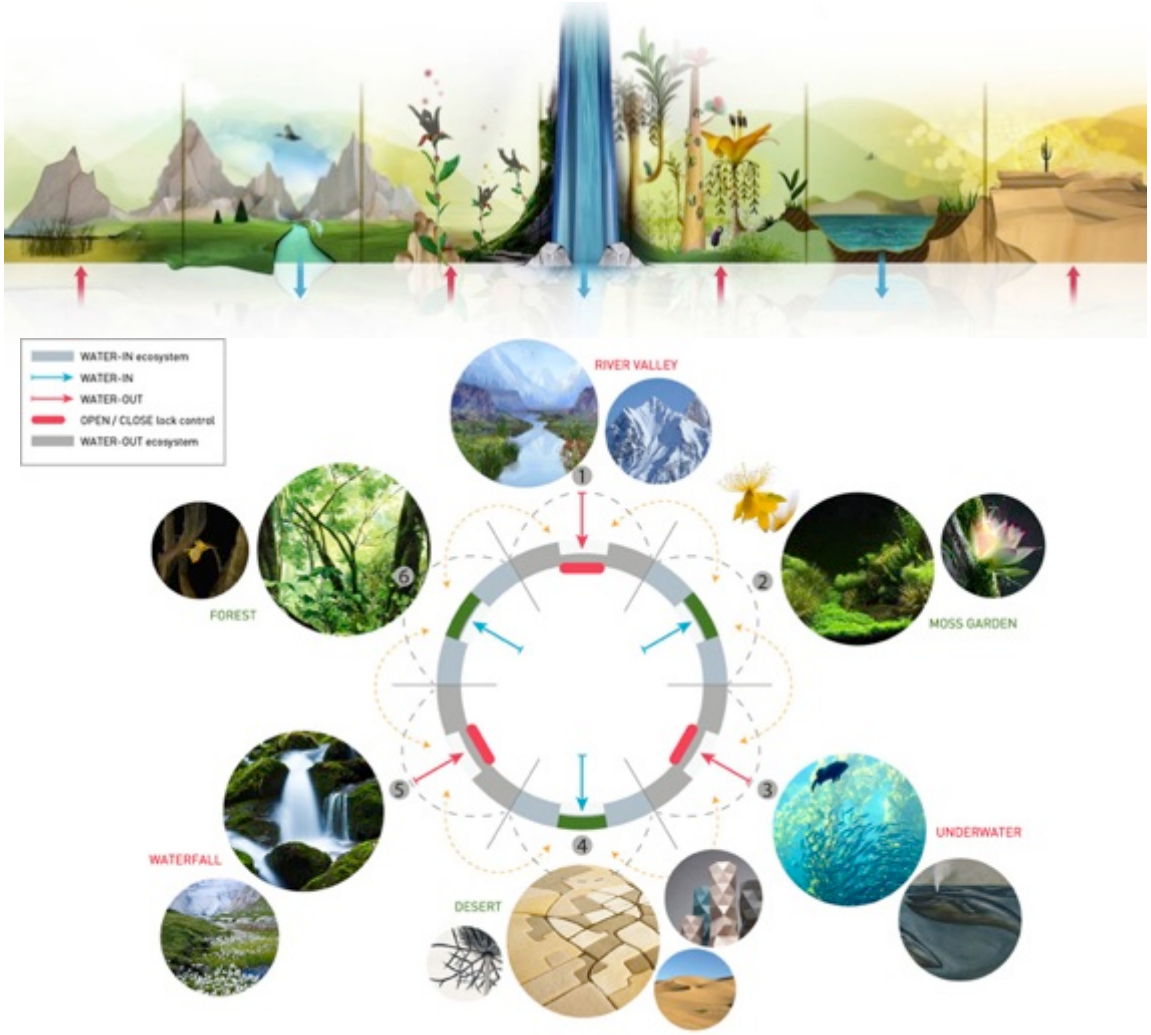
Immersive CGI
Gestural/Sensing/Tracking

Connected Worlds: The Experience

How do we get people "under the hood" of complex coupled human and natural systems and provide them with agency to notice, understand, and affect the interplay among those systems?

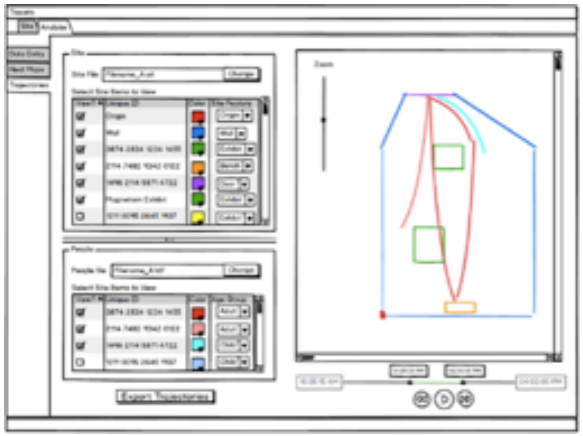


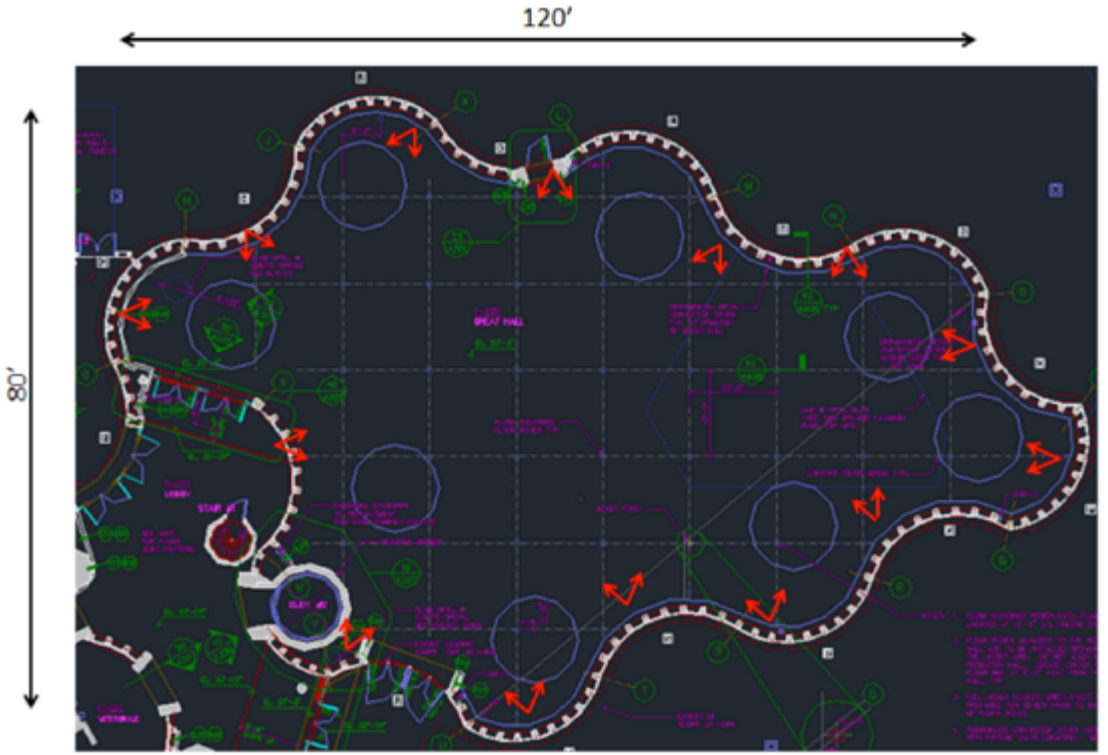
Connected Worlds: Stocks and Flows



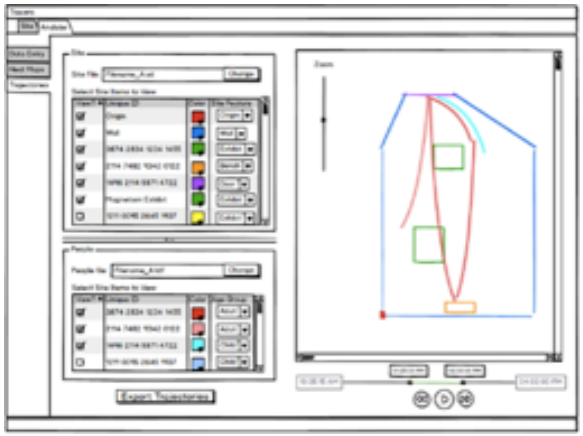
Connected Worlds:
The Experience Responds

Connected Worlds as Cyberlearning Lab



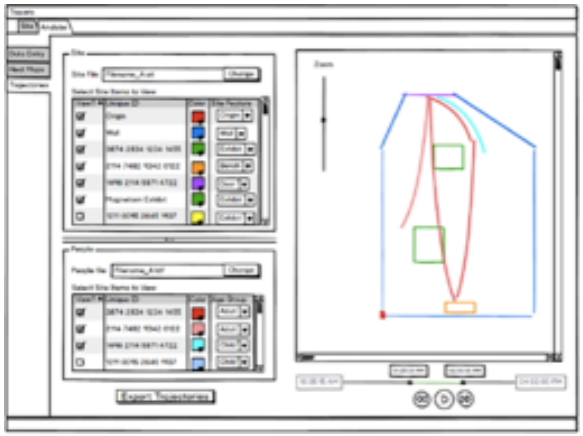


Connected Worlds: How the Enactive Interface Works



https://vimeo.com/131665883

Connected Worlds: How the Enactive Interface Works



RainStormFromCloudBunching

CloudBunchTimeToRainStorm:

19.974

RainStormDuration:

12.8

RainStormDelay:

10.027

WF_RainPctToCollectFromClouds:

0

WF_RainBucketPctOfTotalForRainstorm:

1

Recognize_Seed_Menu_Time:

1.05

Seed_Menu_Charge_Time:

0.276

SeedMenu_MoveInX_To_Cancel:

105.86

Seed_Menu_Switch_Seed_Time:

2.0734

TreeGrowthTime:

3.000E

TreeMatureGrowthTime:

10.00E

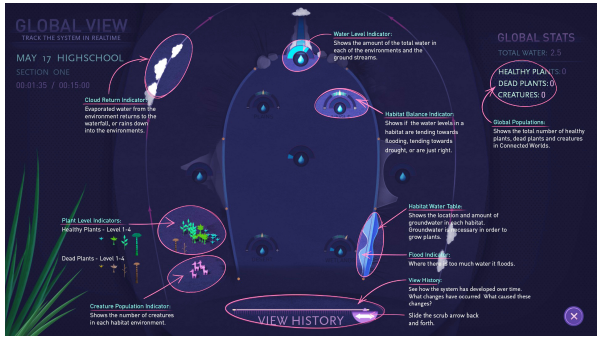
Tree_Wither_Time:

20

Tree_Rot_Time:

10.00E

The Analytics: Logging

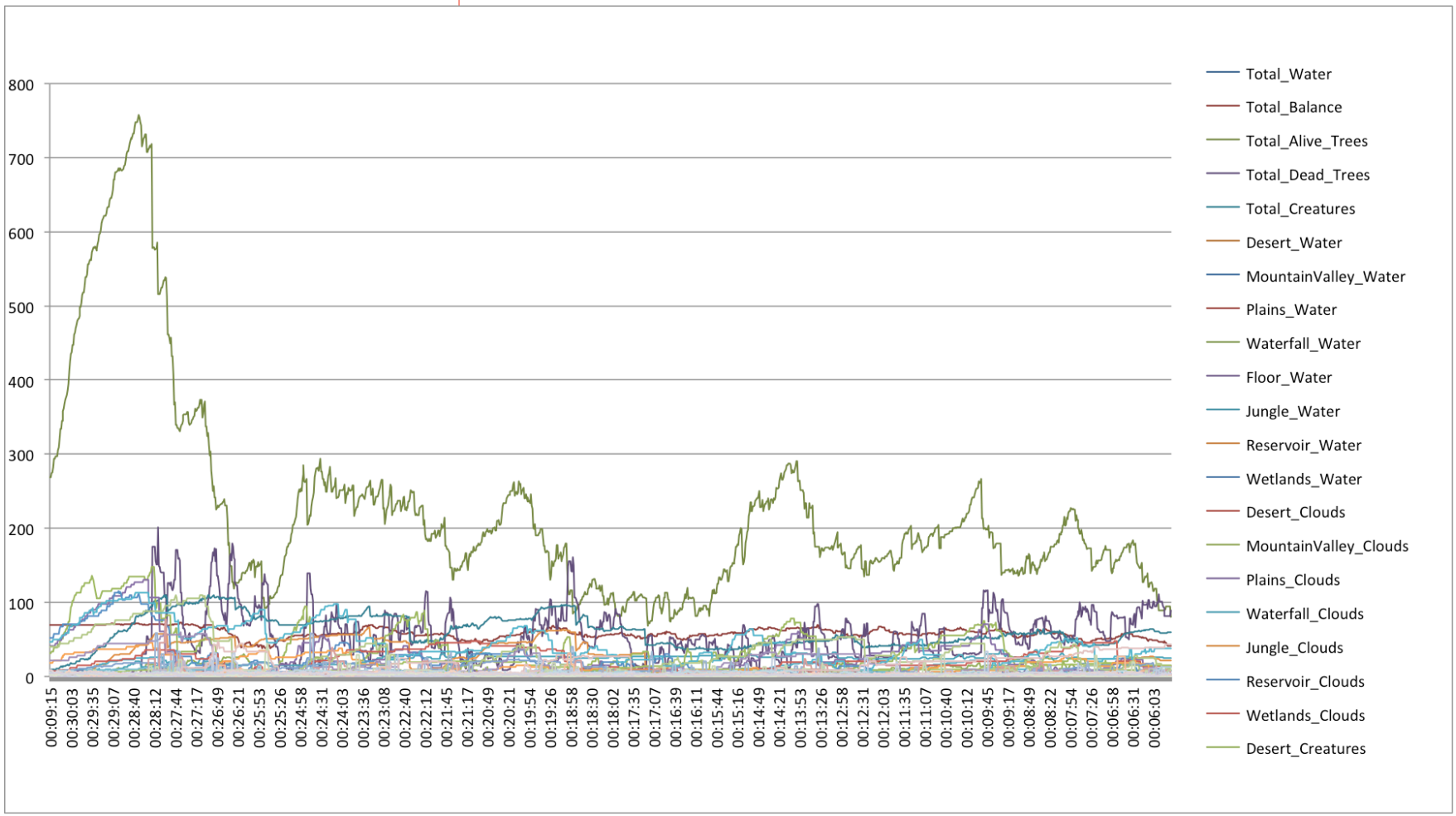


Desert

waterAmount: 1.64753
numPlants: 33
numHealthyPlants: 33
numAwesomePlants: 0
numDiffTypeOfPlants: 7
numTotallDiiffTypeOfPlants: 6
healthyPlantPct: 1
numLevel_0_Plants: 0
numLevel_1_Plants: 19
numLevel_2_Plants: 9
numLevel_3_Plants: 5
numLevel_4_Plants: 0
numPerchSpots: 20
numAvailablePerchSpots: 11
numAvailableFllowers: 0
numAvailableBranches: 11

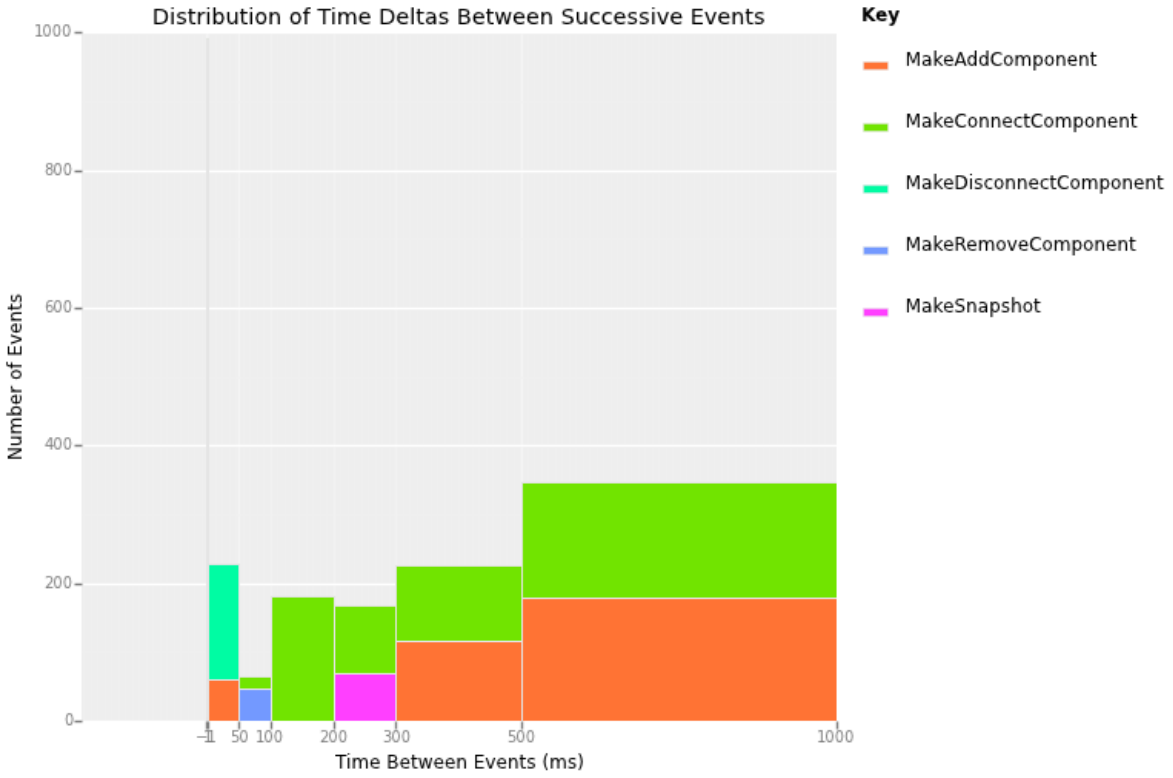
numCreatures: 2
numFlowerBirds: 0
numFishBirds: 0
numStoicBirds: 1
numWaterDeers: 0
numGrazers: 0
numCasterCreatures: 0
numRocknRollers: 1
numWaterDroppers: 0
numUsers: 0
waterLevels:
218,651,966,498,107,42,26,30,408,782
floodLevels:
0,100,100,100,0,0,0,0,74,100

The Analytics: Logging

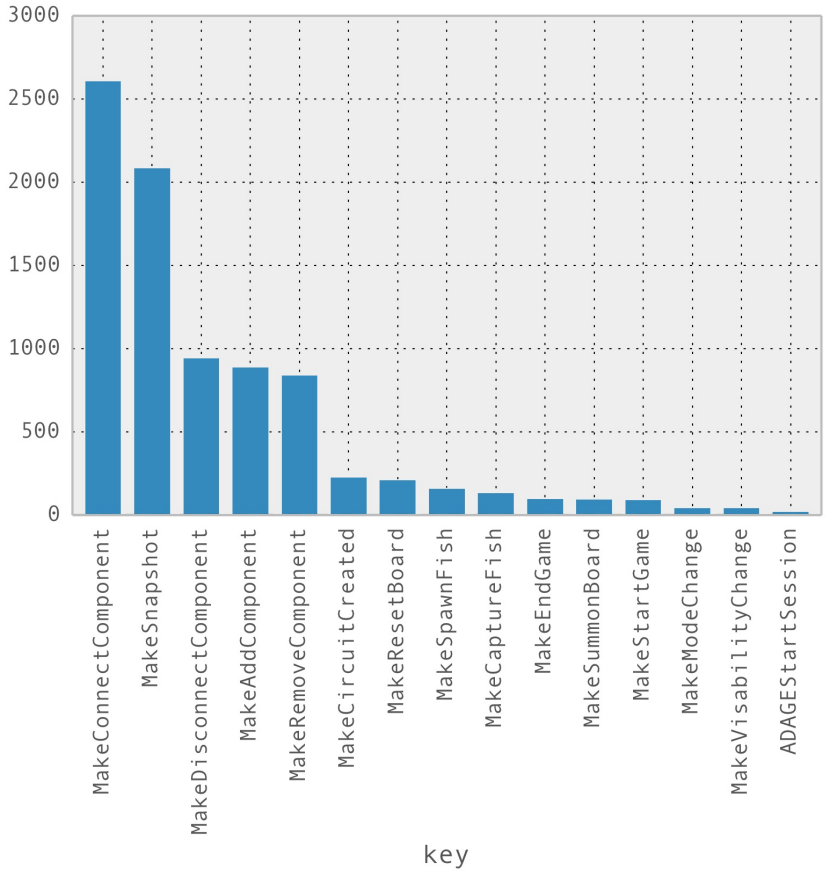


The Analytics: Logging

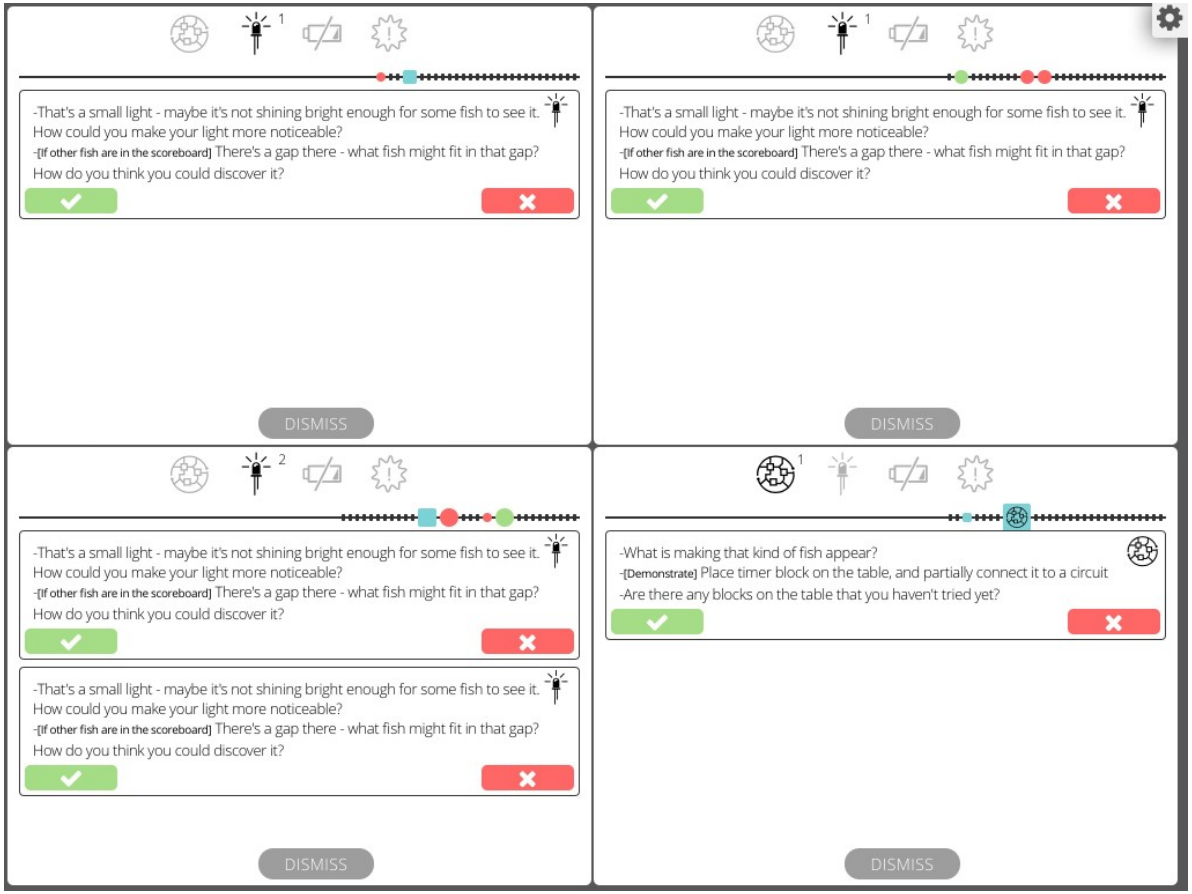
The Analytics: Logging



The Analytics: Logging

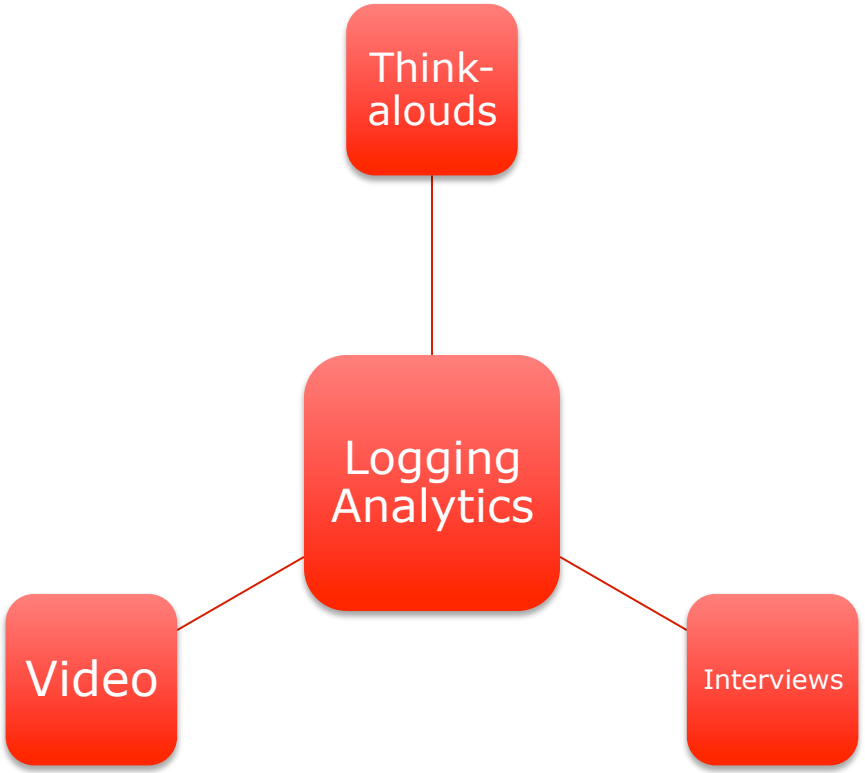


The Analytics: Logging

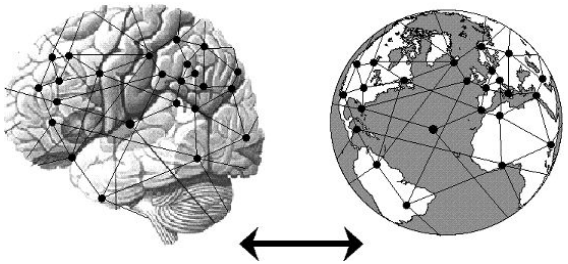


Ground Truth

GoPro, Inc.

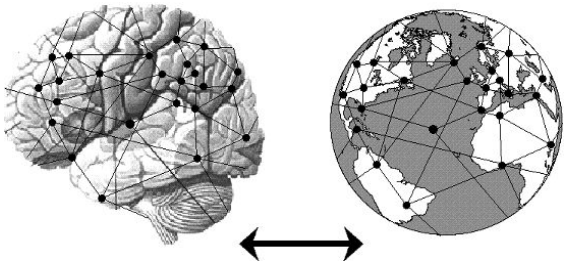


The Future



NASA

The Partners

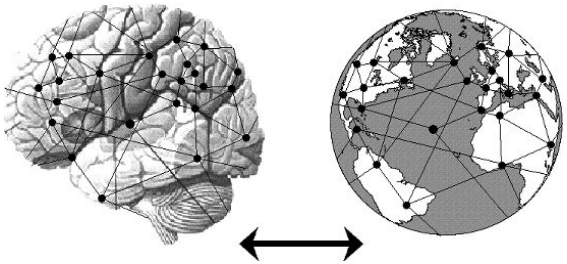


Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

NYU

Y

I/O



The Funders

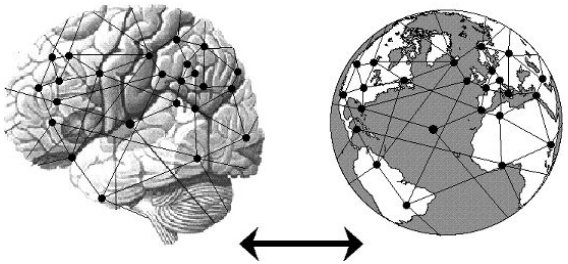
Google

xylem

NSF

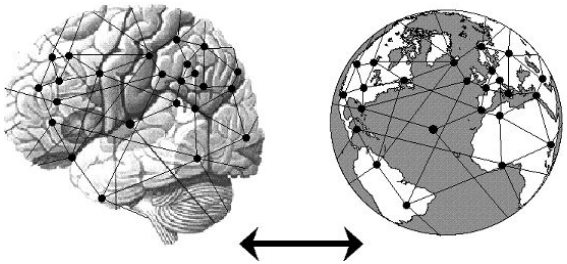
THE JPB FOUNDATION

CARNEGIE CORPORATION



References

- *Bateson, G. (1979). Mind and nature: A necessary unity. London: Wildwood House.*
- *Birchfield, D., & Johnson-Glenberg, M. C. (2010). A next gen Interface for embodied learning: SMALLab and the geological layer cake. International Journal of Gaming and Computer-mediated Simulation, 2, 1, 49-58.*
- *Cosmides, L., & Tooby, J. (1992). Cognitive adaptations for social exchange. The adapted mind, 163–228. doi: 10.1073/pnas. 122352999*
- *John H. Falk, Lynn D. Dierking (2010) The 95 Percent Solution: School is not where most Americans learn most of their science. American Scientist, 98. 486-493*
- *Iriki, A. and Taoka, M. (2012) Triadic (ecological, neural, cognitive) niche construction: a scenario of human brain evolution extrapolating tool use and language from the control of reaching actions Philosophical Transactions of the Royal Society B Biological Sciences 367, 10–23*
- *Maturana, H. (1970) Biology of Cognition. Biological Computer Laboratory Research Report BCL 9.0. Urbana IL: University of Illinois.*



References

- *Menon, V. & Uddin, L. (2010) Saliency, switching, attention and control: a network model of insula function. Brain Structure and Function. Vol. 214, No. 5. New York: Springer. 655.*
- *Pinker, S. (2010). The cognitive niche: Coevolution of intelligence, sociality, and language. Proceedings of the National Academy of Sciences , 107, 8893-8999.*
- *Tooby J, DeVore I (1987) The reconstruction of hominid evolution through strategic modeling. The Evolution of Human Behavior: Primate Models, ed Kinzey WG (SUNY Press, Albany, NY).*
- *Uomini, N and Meyer, G. (2013) Shared Brain Lateralization Patterns in Language and Acheulean Stone Tool Production: A Functional Transcranial Doppler Ultrasound Study. PLoS One. http://dx.doi.org/10.1371/journal.pone.0072693*
- *Whiten A, and Erdal D.(2012) The human socio-cognitive niche and its evolutionary origins. Philosophical Transactions of the Royal Society B Biological Sciences 367, 2119-29*

New York Hall of Science