

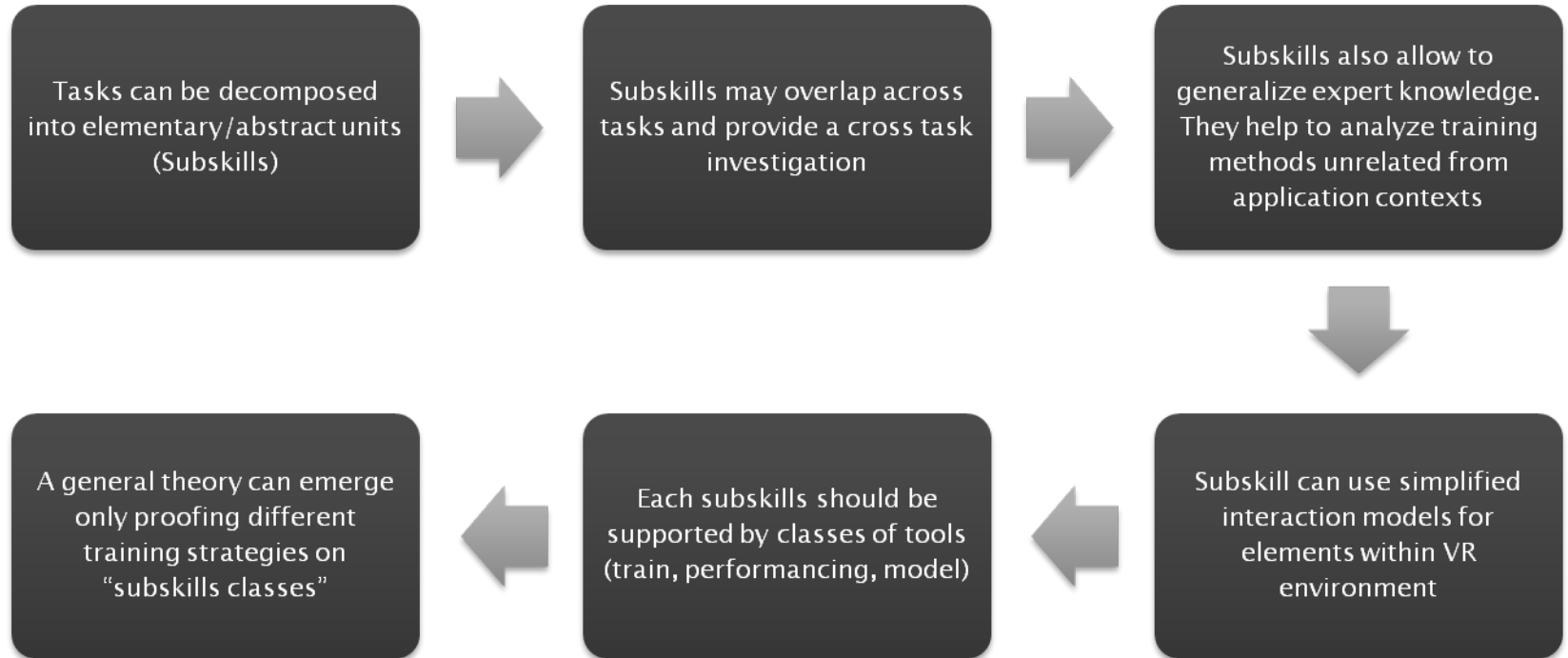
Skills Models for Training in Multimodal Environments

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SKILLS-IP FP7-35005



PERCRO Perceptual
Robotics Laboratory

Roadmap to investigate skills training



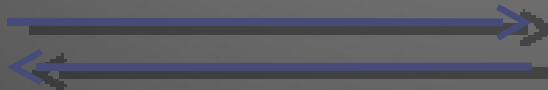
Use Cases

- Styles
- Expertise
- Performances



Teacher

Supervised Learning



Unsupervised Learning

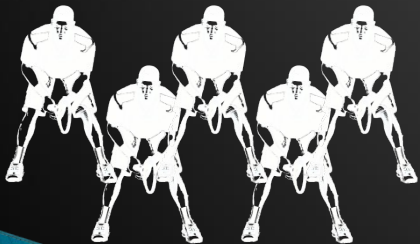


Learner

Becomes



Experts

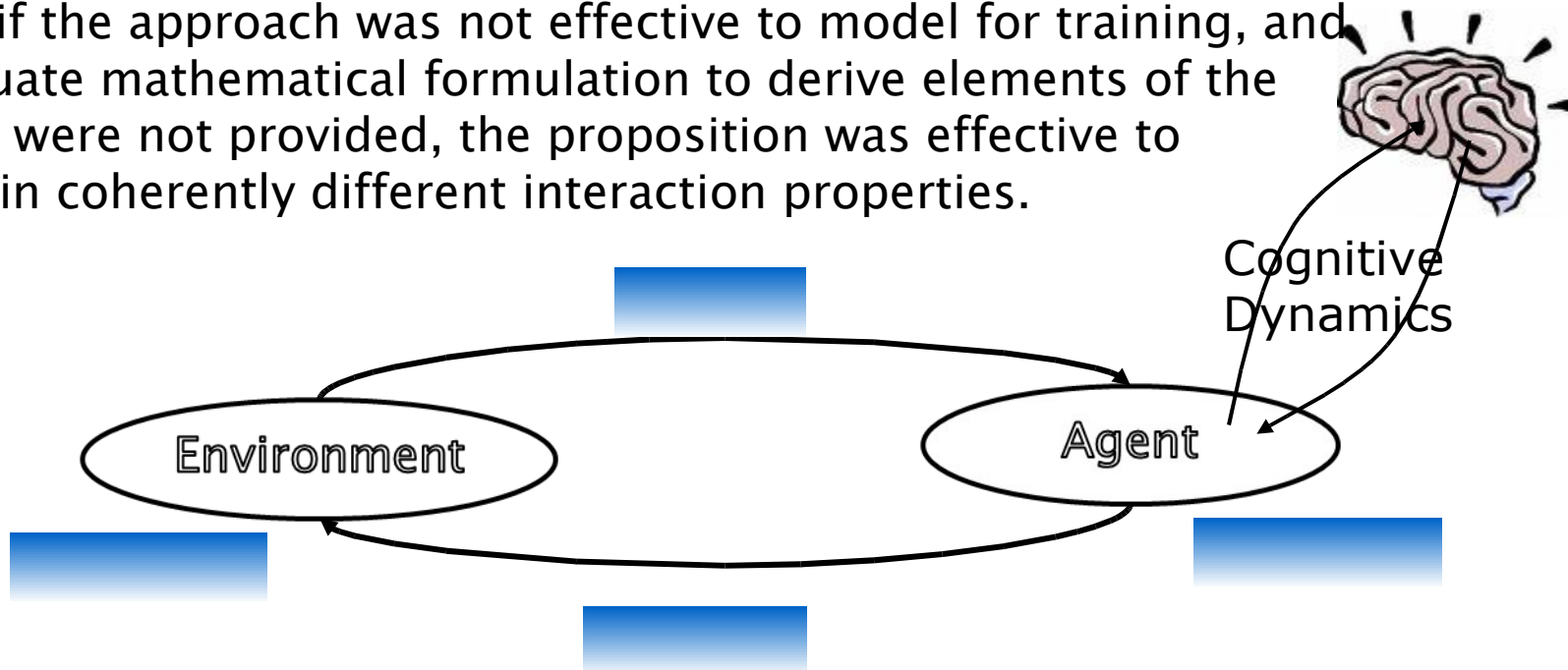


Becomes



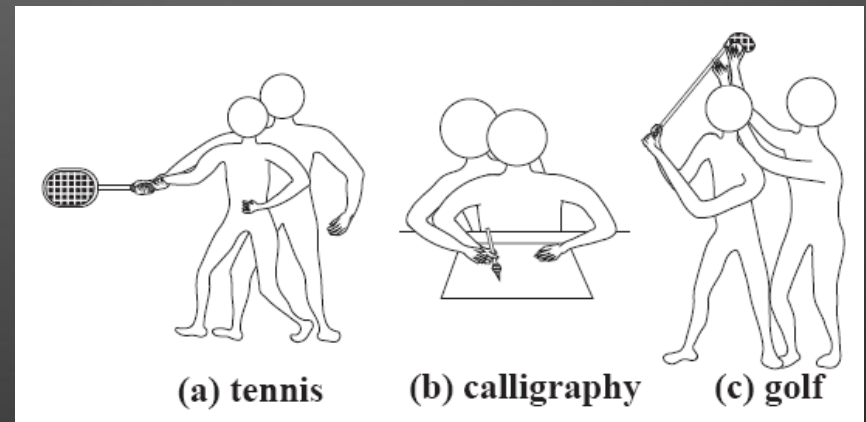
Warren theoretical model

- ▶ In 2006, William Warren introduced a theoretical model to represent the user different level of user/environment interaction in a closed loop modelisation (see figure);
- ▶ Even if the approach was not effective to model for training, and adequate mathematical formulation to derive elements of the loops were not provided, the proposition was effective to explain coherently different interaction properties.



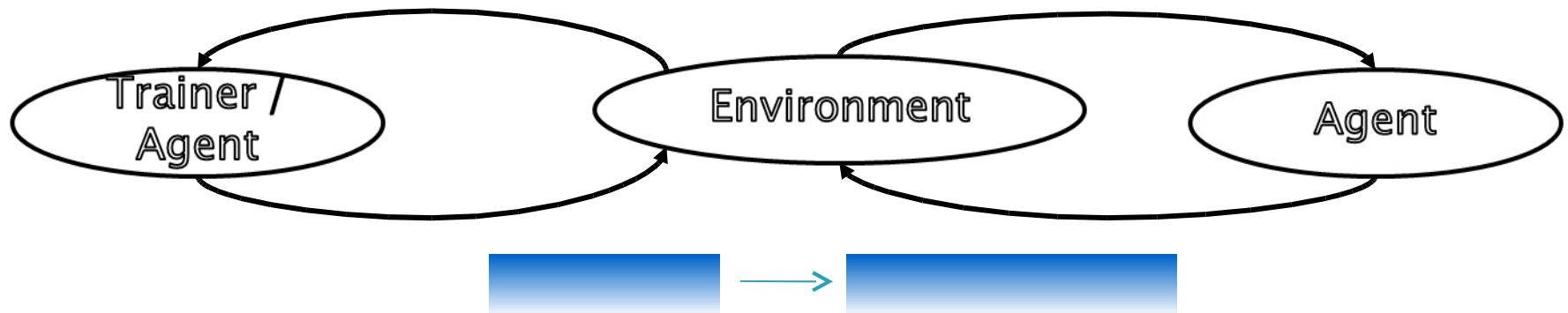
Training approaches

Classical training approaches intervene on such loops to provide proper sensorimotor and cognitive stimuli, to focus attention and facilitate memory effects (and aftereffects) on learning



Extension

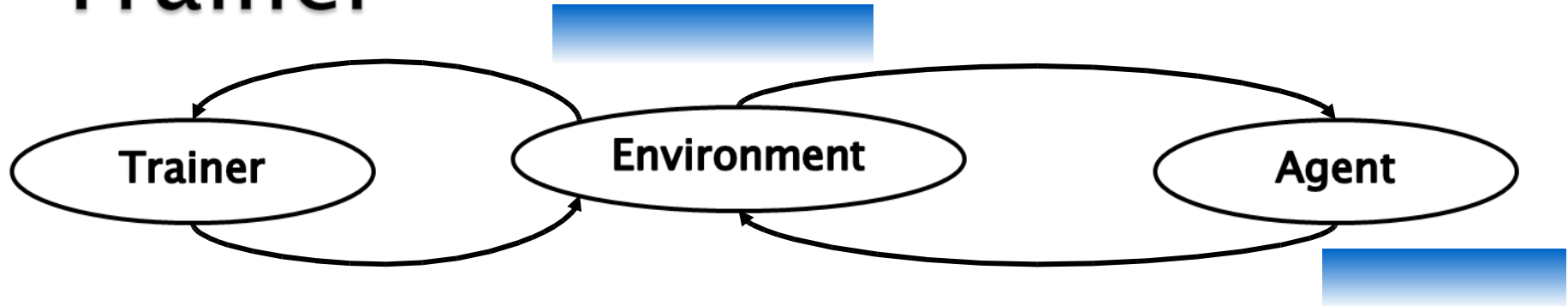
In order to cope with a training or a multiuser scenario, the Warren model can be extended without requiring main changes to the description of the physical interaction user/environment.



Doubles the inputs



Trainer



However the presence of the trainer affects the Agent cognitive behaviour and dynamics and vice-versa. The adequate knowledge of this change is at the basis of the learning process.

Trainers have an implicit knowledge of this model they apply accordingly a set of observation, performance evaluation, training protocols and interaction metaphors.

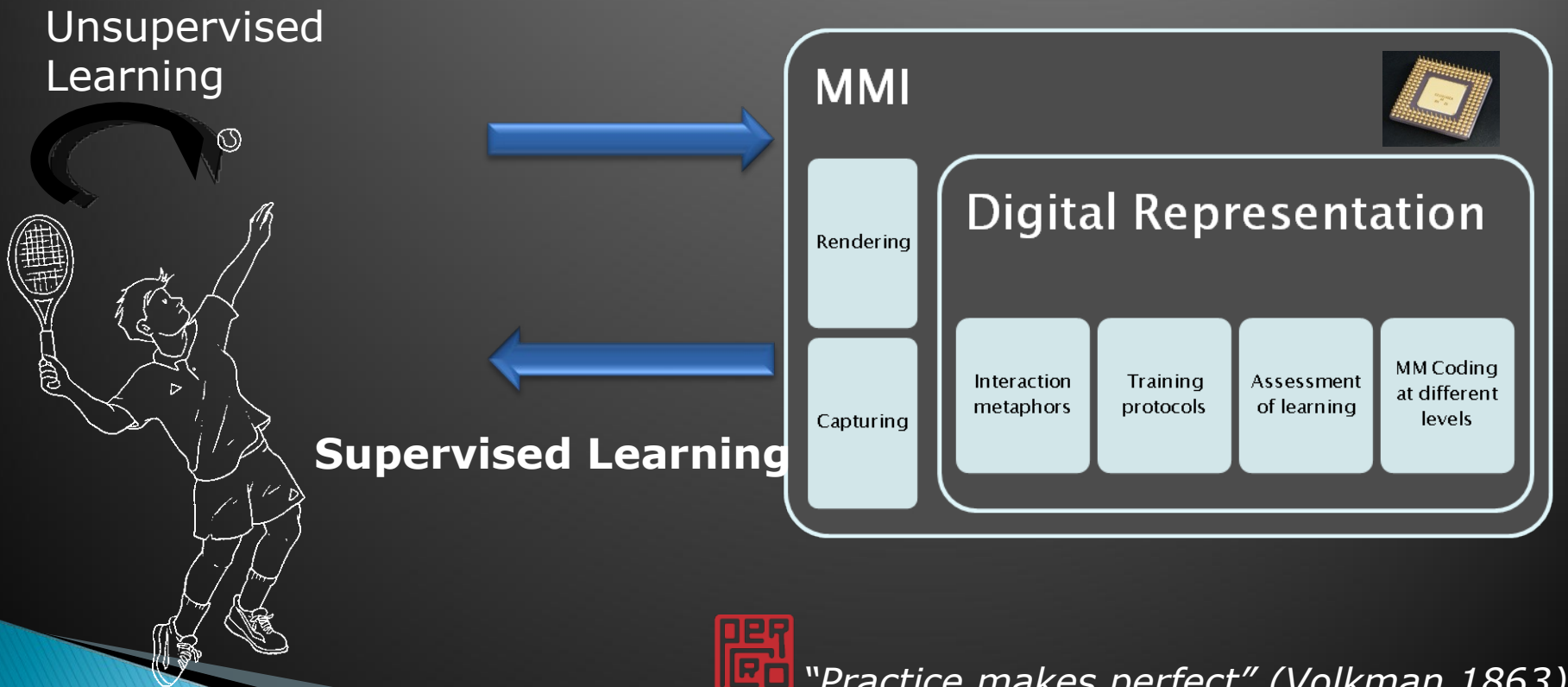
The presence of the Trainer changes the strategy

The training strategy



Using a digital training model

Taking the above considerations as a basis it is possible to propose an extension which takes a particular value when we consider to limit the interaction within a Multi Modal Virtual Environment and to associate the training function to a digital model of training



Constraints

Training knowledge act on a highly complicated model and do not come alone or can be easily modeled

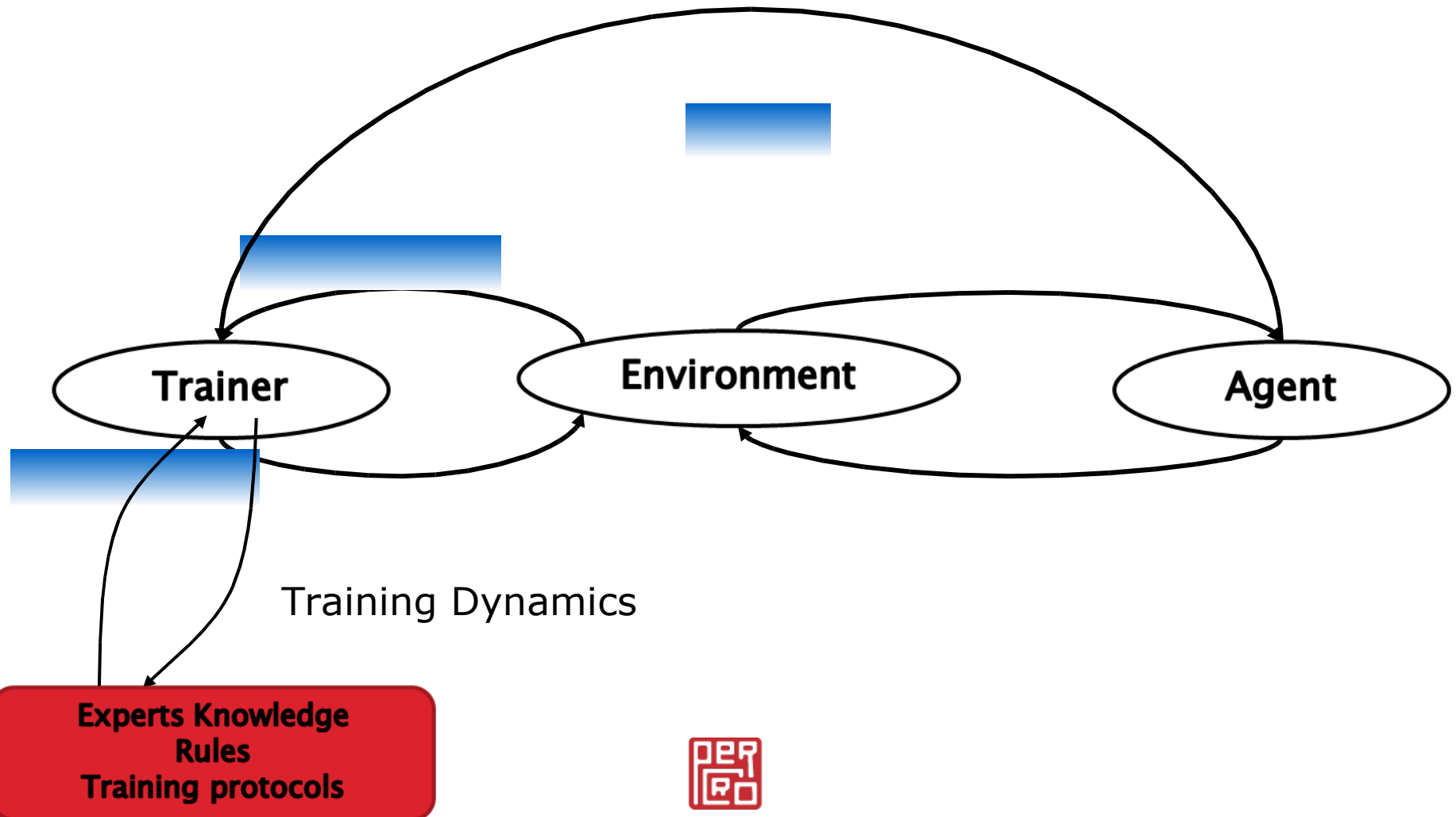
It is therefore required to have a deep understanding of strategies used by trainers

Multimodal environment are not like human beings nor perceived from user as they were similar

It is therefore required to recreate a remap of training process accordingly the new type of interaction



A behavioural model of digital training is required as well



Inside the Digital Trainer

The Psi of the Digital Trainer contains the analysis of the input coming from Env and Agent and the evaluation of the execution

The Psi function should take into account: Agent History, Style of the Agent and the Experts Knowledge

The Digital Trainer takes the information from the evaluation and decides which feedback generate to the Environment and to the User.

The Digital Trainer uses the following information:

- Recorded Experts Knowledge
- Rules from Task Analysis
- Accelerators



Enactive Digital Trainer

Once the above constraints have been taken into account, there are additional benefit we can take from this paradigm shift.

The Enactive approach is extremely powerful and allows to a digital trainer much more control of the training process with respect the one in the hand of a physical trainer.

Beyond the benefits of using computer based training (e.g. databases, real time assessment, ...) it is also possible to benefit from a better interaction



Enactive Digital Trainer



Actions in the Environment (e.g. balls position in juggling)



Directly actions to the user through audio and BioFeedback (e.g. vibrotactile stimulation)



Information sent to the user as of visual and audio (arrows and Text)



Changes to the Parameters of the Environment (e.g gravity)

1. The Digital Trainer acts on the Environment more effectively than the Trainer and it can affect the agent directly

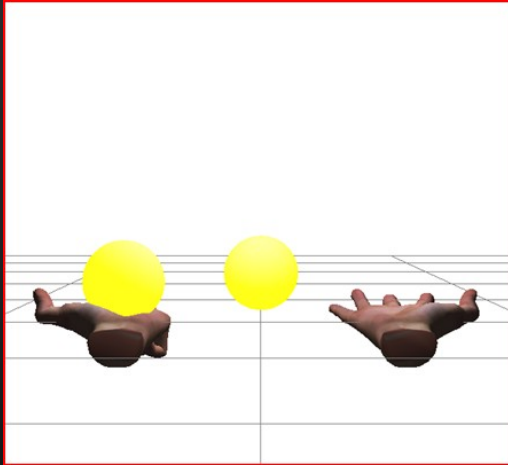


2. The Enactive Trainer may change parameters and physics of the Environment



ENACTIVE Training: preliminary test

»» LWJ (Light weight juggling)



Environment model

Hands

- Positions (6)
- Velocities (6)
- Grasping states (2)

Balls (3)

- Positions (9)
- Velocities (9)

Constraints

- Grasping
- Launch order if multiple balls
- Equilibrium



SKILLS Assessment Variables

Direct factors

- Success or endurance of loops
- Distribution of ball tossing times (phases synch.)

Indirect factors (not immediate)

- Shannon formula
- Distance from expert data

Body issues

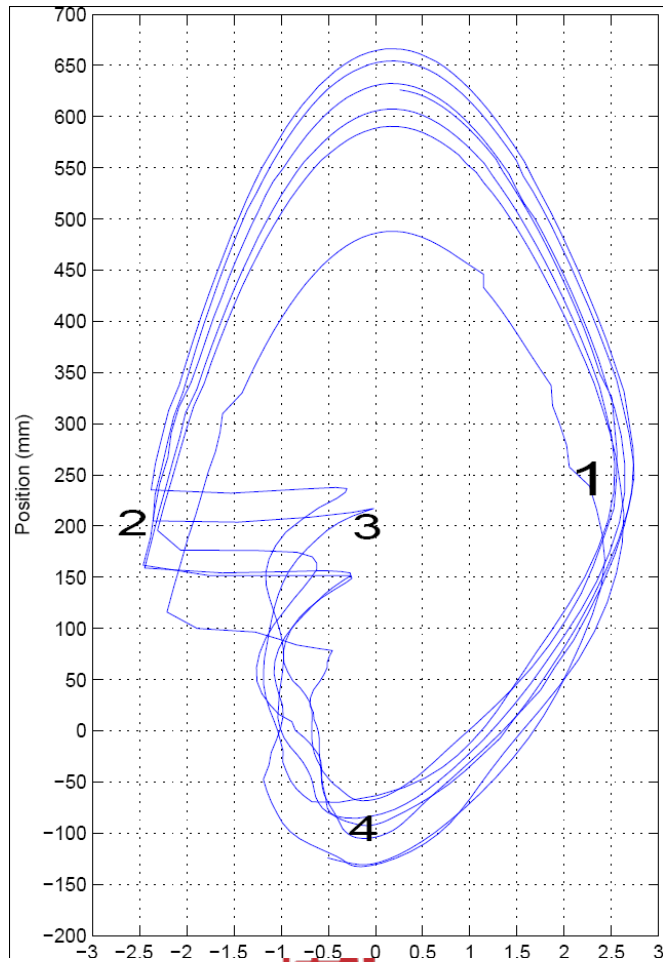
- Rhythm consistency
- Frontal and Lateral balance/stability

Trajectory issues

- Acceleration regularities (launch height, velocity, direction)
- Accuracy of motion
- Height/velocity ratio



State Space Analysis



Enactive Trainer approach: Control of the environment and training

Real Time analysis of the User

Environment driven feedback

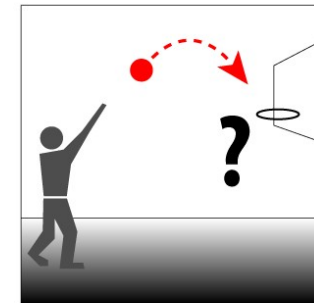
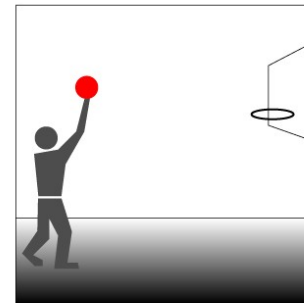
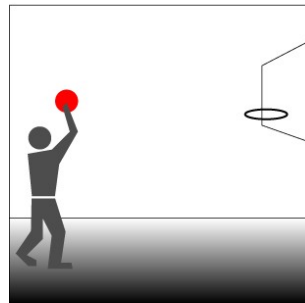
Feedback as accelerator

Minimize figures in an easy task

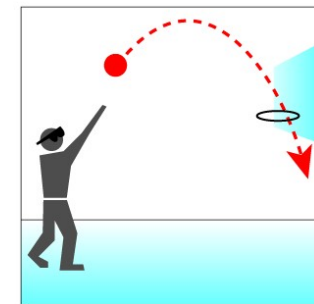
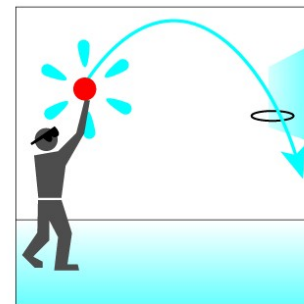
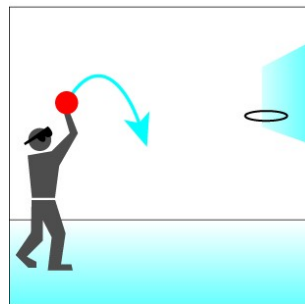
Create additional synthetic variables

Synthetic variables can be better than real observation

1. Typical situation:



2. Same situation with anticipatory feedback:



Exemplary tools for training

Zero error trainer

- Field vectors: e.g. magnetism of the proper hand (E)
- Or auto juggling (M)
- ...other possible auto visual metronome (H)

Facilitator

- Auto gravity scaling (E)
- Auto ball replacement (E)
- Visual trajectories (H)
- Hand motion predictors (M)
- Zero stability control (E)



Additional indirect training variable

Energy provided by field

Miss counter

Average gravity

Predictor tracking

Virtual Shannon formula

...



Magnetic/Speed trainer

