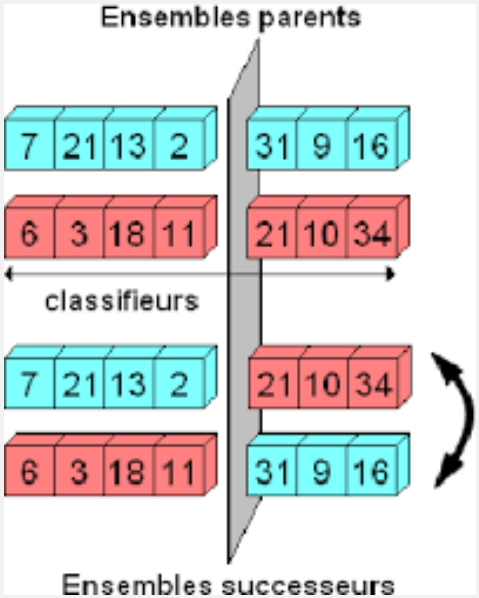
Modélisation des

stratégies visuelles

Profilages utilisateurs

E-communications – Design d’interfaces – UX



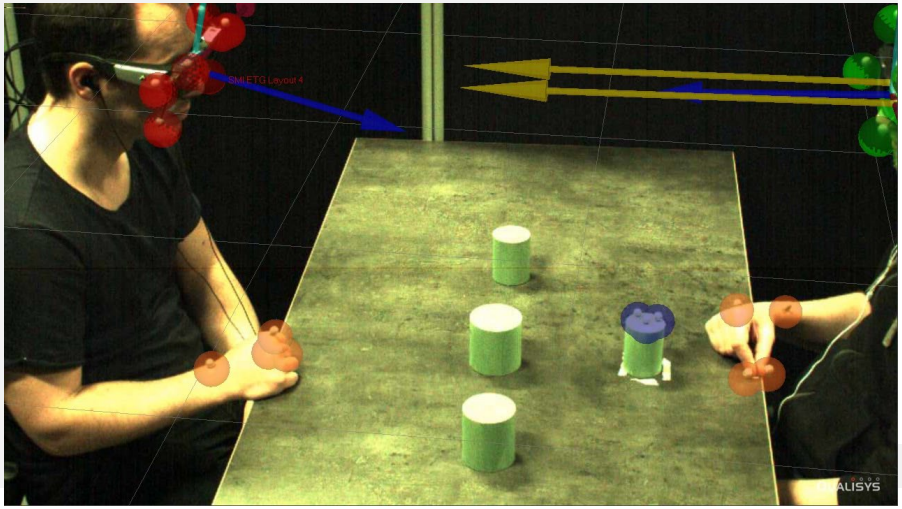
Réalité virtuelle – serious gaming

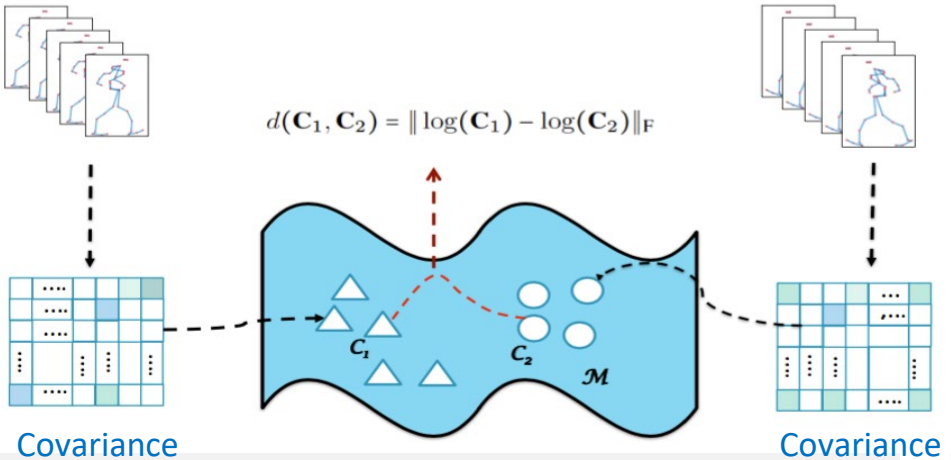
unity

ankama

oculus

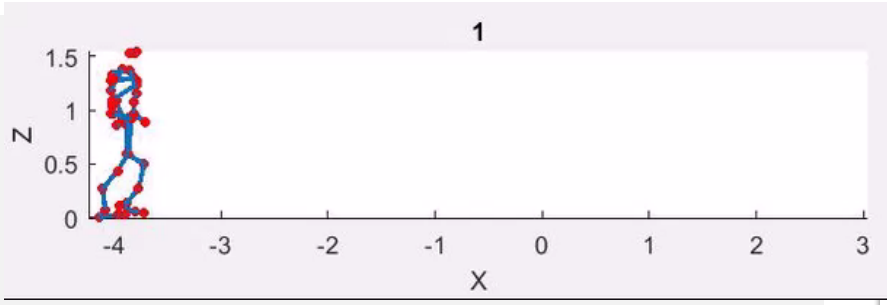
Former *pour* et *par* la Recherche





Objectifs:

Acquérir les bases **méthodologiques** et **théoriques** permettant la mise en œuvre de recherches fondamentales et appliquées.



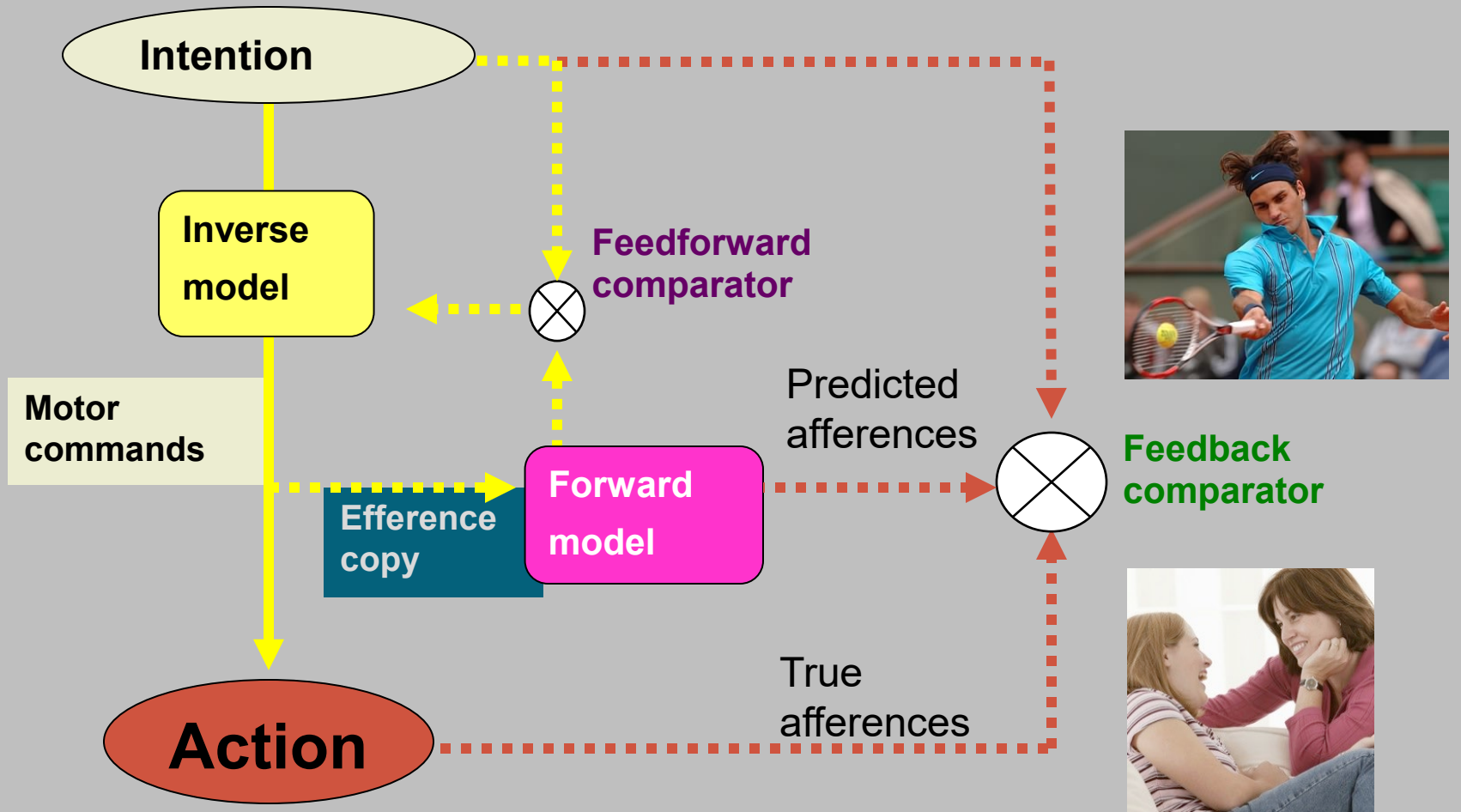
Simulation to interact

INTERNAL MODEL THEORY

4 MOTOR AND SOCIAL INTERACTIONS

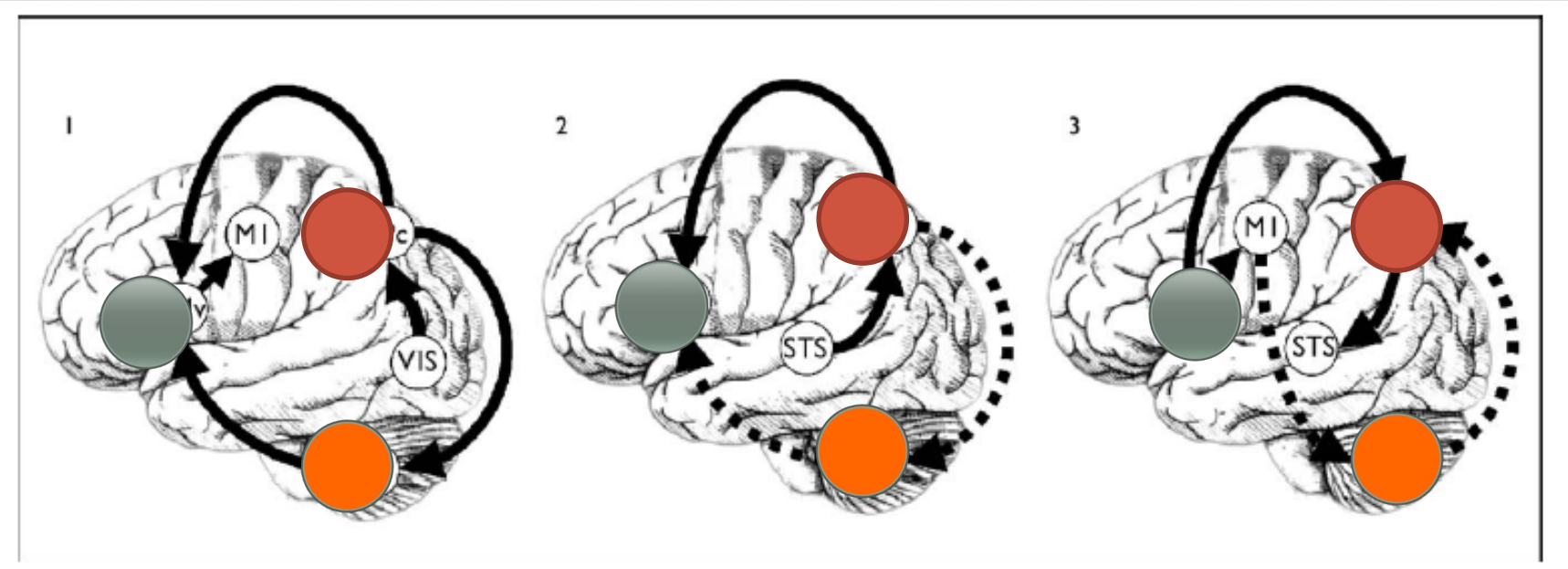
Sensory closed Loop
⇨ AFTER execution

Internal Loop
⇨ BEFORE execution



Functional equivalence between producing, imagining and observing

Action production Action observation Action simulation



➡ The predictive brain

L'équivalence fonctionnelle entre produire, simuler et observer une action.

Pour Jeannerod (2001),

« la représentation de l'action est sollicitée dès que le sujet perçoit, simule ou envisage de produire une action. A ce niveau l'action n'est donc pas exécutée en tant que telle mais ***son but, ses mécanismes et les conséquences*** pour le sujet et l'environnement ***sont simulées*** ».

Ces représentations d'action auraient pour but de **préparer le système à l'action** et également de le renseigner sur la **faisabilité** d'action potentielles

Théorie de la simulation motrice intériorisée

(embodied cognition/théorie incarnée)

Vygotsky

- Acquisition of cognition = intentional activity that is socially oriented
- Two phases:

(1) child and the world;

(2) within the virtual world of the child (theory of mind)

- Elementary cognitive functions transform and become complex through the interaction with the social world (theory of mind order 1 & 2)

Figure 1

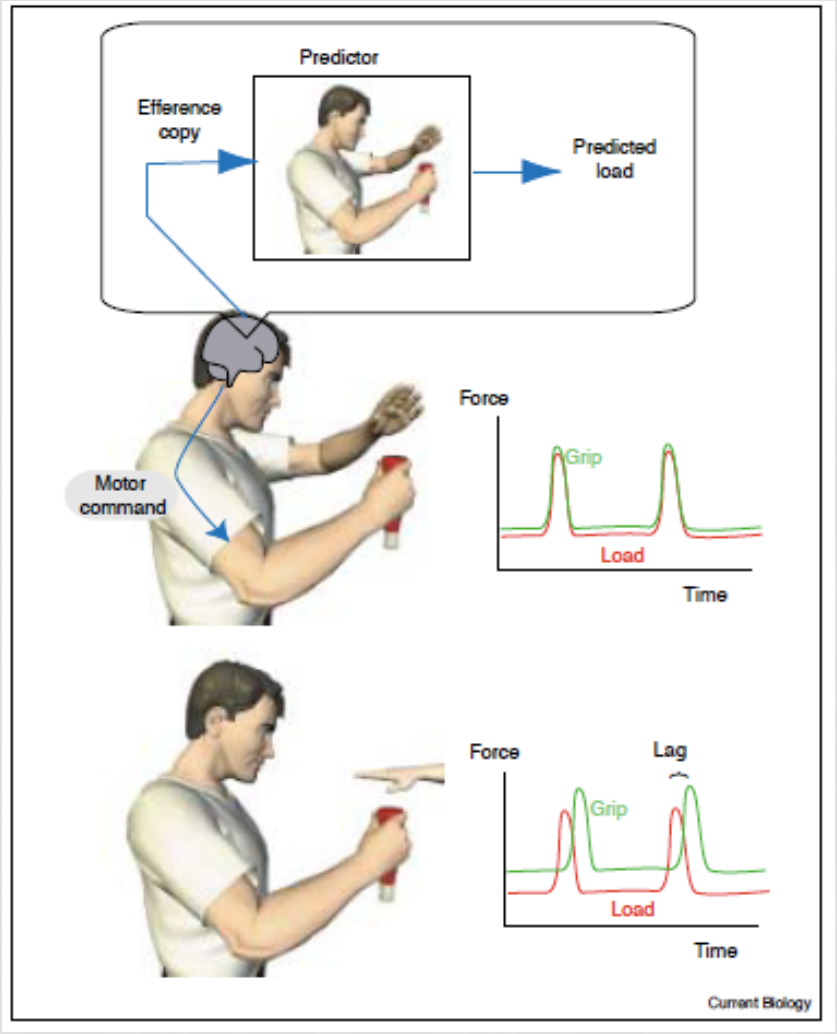


Figure 3

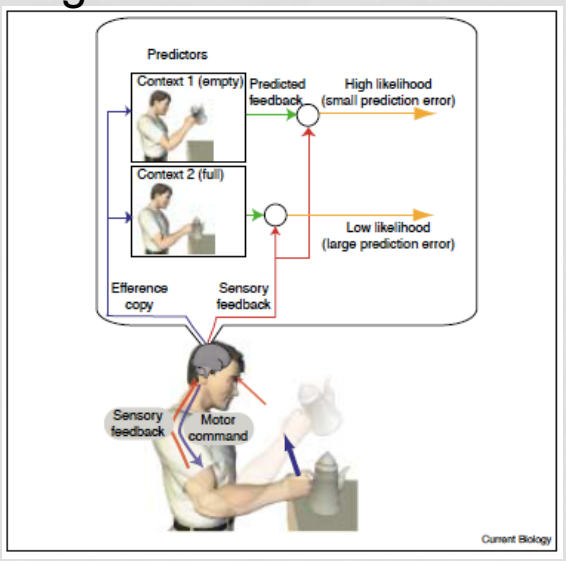
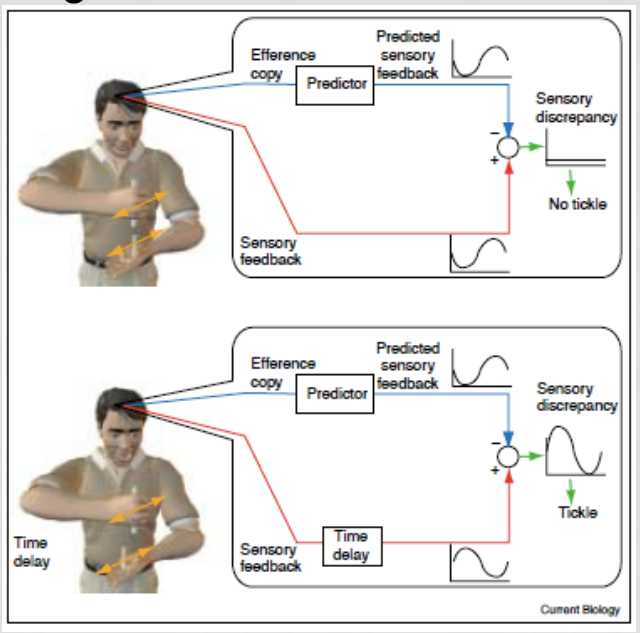


Figure 2



La cinématique du mouvement pour comprendre les intentions et les états affectifs internes d'une personne

Delevoye-Turrell Y., Wamain Y., & Lewkowicz D.
Université Lille Nord de France

Comment coder un système humanoid pour optimiser les interactions motrices et sociales?

Fluidité ?

Adaptabilité?

Hypothèse théorique

Les paramètres cinématiques des marqueurs de:

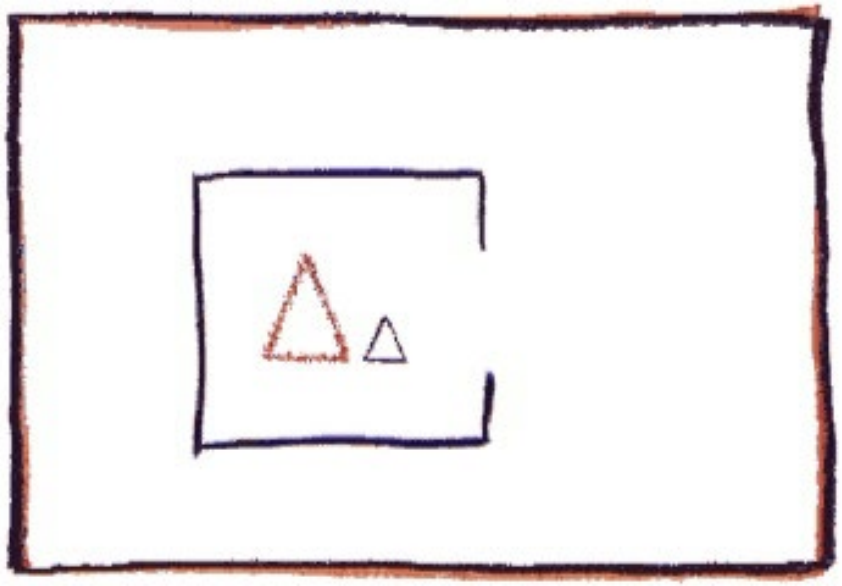
Intention

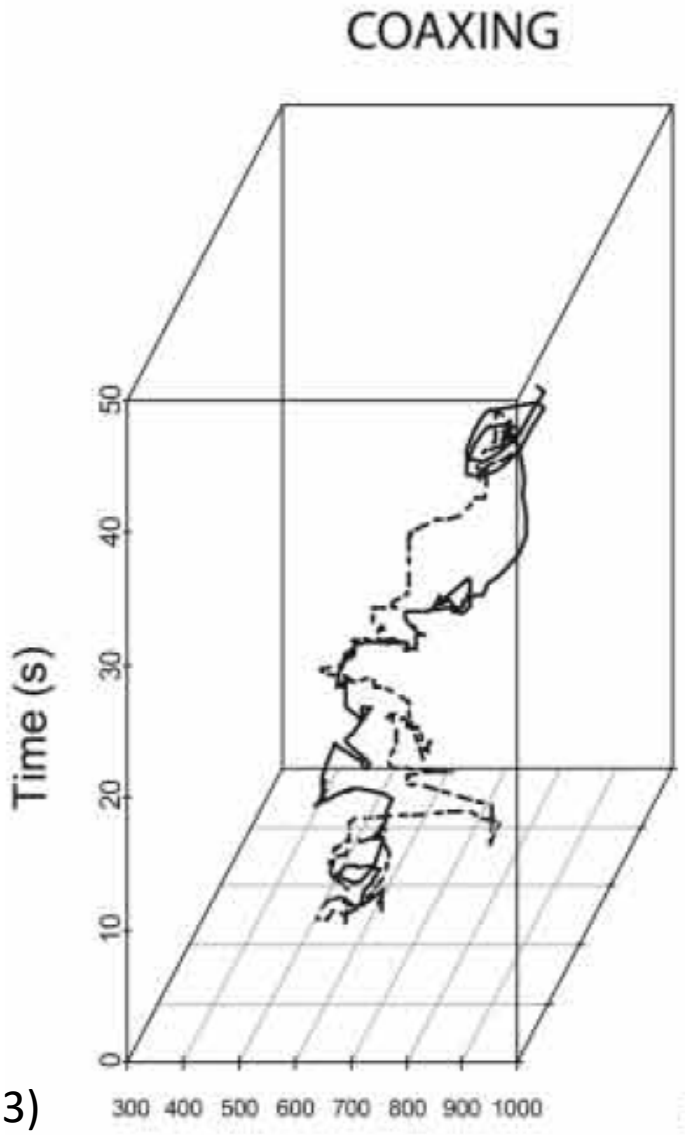
Emotion

Motivation

Introduction

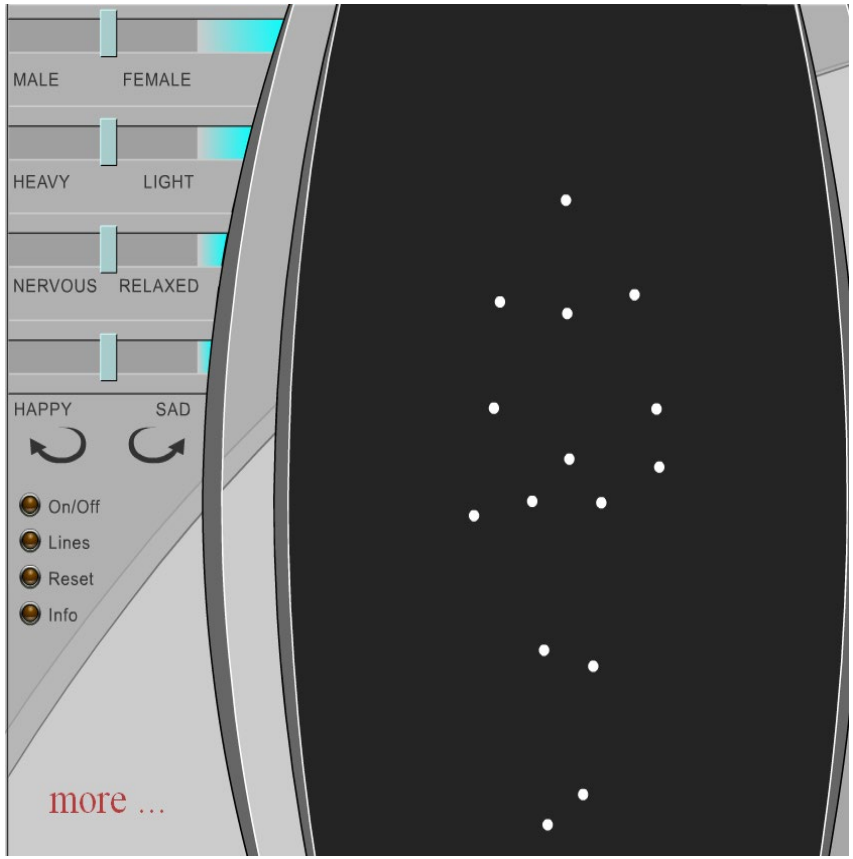
Frith-Happé animation

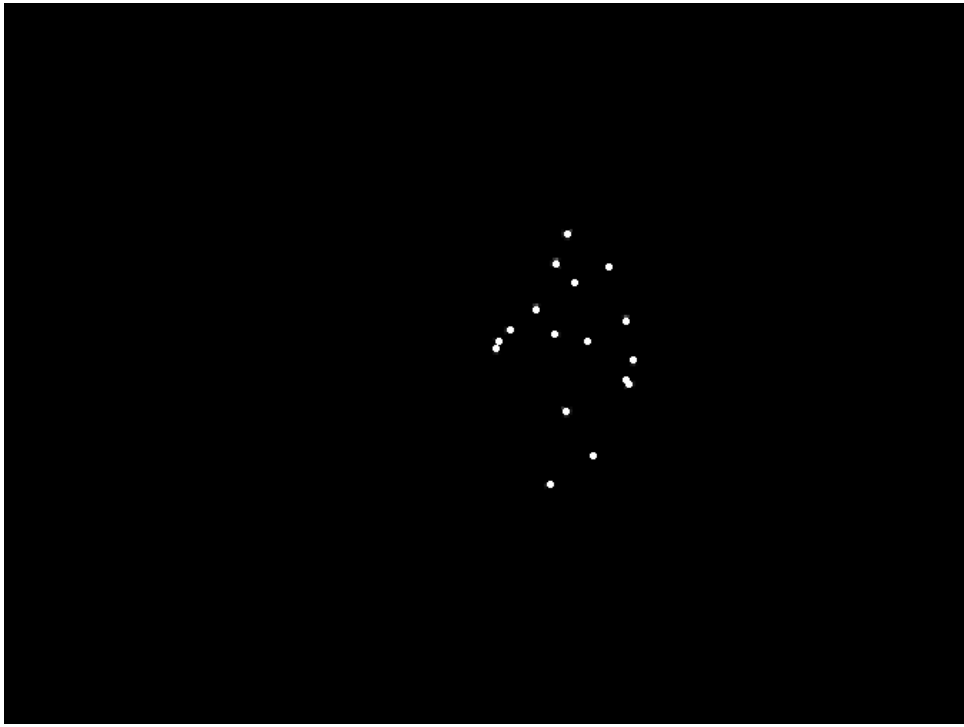




Roux et al. (2013)

Perception of point-light displays





(Johansson, 1973, 1976; Barclay, Cutting, & Kozlowski, 1978; Blakemore & Decety, 2001; Dittrich, Troscianko, Lea, & Morgan, 1996; Mather & Murdoch, 1994; Pollick, Paterson, Bruderlin, & Sanford, 2001; Runeson, 1994; Troje, 2002a, 2002b).

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SCIENCES COGNITIVES ET SCIENCES AFFECTIVES

Partie 1:
Reading intention from motion kinematics

Introduction

3 differents dyads: “ll”, “le” or “ln”

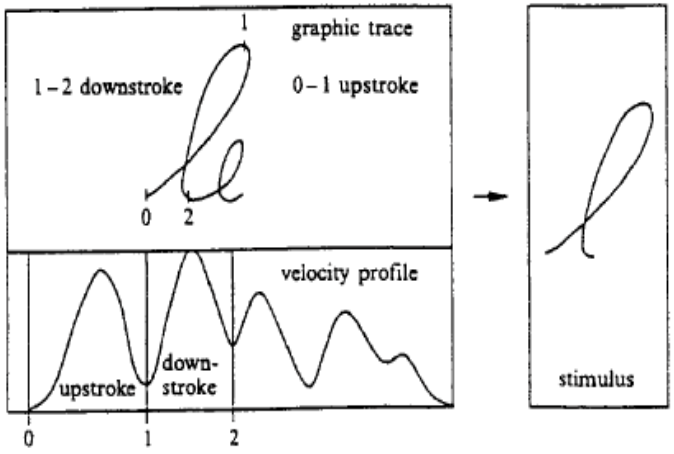
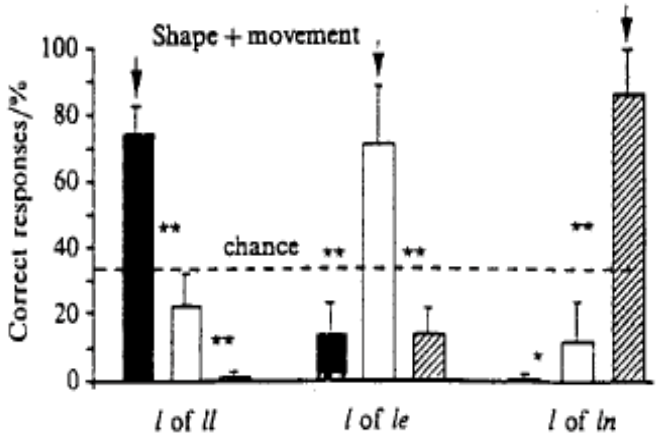


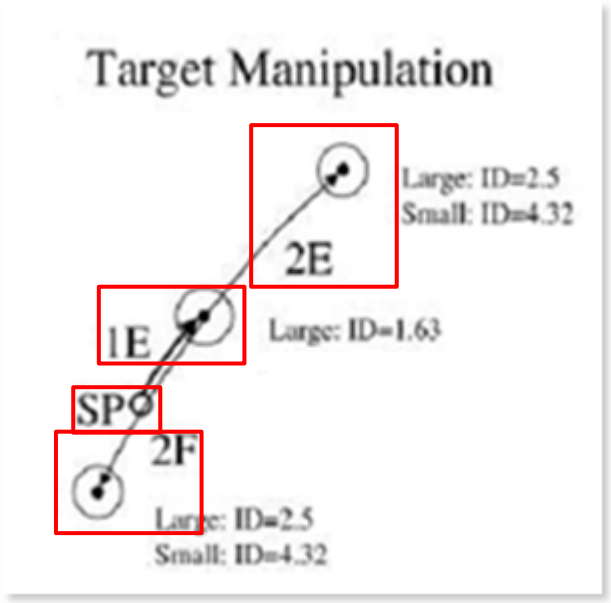
Figure 1. Display of the graphic trace and velocity profile.



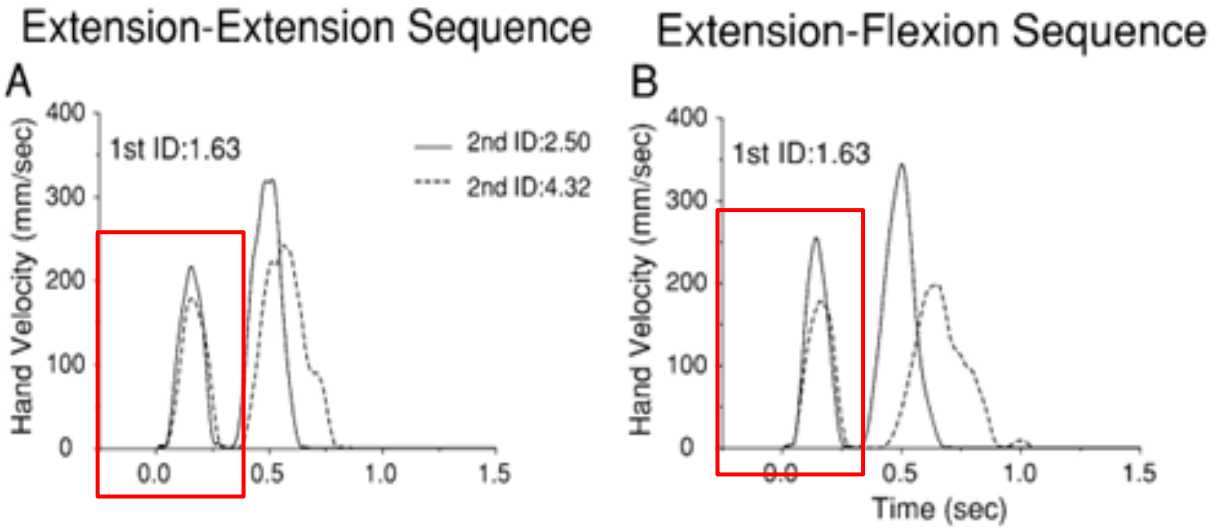
Downstroke movement time of the first *l* differs as a function of the second letter identity

Boe et al., (1991); Orliaguet et al. (2000)

Introduction



Results



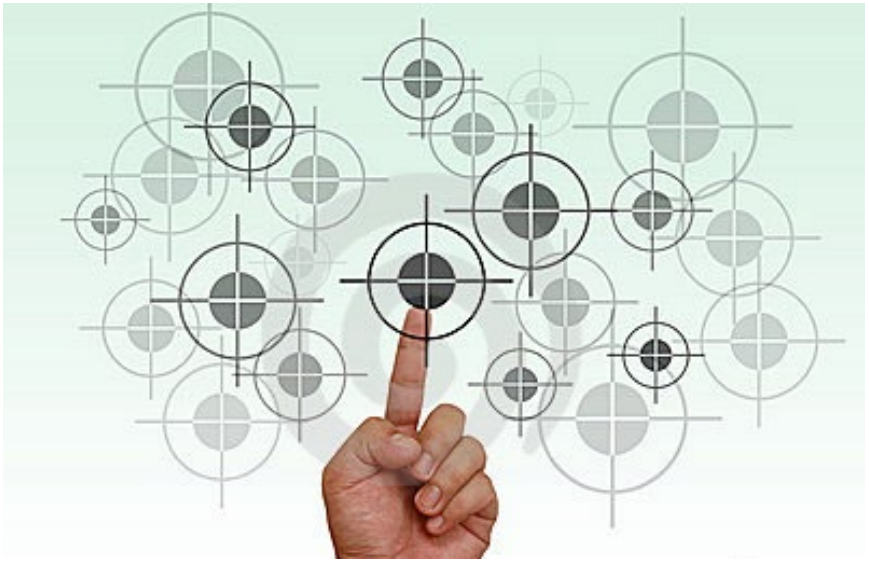
Conclusions:

There is an effect of the 2nd target size on the first motor element. The two movements are not independant, they are inter-dependant.

Rand et al. (1997)

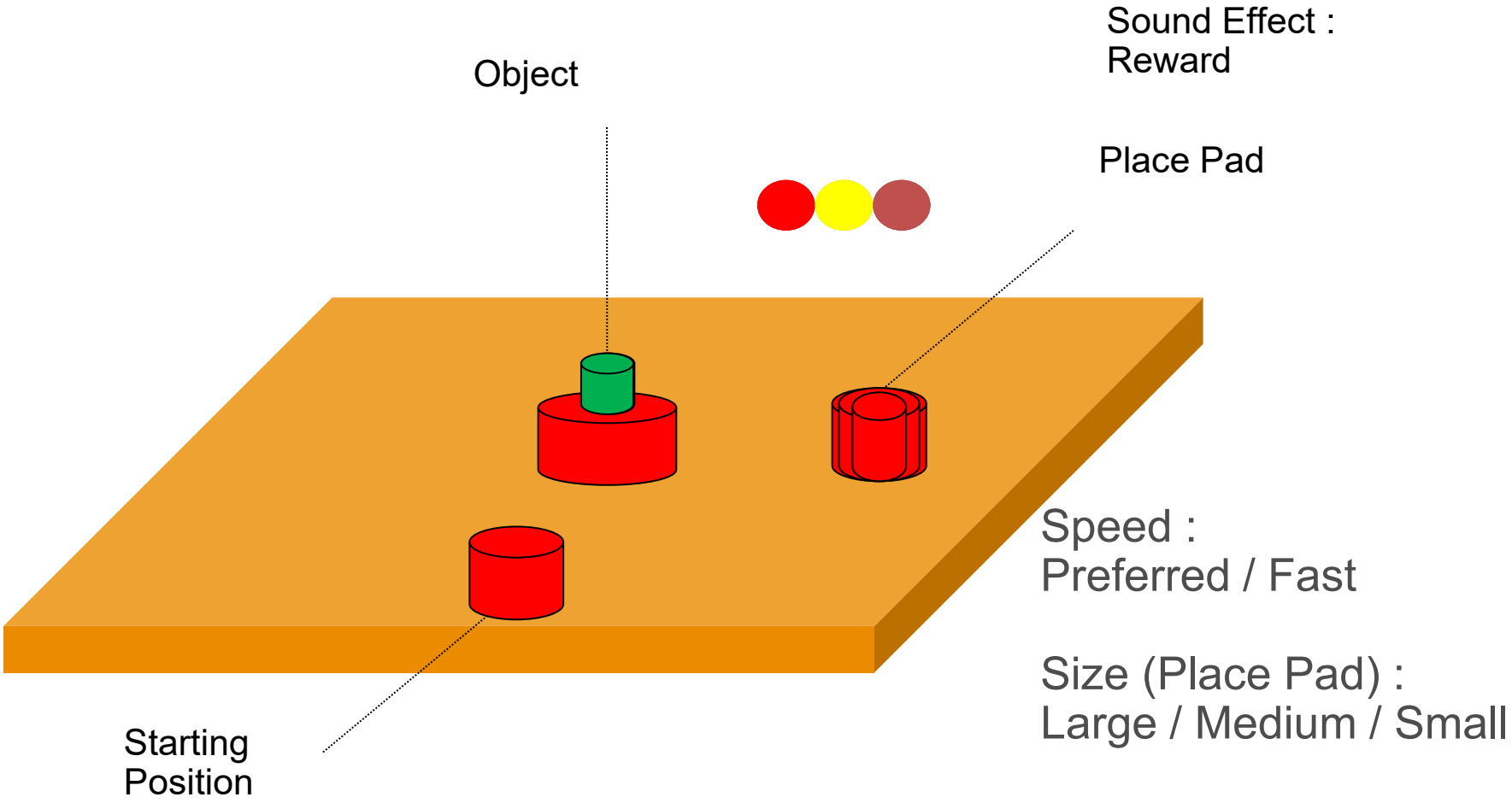
Introduction

From pointing to object manipulation



How does the brain compute the sub-elements of a sequence to ensure a correct achievement of the task ?

Procedure for Real-Time



Lewkowicz, D., Delevoye-Turrell, Y. N (*in revision*). Coupled planning of sequential actions under speed and accuracy constraints. *Journal of Experimental Psychology : General*.

Real-Time 3D Motion Capture

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- QUALYSIS cameras, frequency : 200Hz, latency : 3ms
- MATLAB Interface, analyzing and computing in real-time
- Audio and Video Feedback for participants
- No Verbal instructions between trials

Lewkowicz, D., Delevoye-Turrell, Y. N (*in revision*). Coupled planning of sequential actions under speed and accuracy constraints. *Journal of Experimental Psychology : General*.

Real-Time 3D Motion Capture

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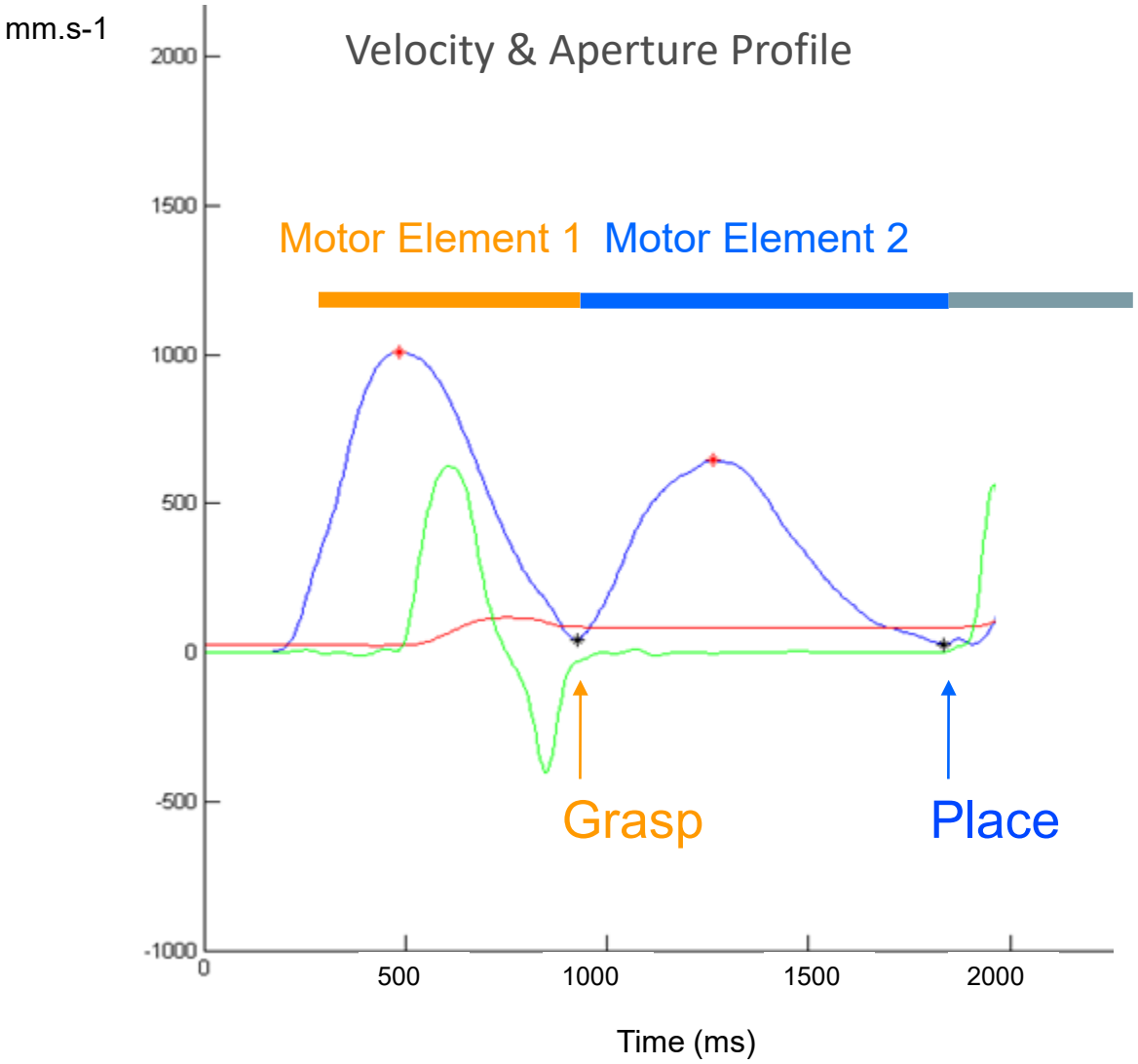
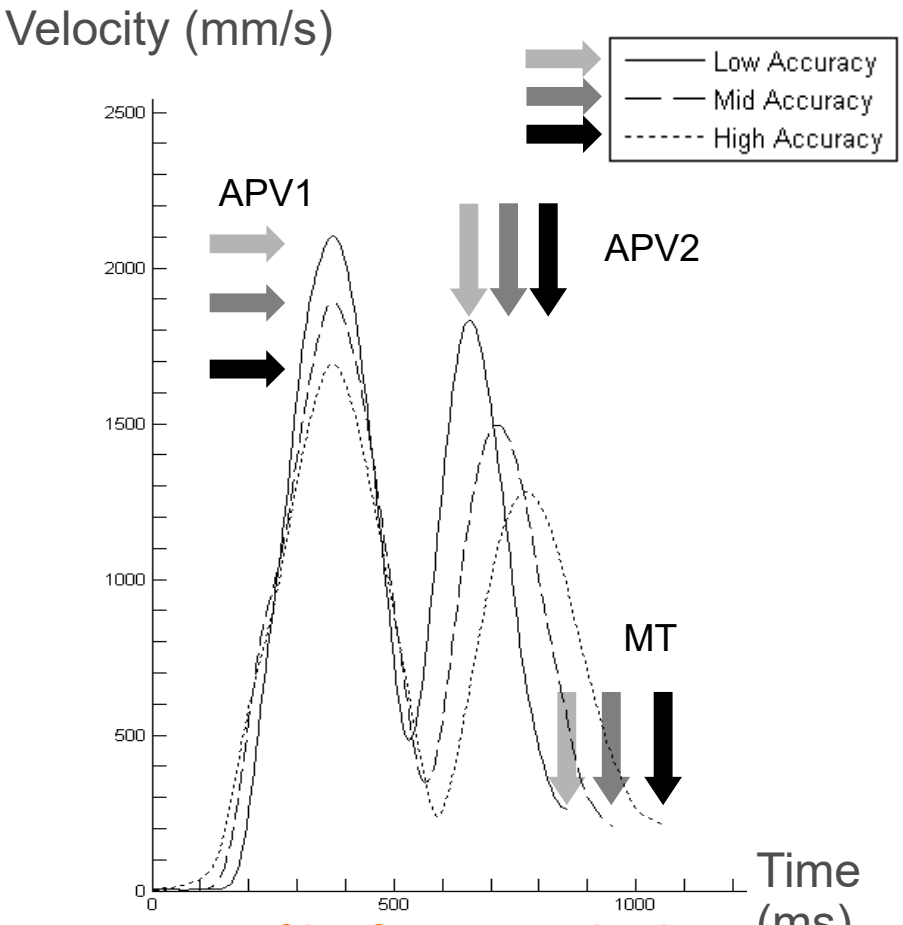


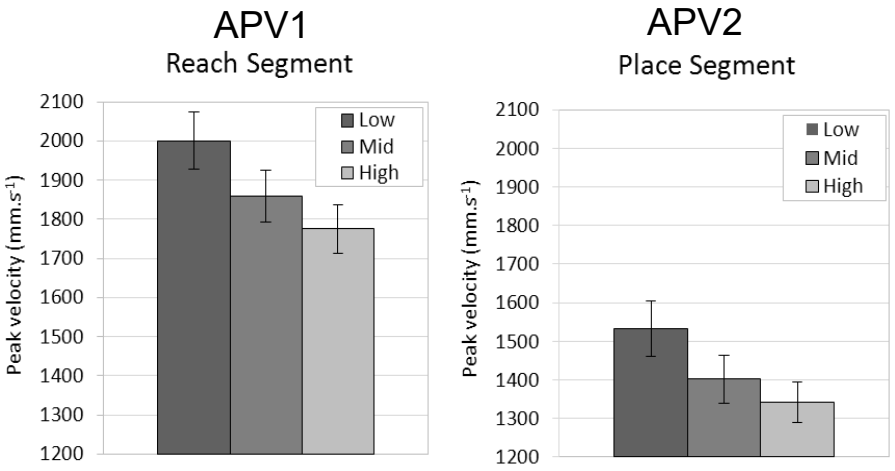
RTMoCap

Matlab toolbox to analyze motor kinematics in real time

Results



Average profiles for a typical subject



Group means (N=28)

Conclusions:
Kinematic profiles of the first sub-element are affected by the terminal accuracy constraints.

Lewkowicz, D., Delevoye-Turrell, Y. N (*in revision*). Coupled planning of sequential actions under speed and accuracy constraints. *Journal of Experimental Psychology : General*.

Results

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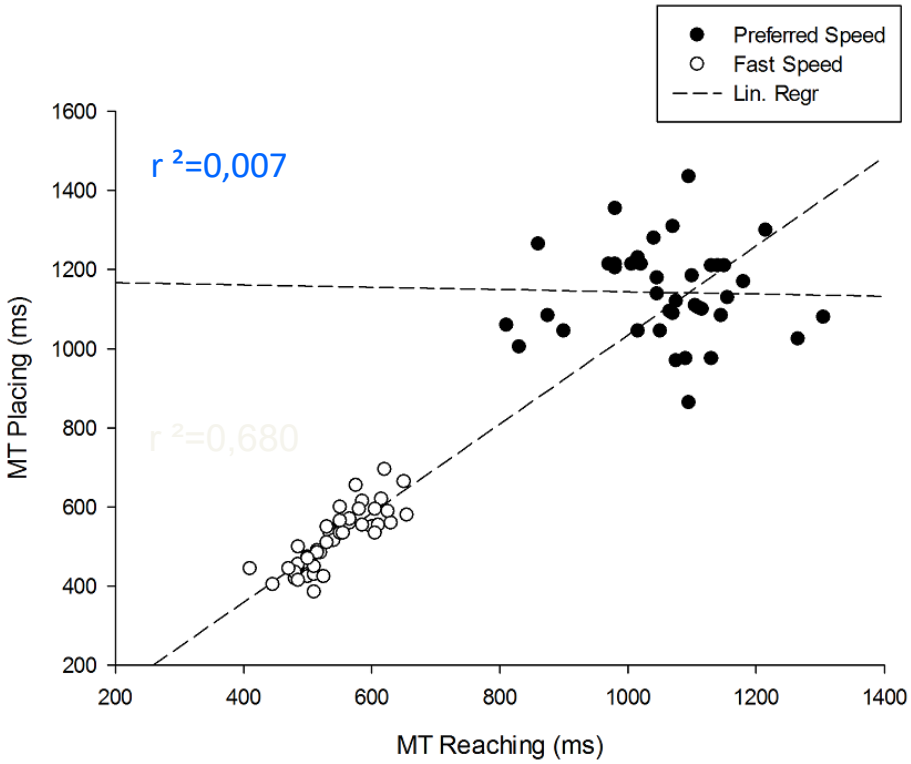
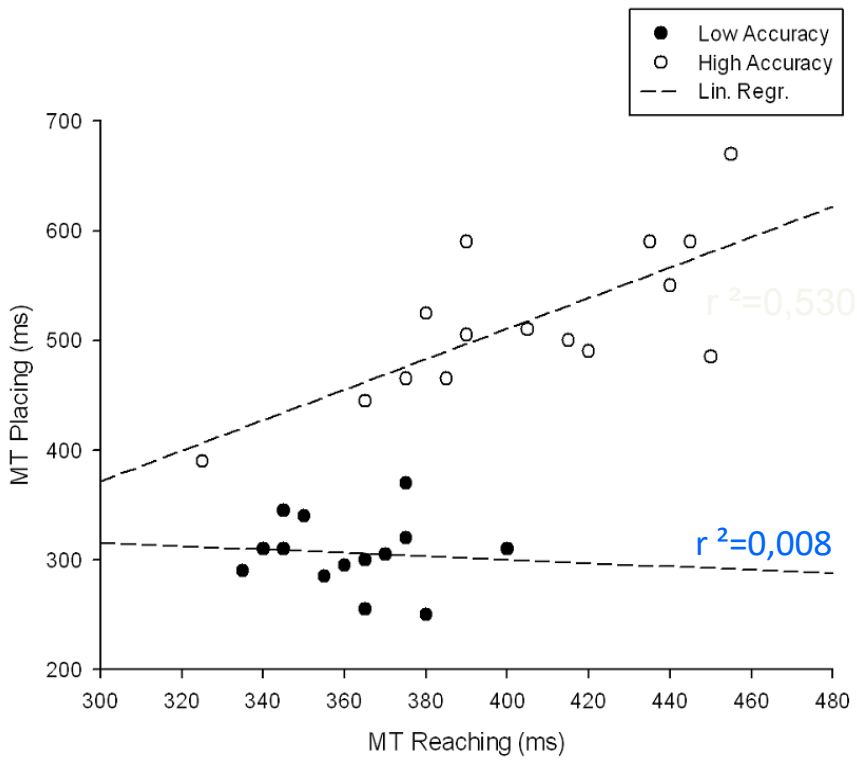
Speed constraints



Accuracy constraints

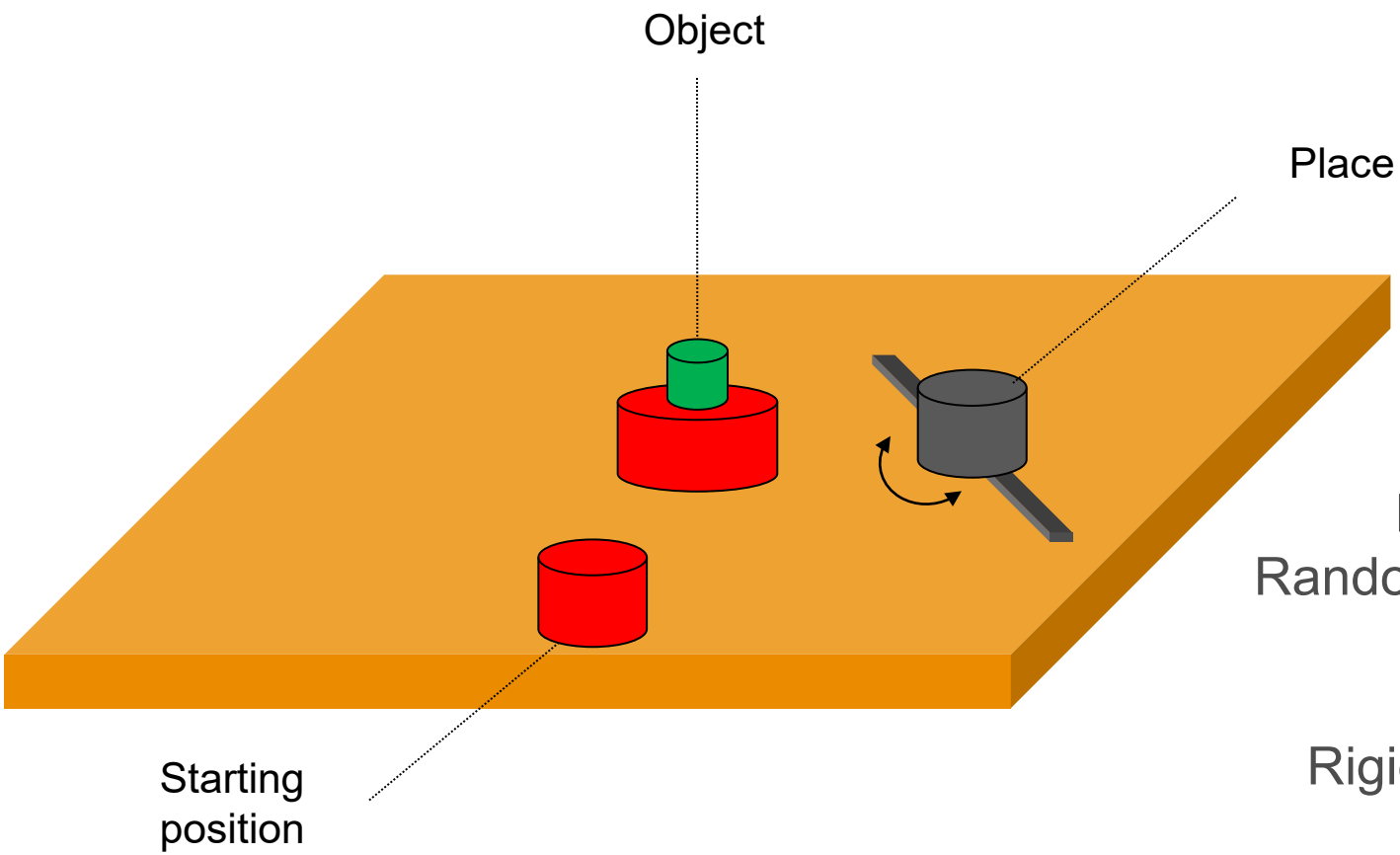


Correlation analysis for a typical subject

Conclusions :

When the constraints are important, the coupling increases between the different sub-elements of the sequences.

Predictability and Stability



Rotation :
Random / Predictable

Texture :
Rigid / Compliant

Lewkowicz, D., Delevoye-Turrell, Y. N (in prep). Effect of terminal stability and predictability on sequential pick and place action.

Results Stability

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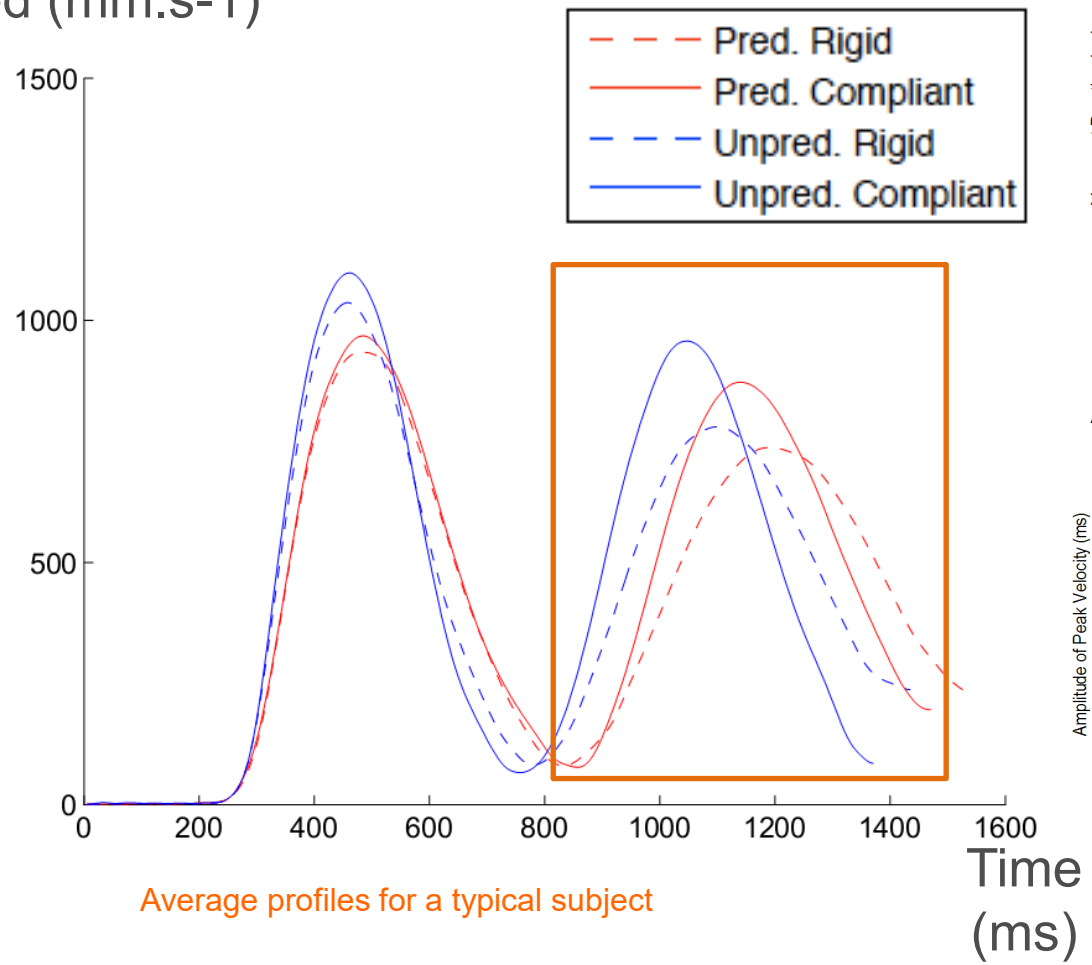
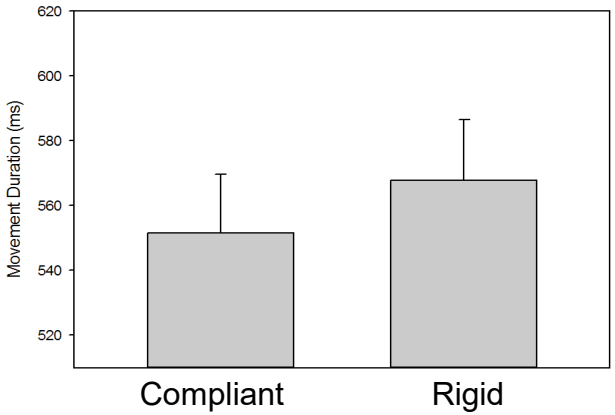
Speed (mm.s-1)

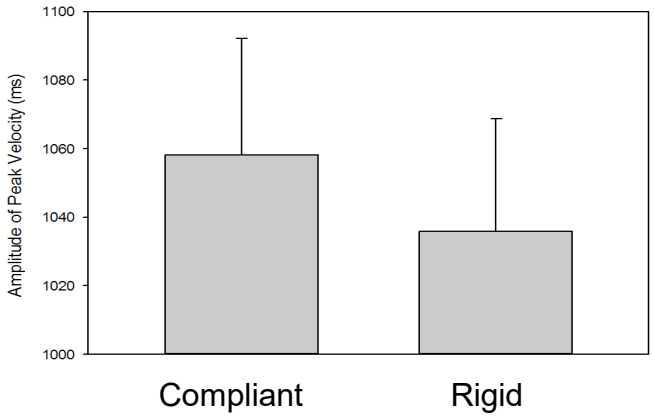


Average profiles for a typical subject

Movement duration (MT2)



Amplitude of Peak Velocity (APV2)



Group means N=21

Results Predictability

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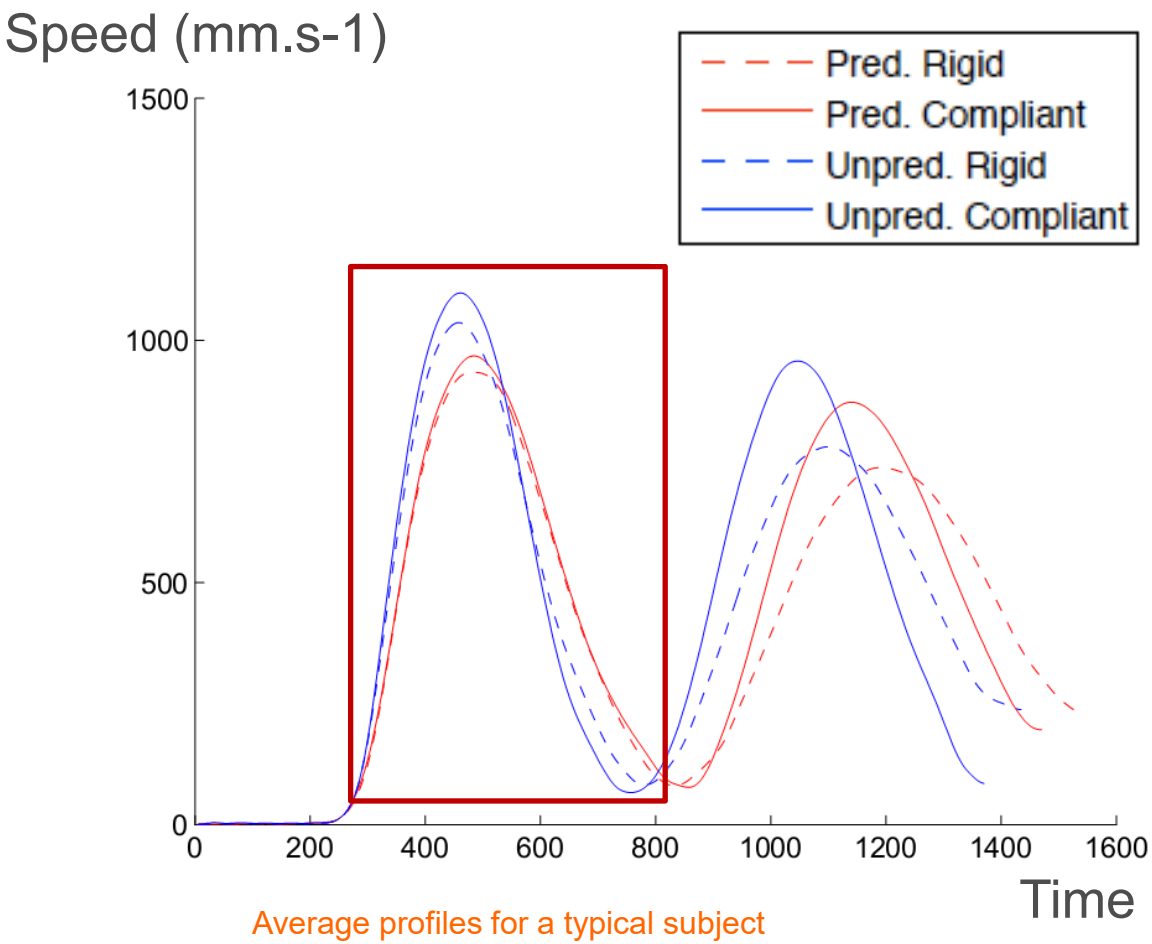
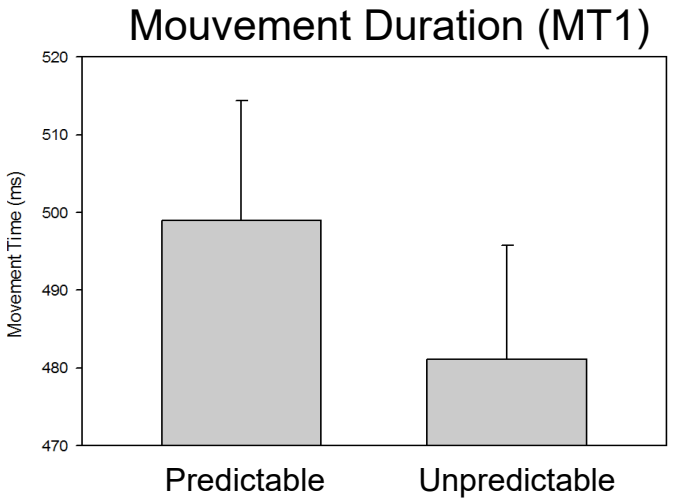
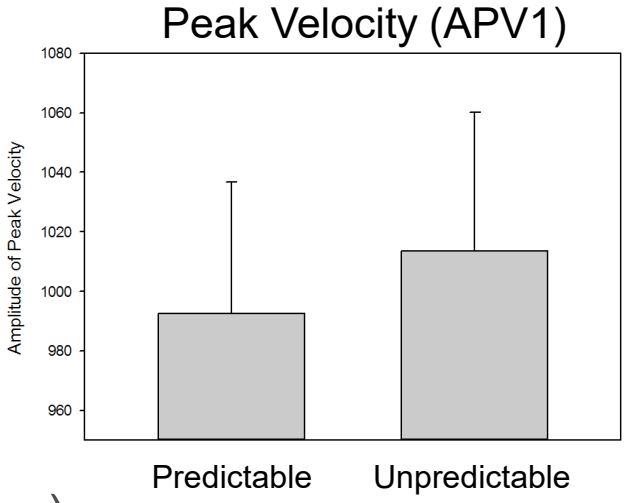


Average profiles for a typical subject





Group means N=21

Conclusions

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1) The accuracy constraints are back-propagated to the 1st motor element of a sequence. This suggests « coupled planning ».

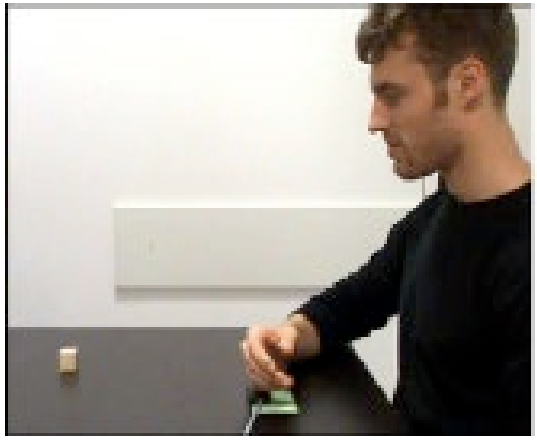
2) The effects are observed even if the nature of the second motor element is maintained the same. We confirmed that the Fitt's law is extended to sequential grasping.

3) At preferred speed, we revealed both local effects (stability) and global effects (predictibility) on motor kinematics.

- ***local effects*** are related to the physical constraints
- ***global effects*** reveal the use an internal representation

But why?

Coupled planning would provide the means for others to read our intentions



Can a person read action intentionality through the observation of the first element of a sequence only?

A social interactive game

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Protocole

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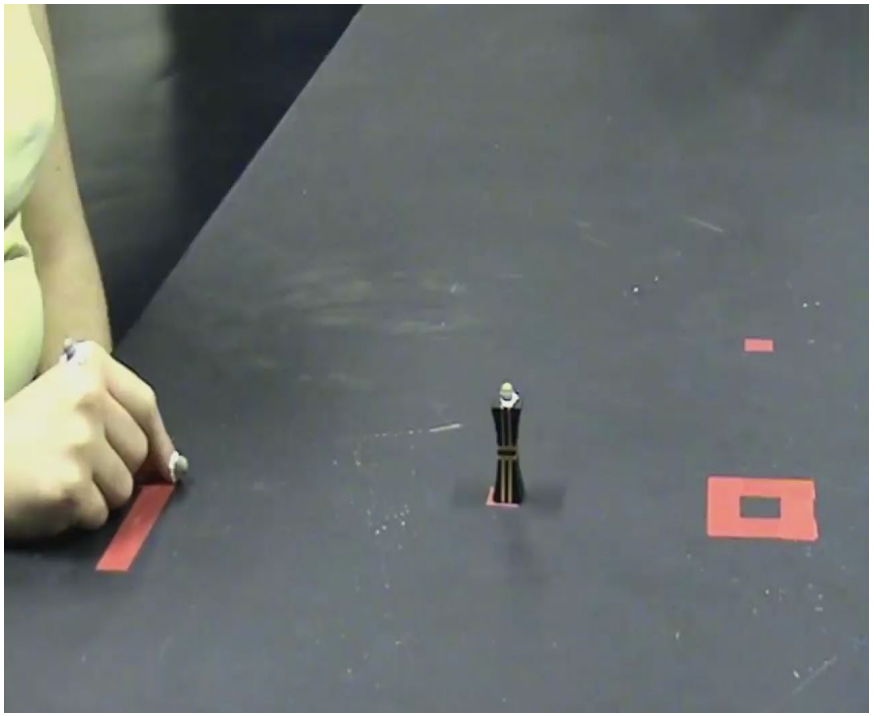
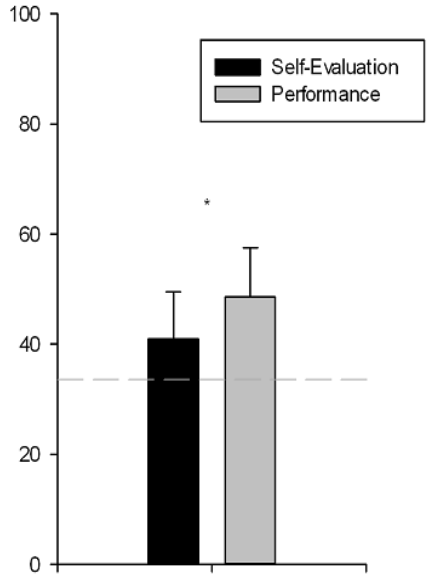
Experimental procedure

- 26 participants viewed 192 trials (48*4 blocks)
- Task: *judge the agent's intention*
- 3 different key presses to select:
  - Initiate the Game (Play)
  - Place in **my** workspace (Me)
  - Place in **your** workspace (You)
- At the end of each block :
  - Self-Evaluation (Analogical Scales)



Results



Conclusions:

Human can read intentions from early movement kinematics.

Under-estimated ability close to chance level.

Protocole

SCA Lab
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- 26 participants viewed 192 trials (48*4 blocks)
- Task: *judge the agent's intention*
- 3 different key presses to select:
  - Initiate the Game (Play)
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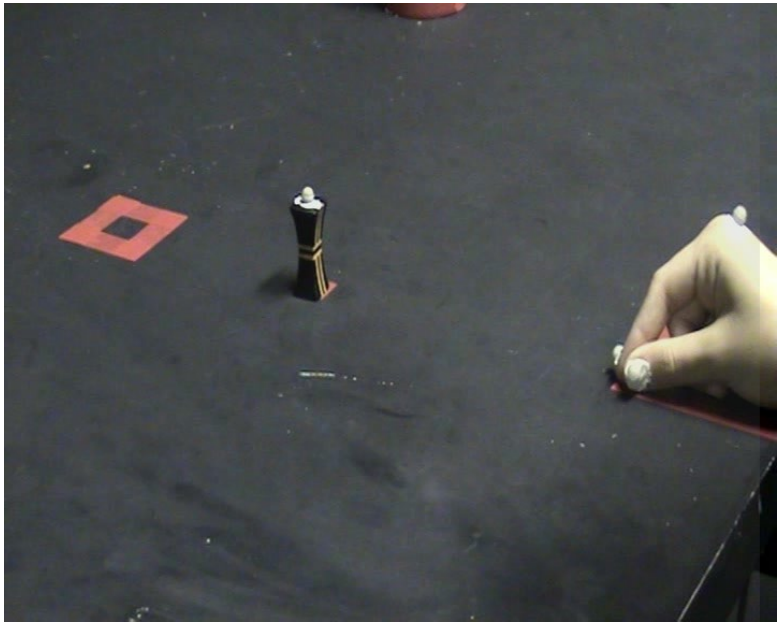
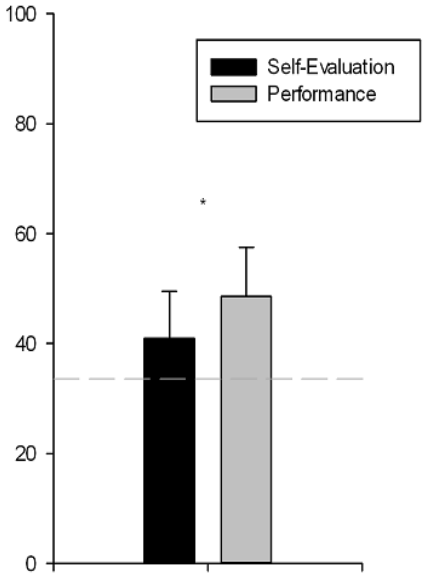
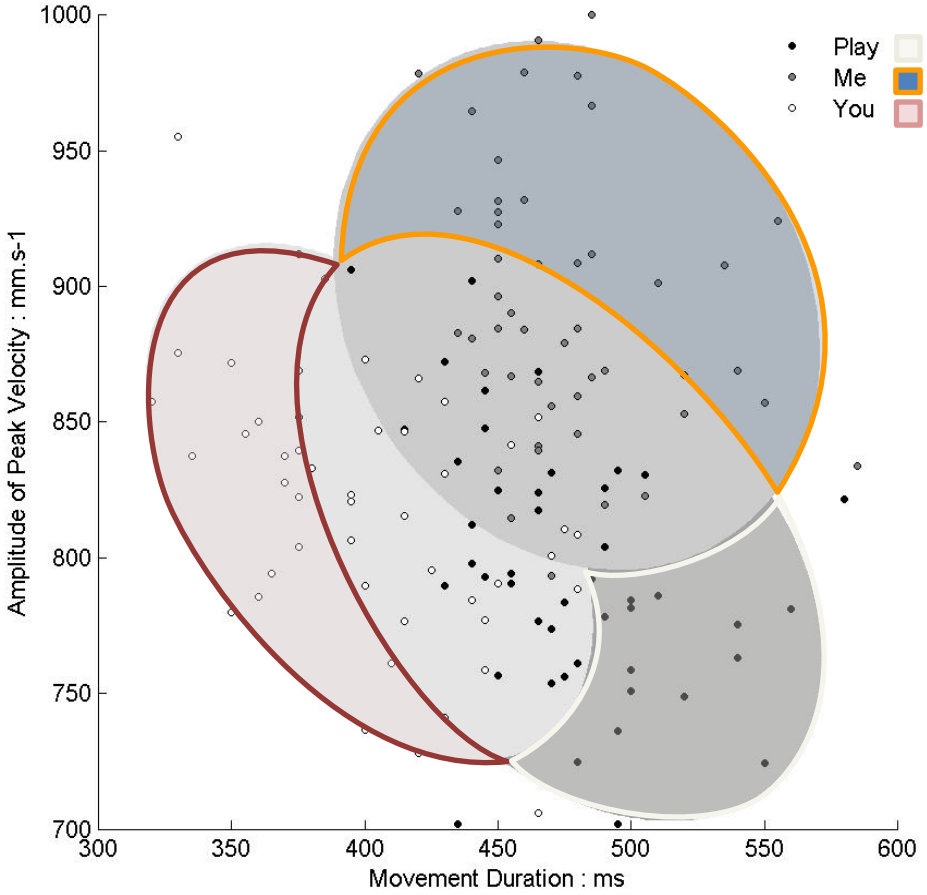


Results

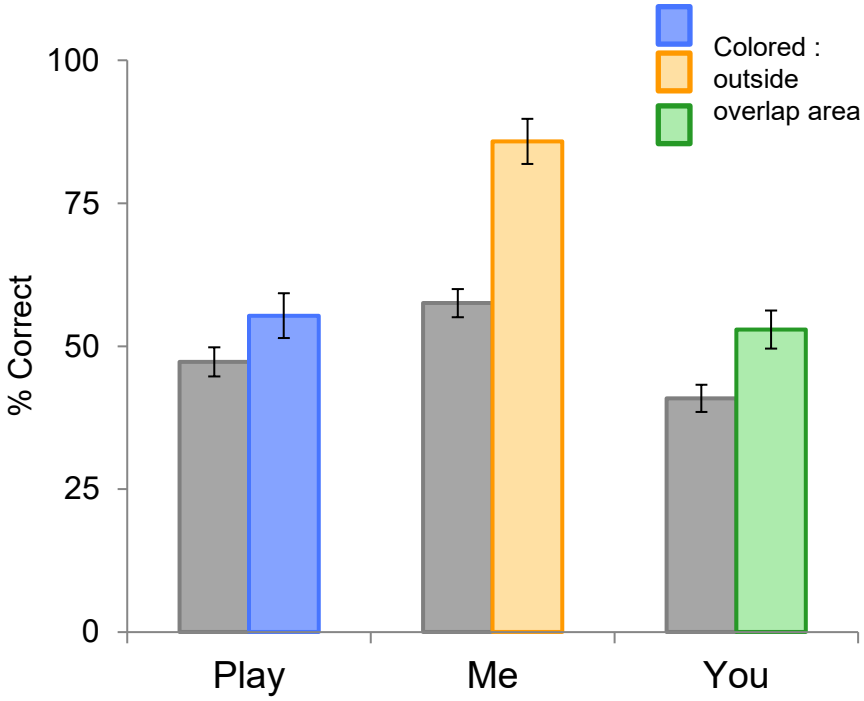


Conclusions:
Human participants can read intentions from early movement kinematics.
Under-estimated ability close to chance level.

Variability is not RANDOMLY DISTRIBUTED !



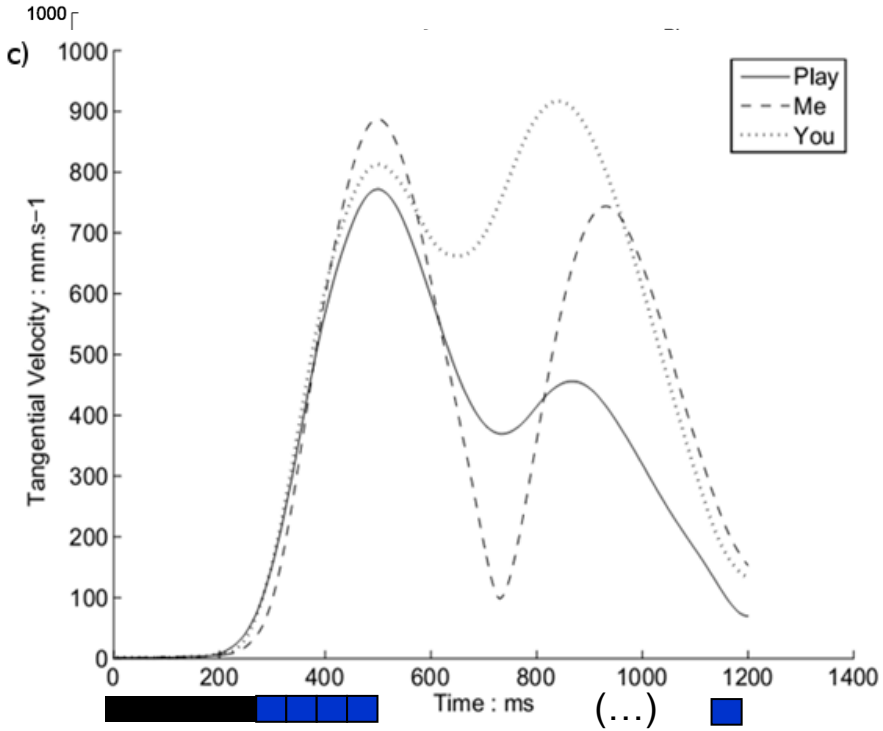
Overlap area : 31,4% No
Overlap : 68,6%



Conclusion :

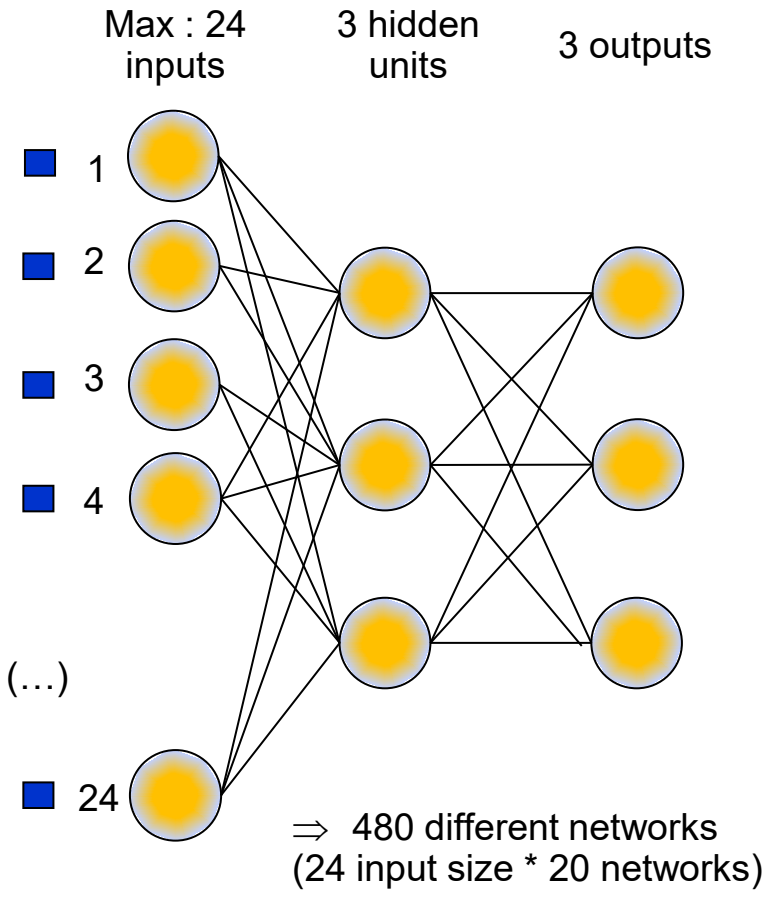
Better classification rates ouside the overlapping area

A complex problem



Quantity of movement information

Database : 192 sequences



Artificial Neural Network Classifier

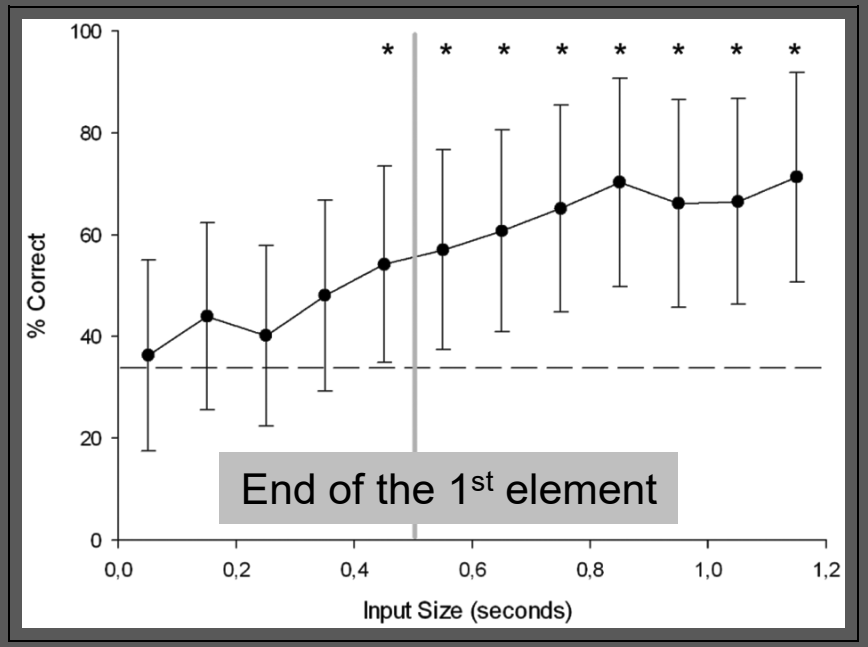
Learning algorithm : backpropagation (FANN, Nissen 2005)

10000 epochs, goal : MSE < 10^{-5}

Robotic applications?

Be inspired by human biological motion
to optimise the control of humanoid architecture and promote intuitive interaction

- Correct classification using a simple classifier ANN with 3 layers
  - Axis horizontal: input size
  - Axis vertical: mean output signals from the 20 tested networks



Conclusions

- Reading intentionality is possible through the observation of action kinematics very early in the sequence.
- A simple neural network classifier reach human performance with only **low-level kinematics** information.
- On overall performance is still far from 100%

=> Eye movement recordings to verify if wrong answers are due to a difference in observation behavior or a problem in the cognitive processing of the percept.

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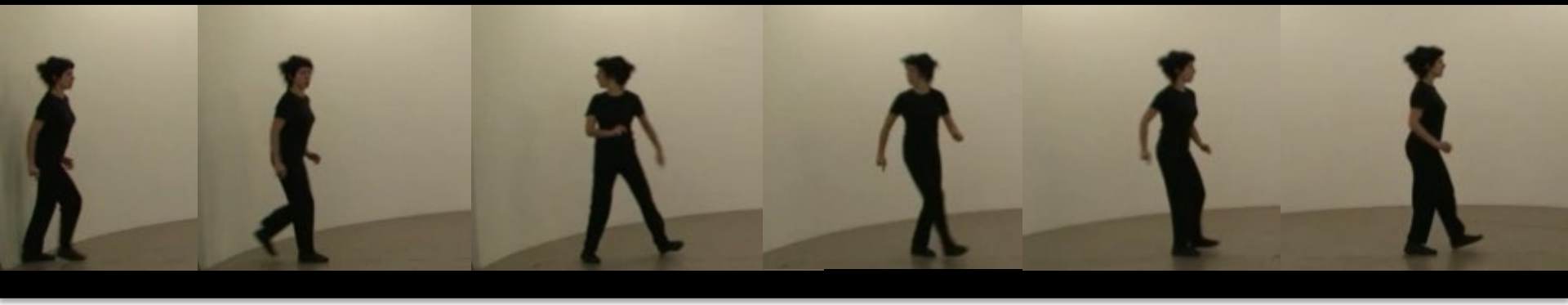
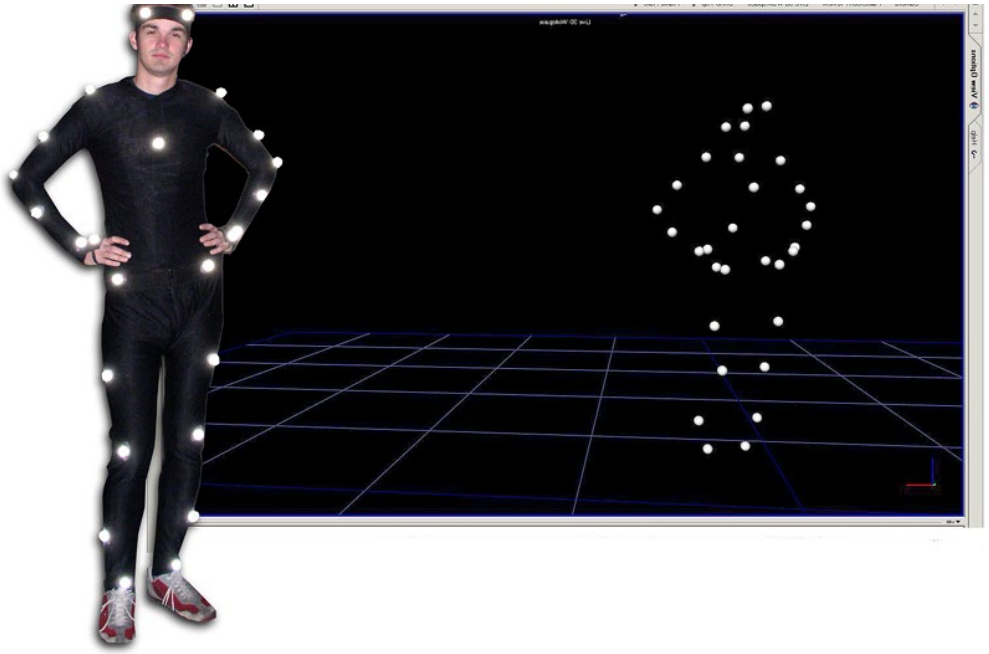
Partie 2:
From intention to empathy…

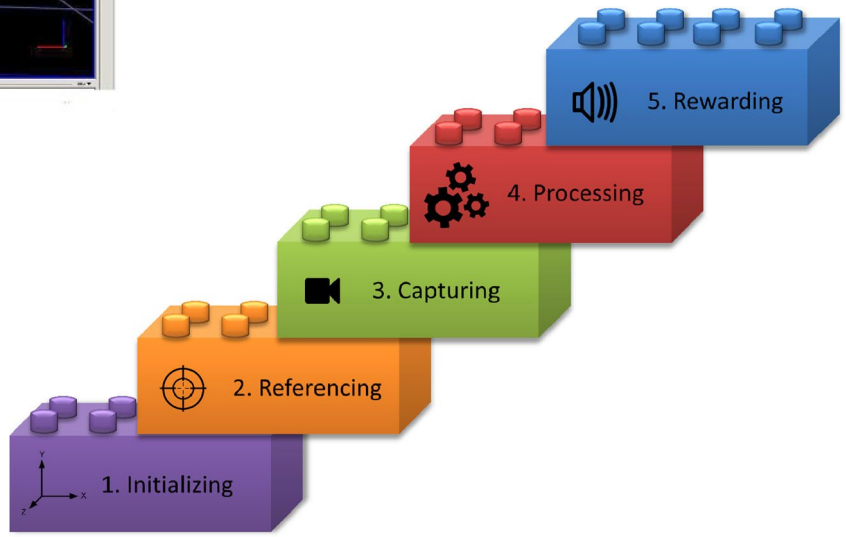


Special thanks to Alain BERTHOZ, Julie GREZES and Halim HICHEUR for data sharing

An interactive MATLab setup



Building blocks for flexible use



Lewkowicz et Delevoye-Turrell (2015) **Matlab toolbox to analyze motor kinematics in real time.** *Behavior research methods*

RT-MoCap

SCA Lab
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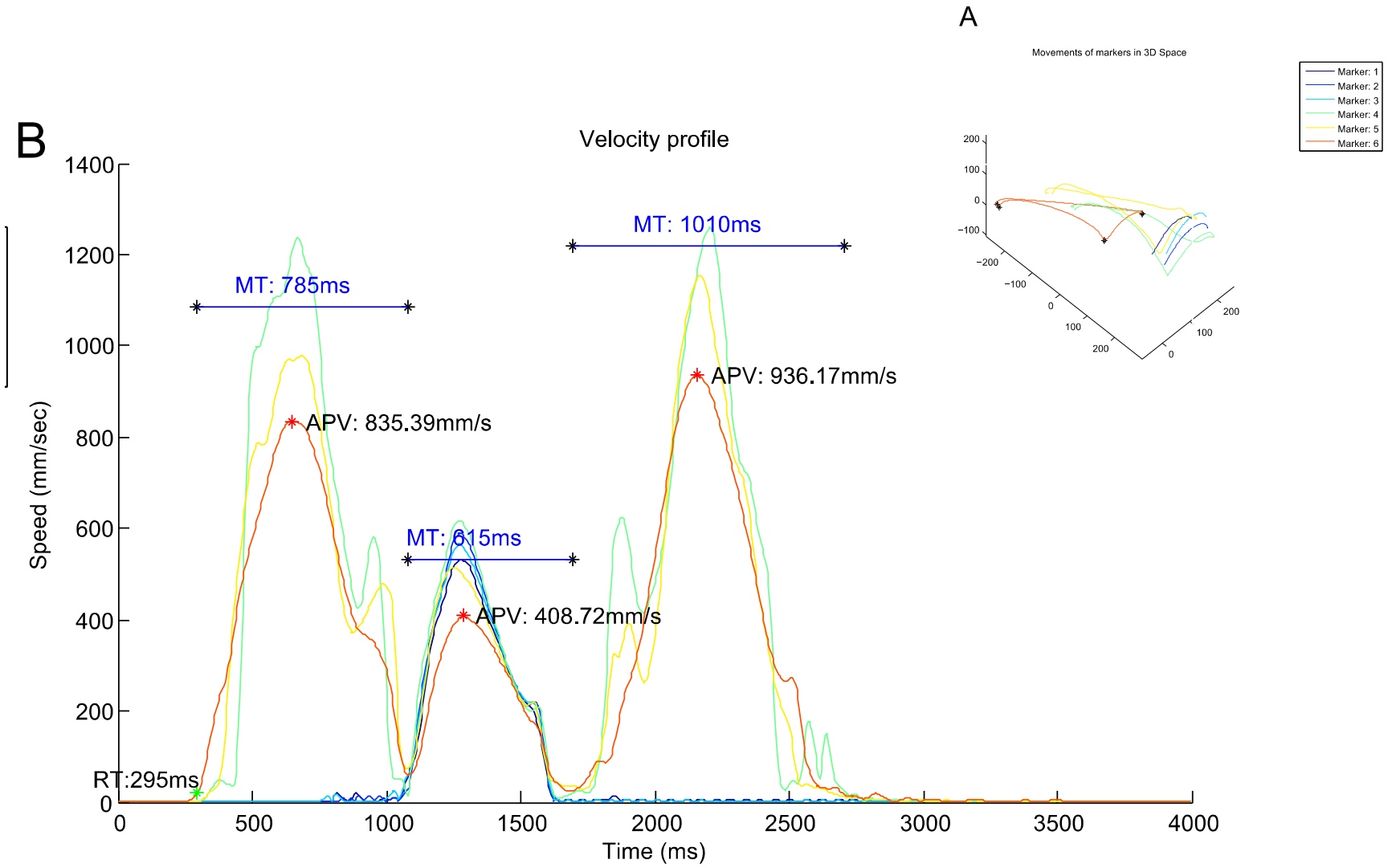

RT-MoCap

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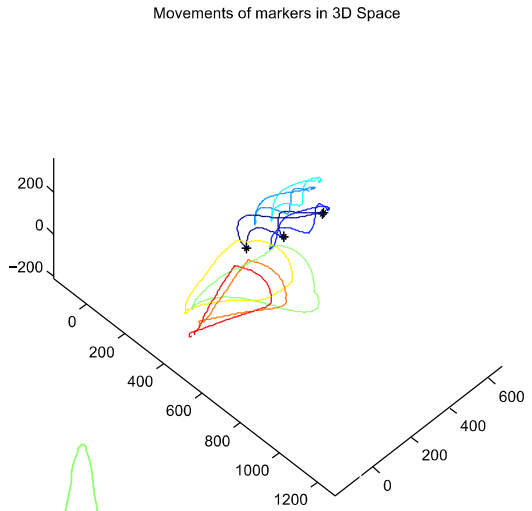
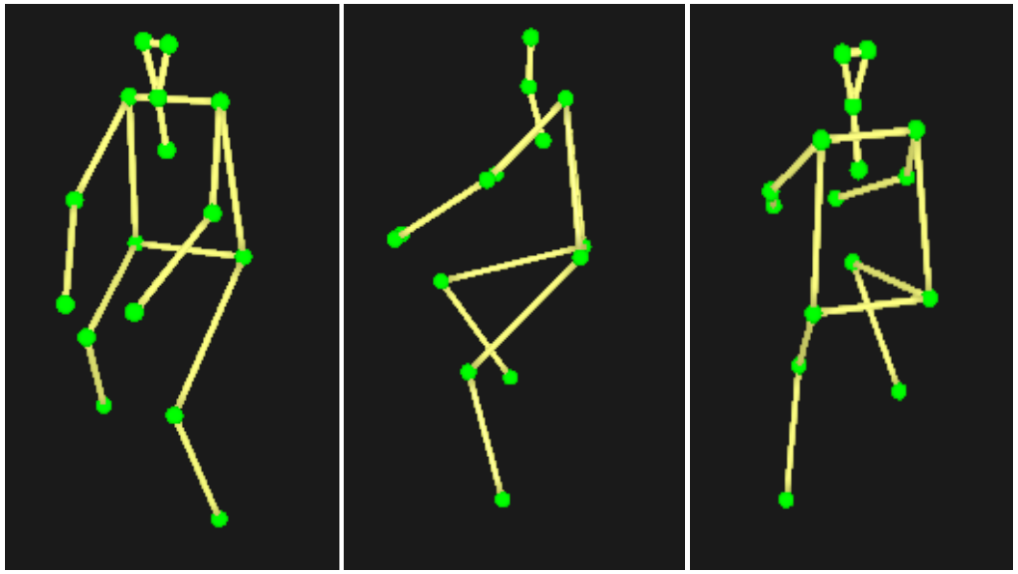
A



B

Emotional spontaneous tempo while cycling

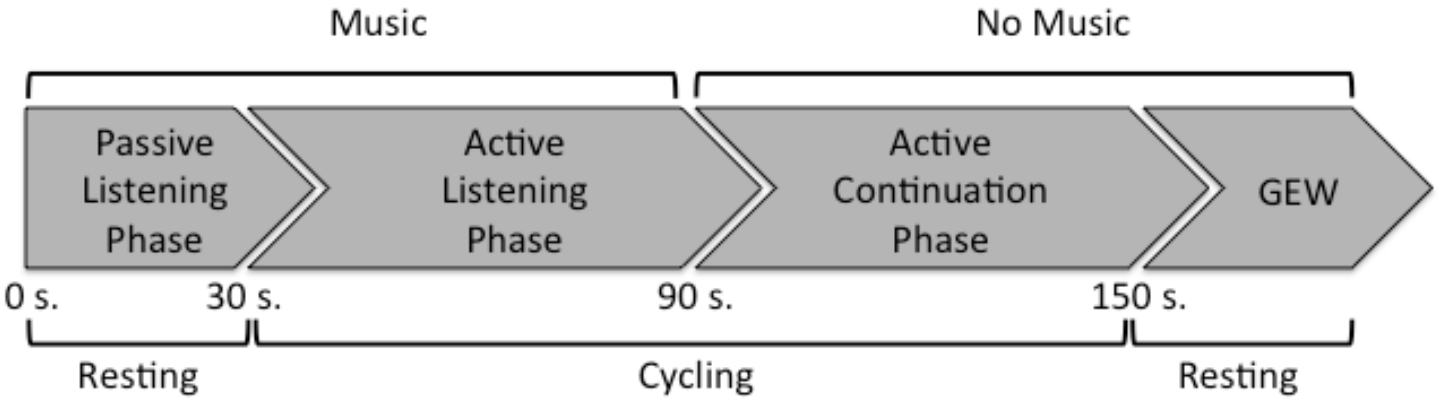
- RT-Mocap control of the musical environment
  - 20 non-experts
- 45 minutes of cycling in various conditions



Wamin & Delevoye-Turrell (2016) **Move your body and I will tell you how you feel: reading emotional states through body kinematics**

Auditory stimuli

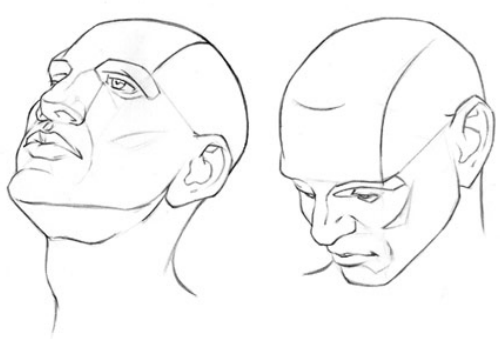
Task: **Listen to the music and then, cycle for 2'**

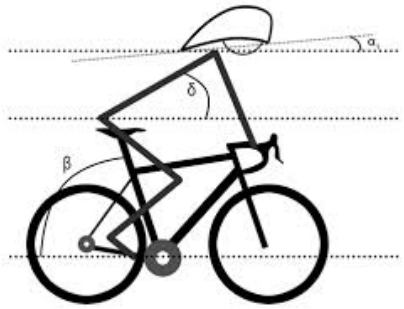


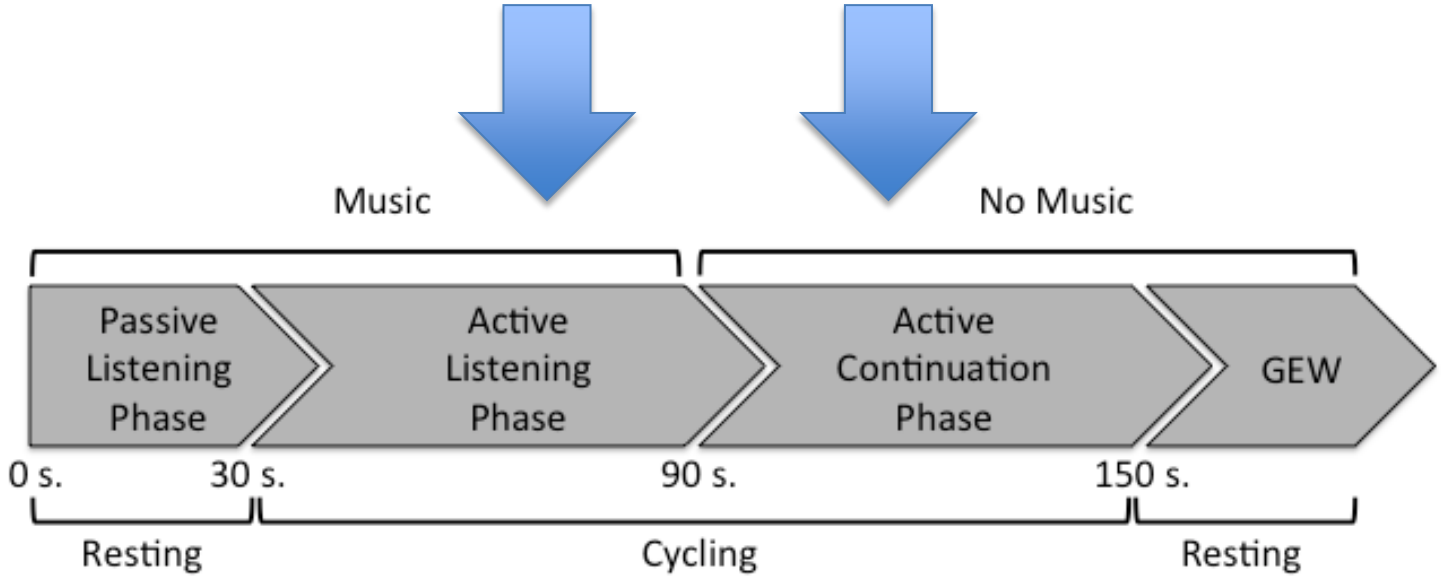
3 Exemplars x 4 emotional states
(Peaceful, Joy, Neutral, Sadness)

Experimental procedure

- Postural variables

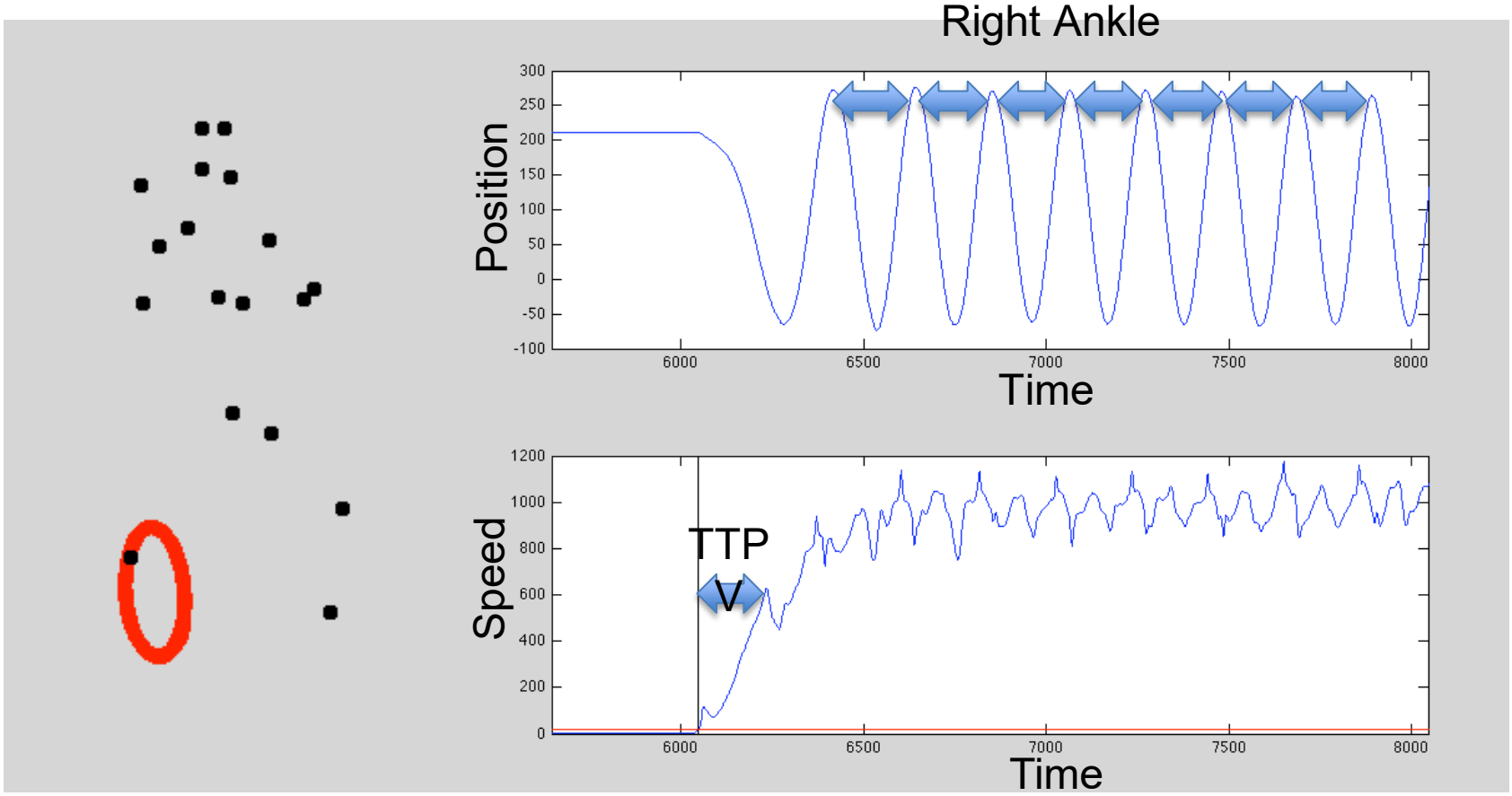




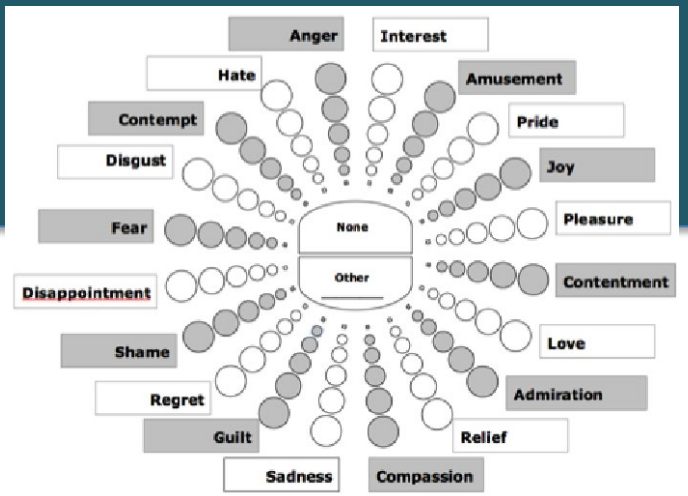


Data analysis

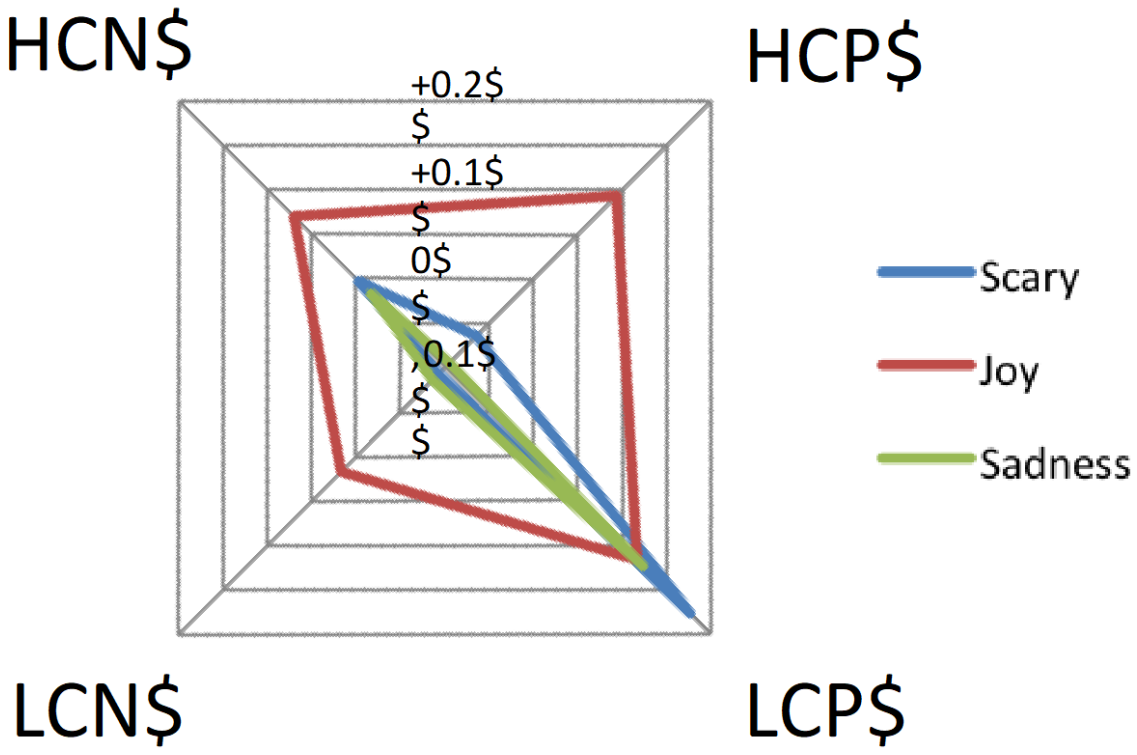
- Kinematic variables



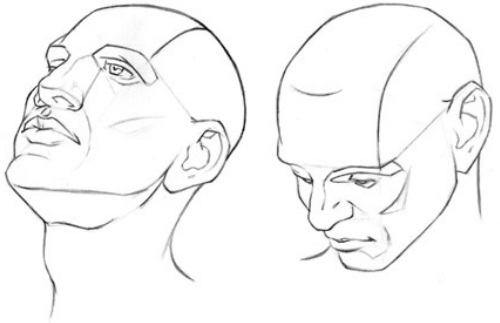
Results



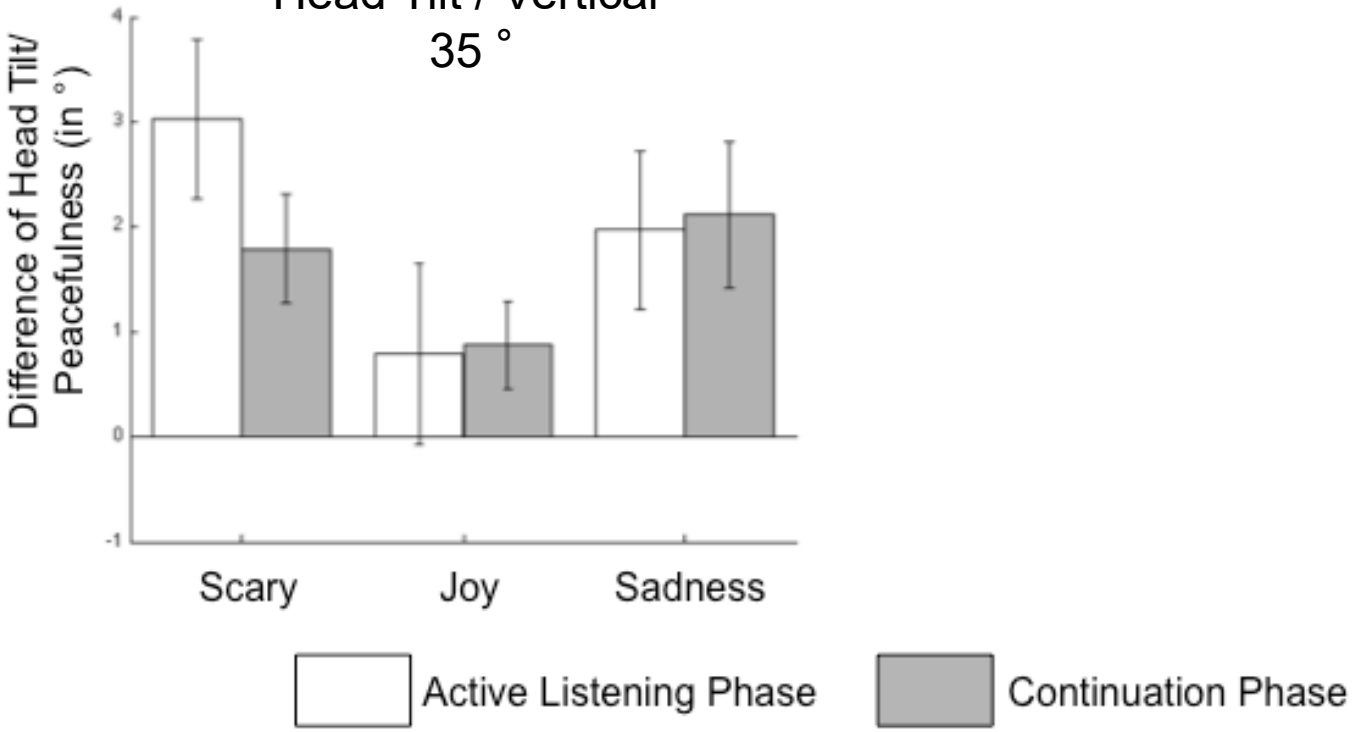
- Differences between the neutral condition
- Scary and Sadness decreased energy
- Joy increased energy but heterogeneous effects across individuals



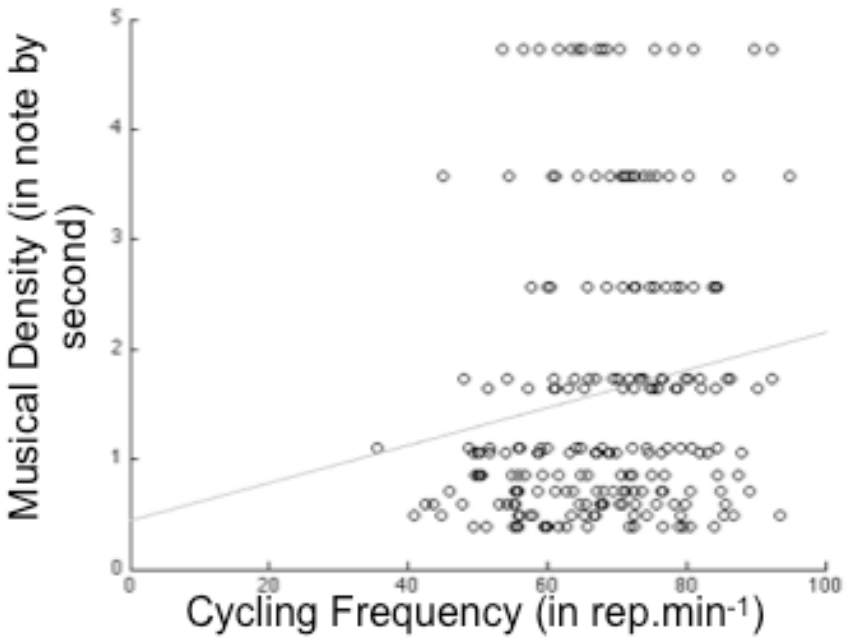
Results: *posture and tempo*

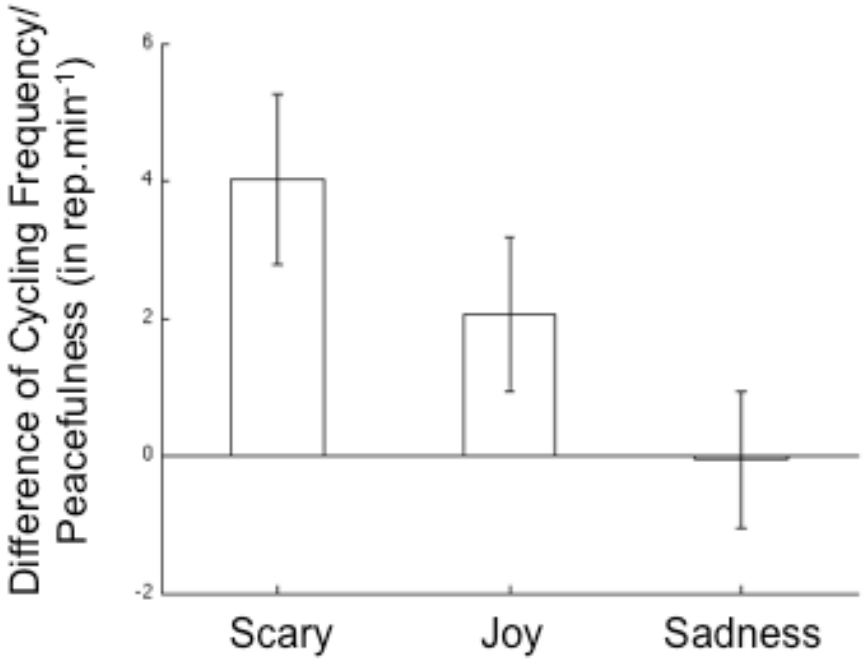


Head Tilt / Vertical = 35 °



Controlling for beat effects





Conclusions

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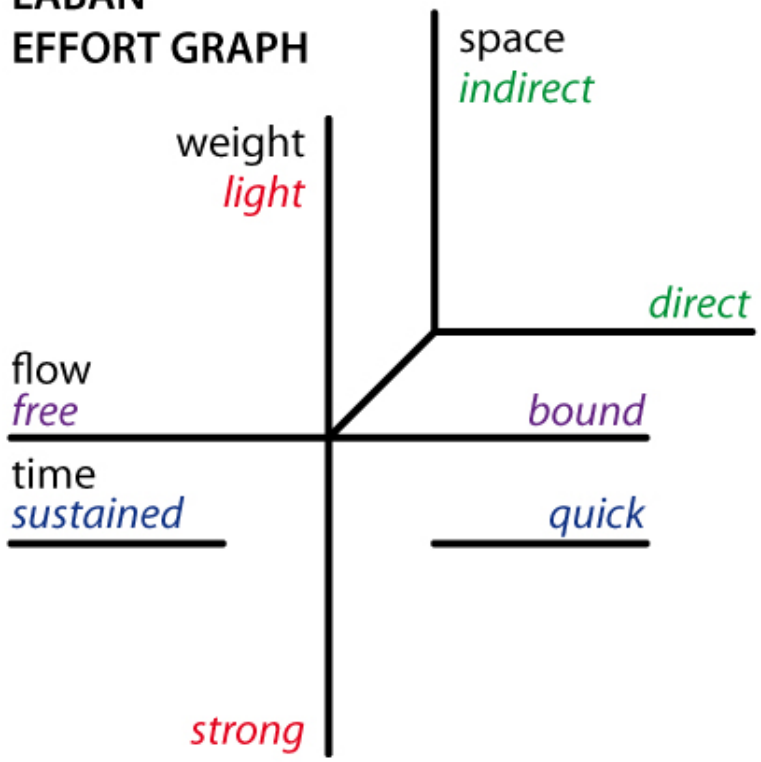
- Emotional body language was revealed in an ecological task with novice none expert individuals
- Music induced a change in the emotional state of the participants (GEW scale)
- These emotional states directly impacted postural and tempo changes in a specific way.

Can this be the basis of empathic interaction?

Study 2: Methods

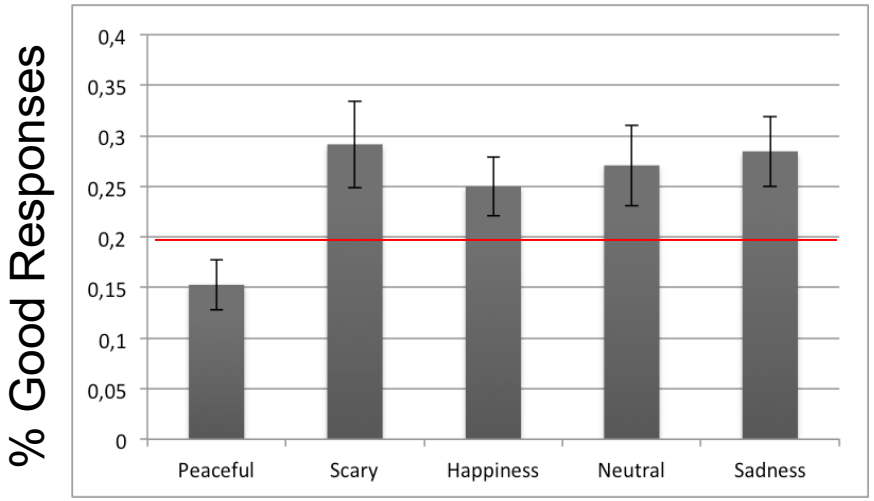


2 tasks

1- Evaluate the quality shape of the movement

2- Explicitly categorize the emotion

Study 2: Results



Significant effort-shape factors:

- Torso posture
- Energy scale (cadence)
- Flow (relaxed/controlled)

Time series to reveal 2 timing modes

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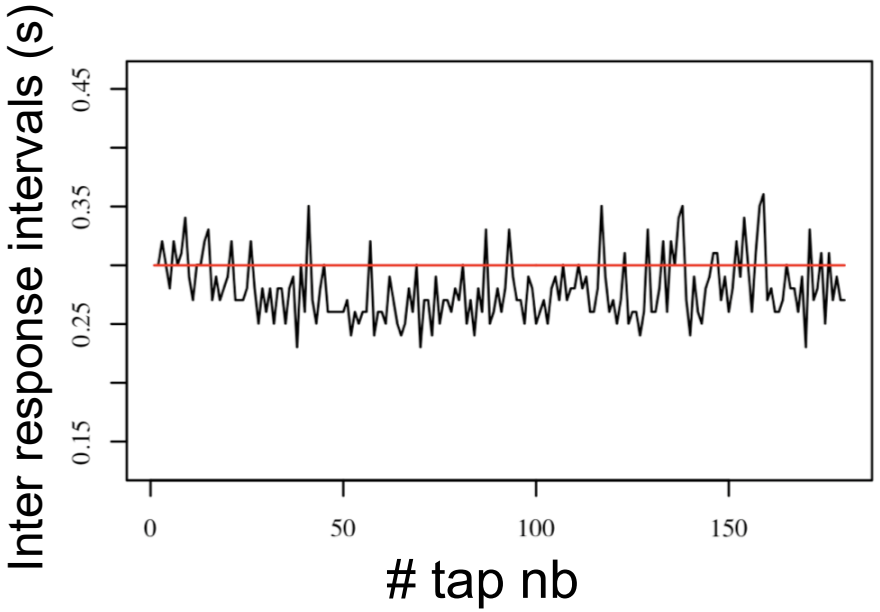
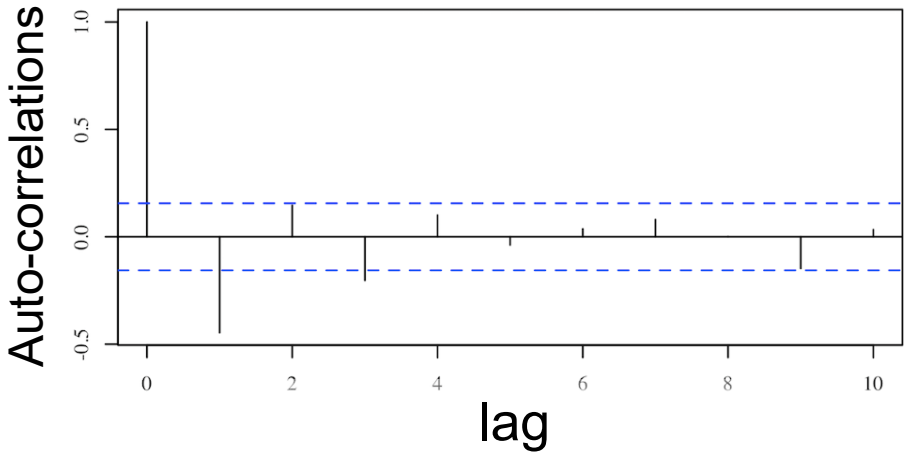
DWA Method (Detrend Windowed Autocorrelation)

Lemoine & Delignières (2009)





Predictive timing AC<0

Vorberg & Wing (1996)
Torre and Delignières (2008)

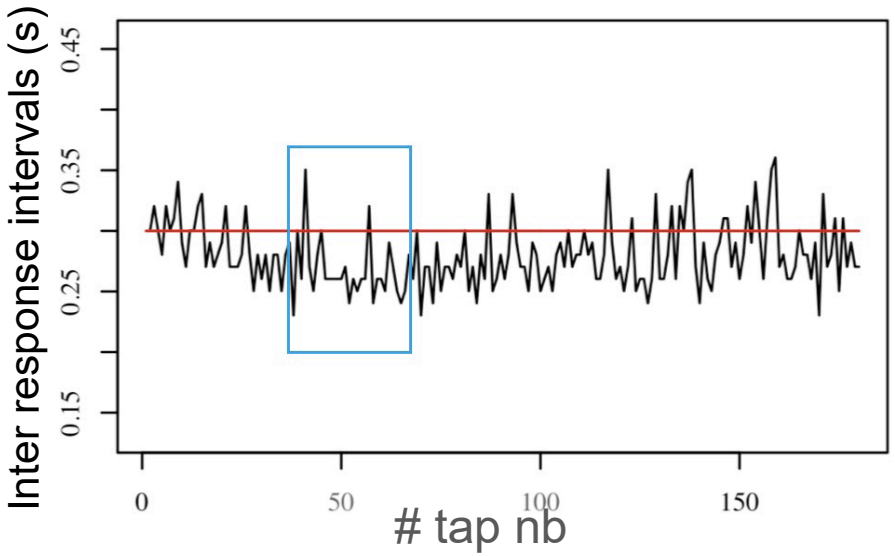
Emergent timing AC>0

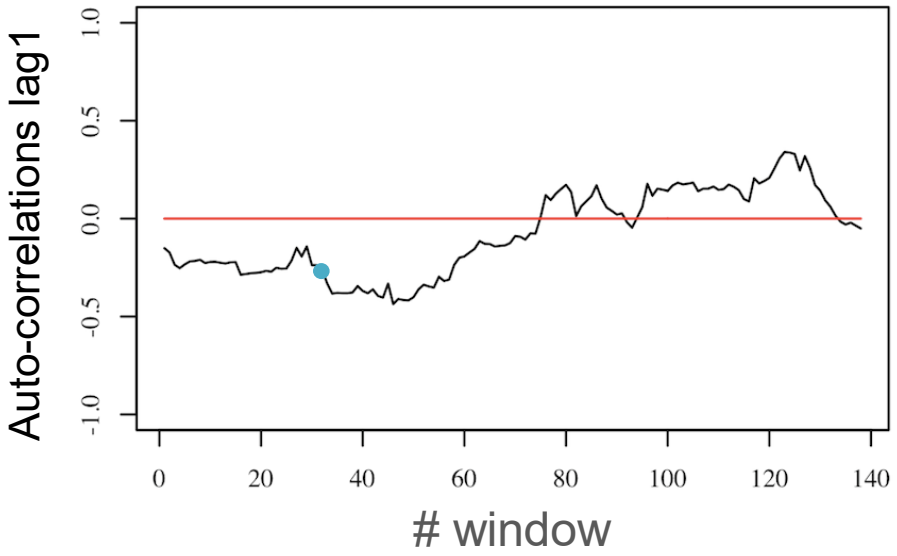
Turvey (1973); Robertson et al. (199
Studenka & Zelaznik (2008)

Study 2: Flow hypothesis

DWA Method (Detrend Windowed Autocorrelation)

Lemoine & Delignières

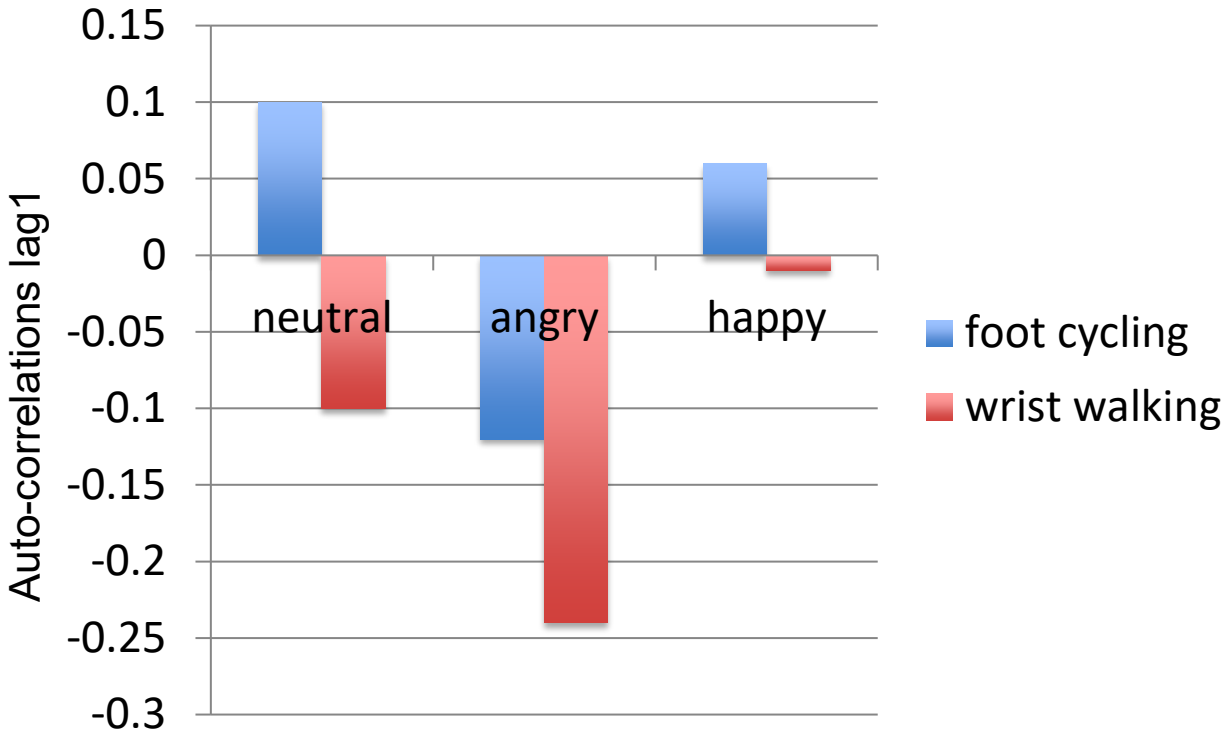




Method to

calculate the auto-correlations lag1 within a moving window to get an insight of the nature of the timing mode dynamics

Study 2: Flow results



Angry actions are characterized by AC<0

Happy actions are characterized by AC>=0

(Delevoye-Turrell, Guerin, Boitout, in prep.)

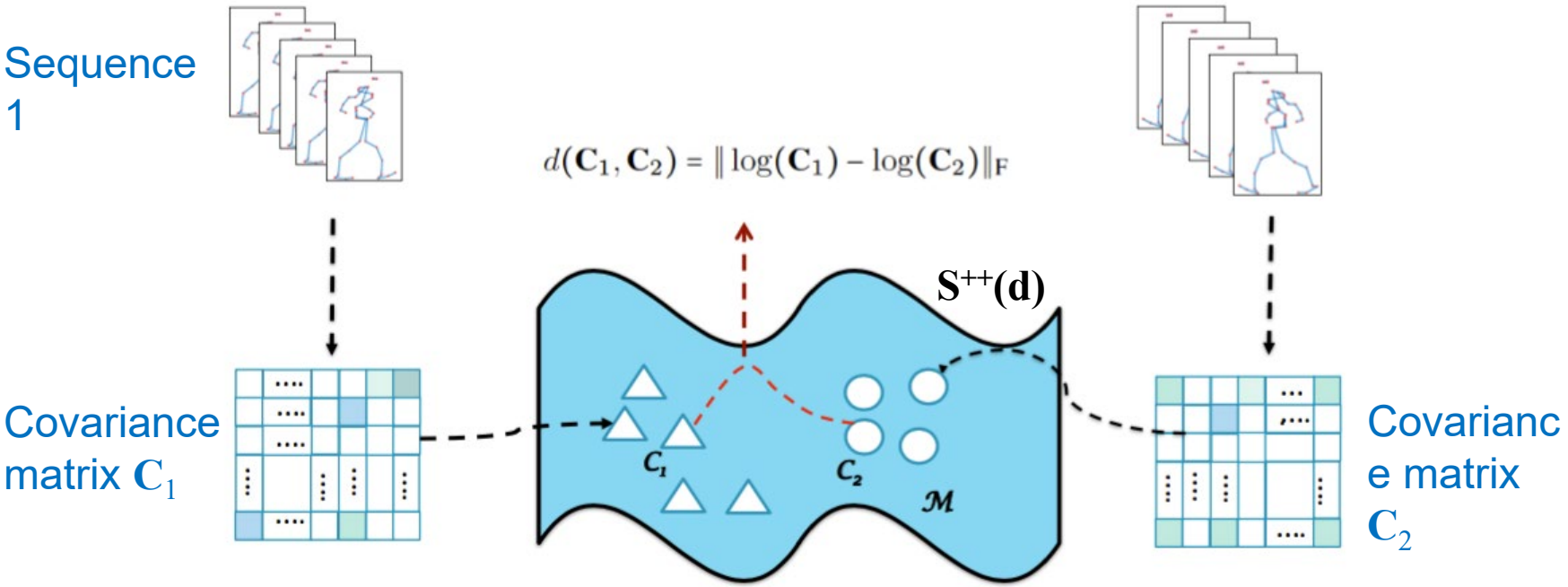
Study 2: Conclusions

- Emotional states impact directly body posture and spontaneous motor tempo. *(Hicheur et al. 2013; Venture et al., 2014)*
- Fluidity of movements can be characterized by auto-correlation functions.
- All three factors are needed to distinguish between emotional states, especially those of similar arousal.

3D modeling: Methods

Distance between sequences is evaluated as the **geodesic** between points on the manifold

*(Daoudi, Berretti, Pala, Delevoye-Turrell,Del Bimbo, **ICIAP 2017**)*

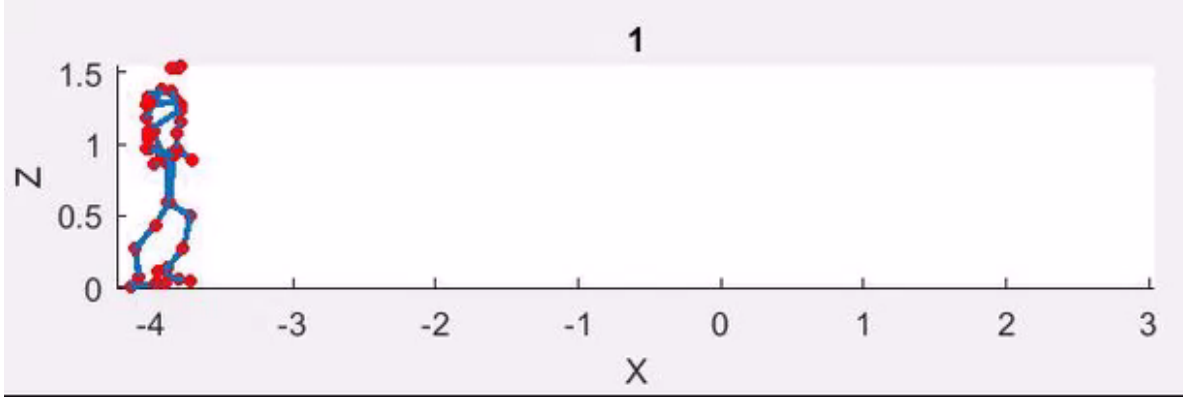


3D modeling: Results

- 43 skeleton joints
- NN Model: LERM to Riemannian centers of mass
- Emotional kinematics
  - body and head postures
  - walking & wrist velocity
  - covariance matrices

LERM

	anger	fear	joy	neutral	sadness
anger	79.31	3.45	13.79	0.00	3.45
fear	3.57	67.86	10.71	0.00	17.86
joy	3.23	6.45	58.06	9.68	22.58
neutral	6.06	0.00	0.00	81.82	12.12
sadness	2.86	20.00	2.86	5.71	68.57



NN Model
Avg = ~ 71.1%

Humans
Avg = ~ 74.2% (N=36)

Computational Modeling of Human Social Intention

Daoudi, Devanne, Quesque & Coello

1st Workshop on Action and Anticipation for Visual Learning, Oct. 2016 Amsterdam, Netherlands

Conclusions

- The body is primarily used to perform social interactions and enable motion, thus **emotional clues can only be detected as secondary signatures** on top of those ongoing actions.

- The nature of the timing processes used to plan and adjust motor actions will impact the 3D dynamics of body movement.

    - Predictive-timing: controlled; discrete (clock resetting?)
    - Emergent-timing: easy; flowing (continuous clock?)

- Participants can switch from one timing mode to the other as a function of their inner emotional state.

Research group

M.Carlier (PhD), J.Blampain (PhD), **S.Guerin (PhD),**
Y.Wamain (MCU), C.Roger (MCU), L.Ott (IG), **V.Brossard (IG)**

Collaborators: Computer sciences

M.Daoudi (IMT Lille-Douai, France)
S.Berretti, P.Pala, A.Del Bimbo (Florence, Italy)
M.Tommasi & J.Legrand (CRisTal, University of Lille, France)

Collaborators: Cognitive psychology

T.Nazir & Y.Paulignan (CNRS UMR 5015, Lyon, France)
C.Karageorghis & M.Bigliassi (Brunel University, UK)

Call for 2 Master students for 2022-2023 on big data and machine learning