

# Use of 3D visualization in teaching anatomy

An opportunity to demonstrate the  
power of images over words

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and Patrick Pelayo  
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Lyon 1

Rhône-Alpes



**A good opportunity.....**

**our english language  
is very bad !**



# The 3D anatomy project at Lyon 1

- 2005 :** first vidéos 3D (*sports sciences, 430 students*)
- 2007 :** 30 % of the syllabus in 3D
- 2010 :** 75 % of the syllabus in 3D  
*Health Science and Sports Science, 580 students*
- 2011 (end) :** 90 % of the syllabus in 3D
- 2012 (dec.) :** 100 % of the syllabus in 3D
- 2012 (sept.) :** new project: videos for medicine students



# A pedagogical process

**Research in  
didactics**

**Tests for  
students**

**LMS Spiral**

learning management system

**Evaluation  
of teaching**

**3D objects**





# A 3D team

## A research lab (pedagogy of science): the CRIS

C. Collet, N. Hoyek  
A. Guillot, P. Thiriet

**Instructors and a coordinator :** P. Thiriet, instructor in anatomy

## An office: iCAP

**Technical team:** C. Batier, technical director  
C. Chenavas, director multimédia, secteur Santé  
N. Van Reeth, director multimédia, secteur Sciences  
C. Yahiaoui, director for communication

**Graphical designers:** O. Rastello (Anatomy)  
A. Poulot  
F. Urien  
A. Rousseau (Unity)

**Evaluator :** E. Sylvestre



## 3 initial hypotheses/needs

- organize structure of space
- create mental pictures
- develop mental rotations

=> a pedagogical use of 3D



# Reusing 3D objects

- **initial use: videos** (QuickTime)
  - Screenshots from videos
    - written course
    - quizzes and final exam
  - Integration of videos in podcasts
- **further use: real time 3D**
  - PDF 3D
  - Unity (2011)



# Open source site

62 498 actions (09.01.10 – this morning)

<http://anatomie3d.univ-lyon1.fr/>



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# Organisation of the lecture

## On line:

- all resources (videos, PDF, class notes)
- multiple choice questions on LMS

## Before the lecture

- Read relevant chapter with picture on LMS

→ *edited as text book (De Boeck)*

## During the lecture

- videos 3D
- PDF 3D
- students can print relevant chapter

**At home** : every student has skeleton model





## A lecture (physiotherapy students)



*Photo credit: Violeta Ivanova*



# Recitation (or at home)





# Demonstrations

initial use: videos (QuickTime)

Spine

Abdominal muscles



# Teaching in 3D

with Quicktime → audio-recording image by image

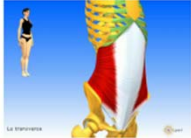


more coherent between sections



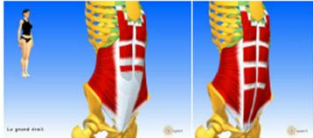
screenshot from videos with copy-paste

**Le droit de l'abdomen**  
Il est situé en avant du transverse.



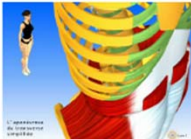
Le transverse

Il descend verticalement des 5<sup>ème</sup>, 6<sup>ème</sup> et 7<sup>ème</sup> cartilages costaux jusqu'au pubis. Ses fibres sont donc verticales. Il recouvre l'aponévrose du transverse :



Le grand droit

Il présente plusieurs intersections aponévrotiques bien visibles sous la peau chez les sujets musclés :  
En avant, il est entrecroisé par les aponévroses des obliques qui se dédoublent, constituant ainsi une gaine aponévrotique :



Le grand droit

En bas, il se termine sur l'épine du pubis. Ses fibres tendineuses se dissènt avec celles du transverse et les ligaments de la symphyse pubienne.

**L'oblique interne<sup>1</sup>**  
L'oblique interne est situé entre le transverse et l'oblique externe.

<sup>1</sup> Ancienne dénomination : petit oblique



# Demonstrations

## Further use

podcasts

[la colonne simplifiée](#)

real time 3D

[51 atlas-axis avec mvts perpétuels.pdf](#)

[50 ostéologie du pied.pdf](#)

[60 Porte-documents Le cou.pdf](#)

Software (in test) : Unity



# 3D and real time 3D now a priority for :

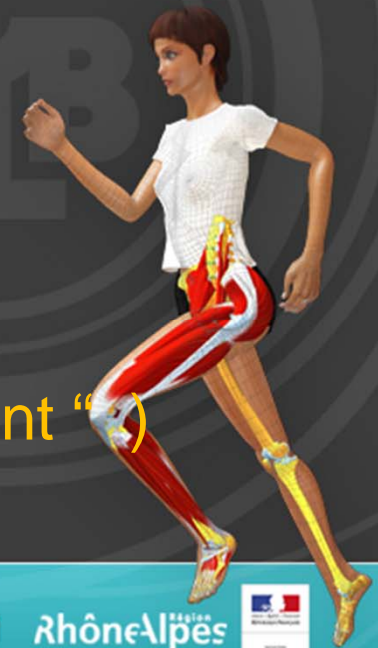
- the University Lyon 1
- our main sponsor ( UNF3S )

## 3D projects : Grants

2005 - 2011: \$ 550 000

Previsions: 2011-2013 : \$ 450 000

( 2011 : \$ 2 millions possible : “ Grand Emprunt “ )



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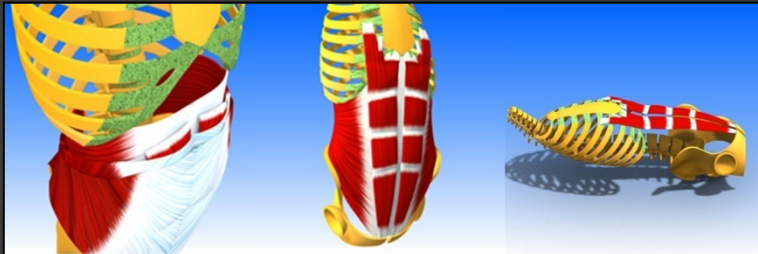


# Research in anatomy pedagogy

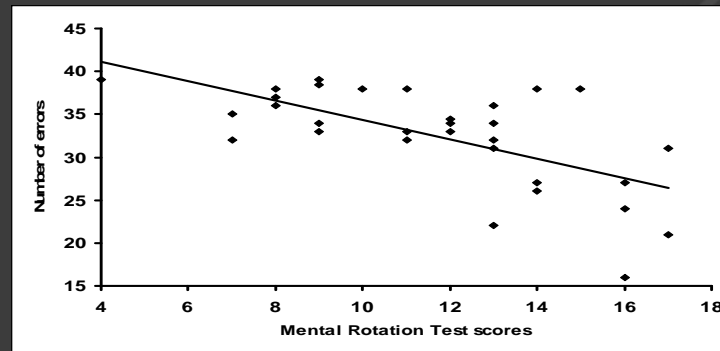


# Hypothesis and application

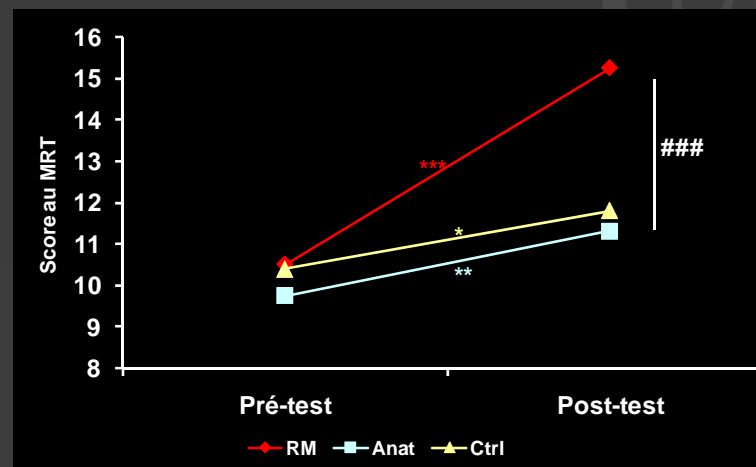
## 1. Determine the necessary skills to learn anatomy



Guillot et al. 2007 - AHSE



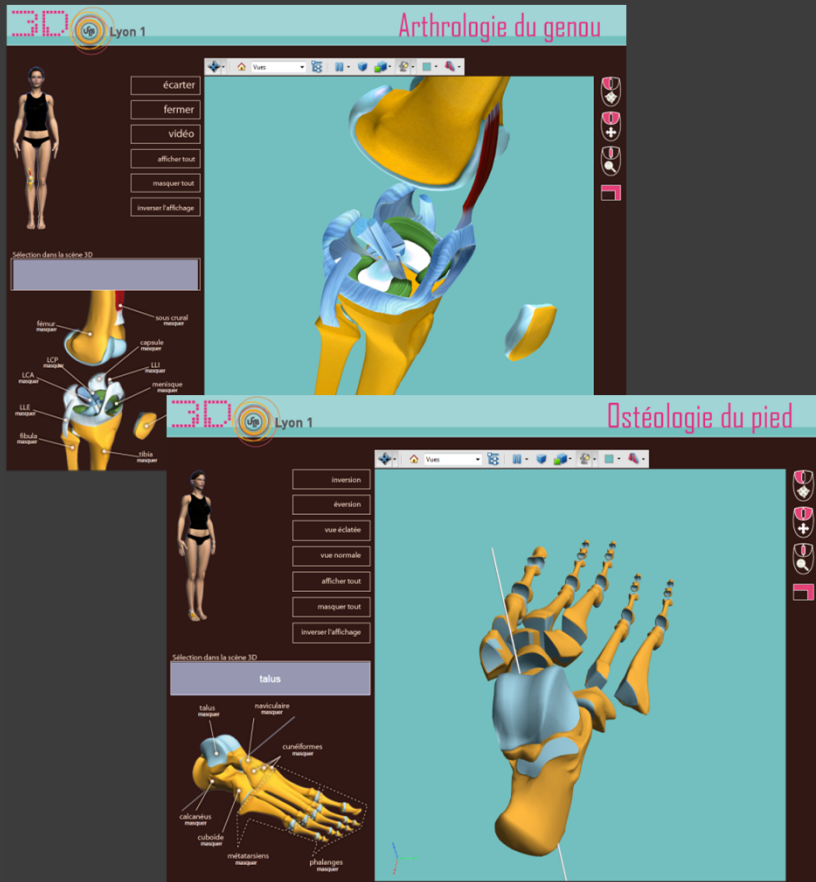
## 2. Organise the contents to promote learning



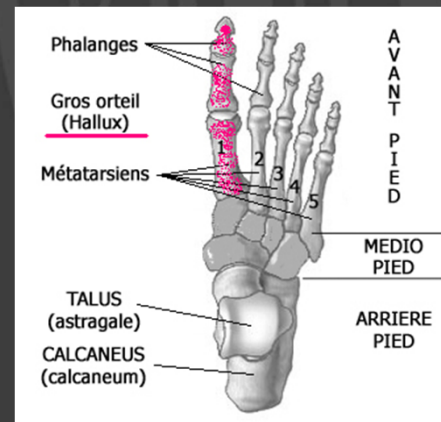
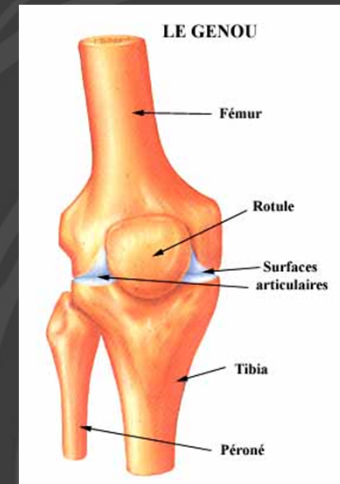


# Hypothesis and application

## 3. Assess the efficacy of new teaching technologies



VS.





GUILLOT et al. Relationship Between Spatial Abilities, Mental Rotation and Functional Anatomy Learning.

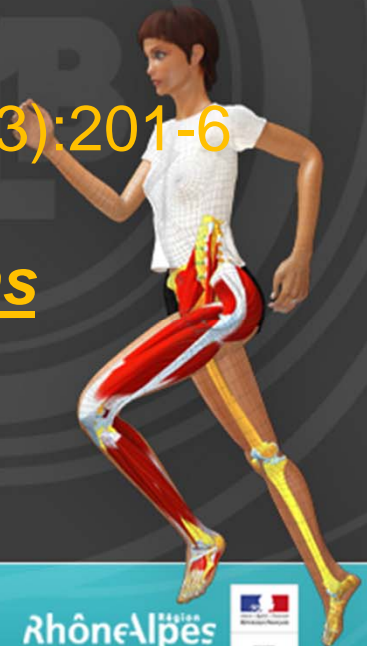
*Adv Health Sci Educ Theory Pract.* 2007 Nov;12(4):491-507.

**Good visual-spatial skills = success in anatomy**

HOYEK et al. Enhancement of Mental Rotation Abilities and Its Effect on Anatomy Learning.

*Teaching and Learning in Medicine.* 2009 Jul;21(3):201-6

**Training students to do mental rotations can improve results in anatomy**



# Teaching evaluation

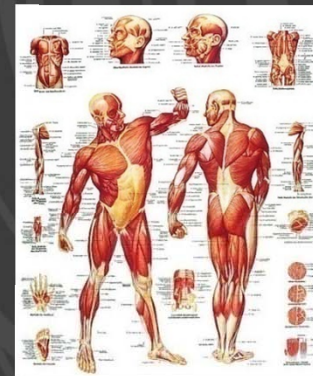
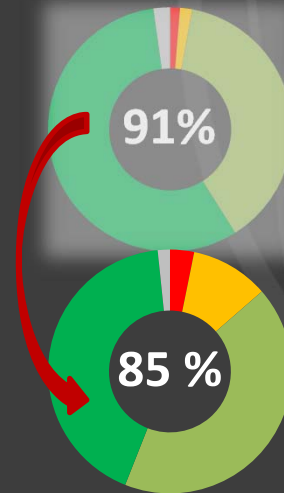
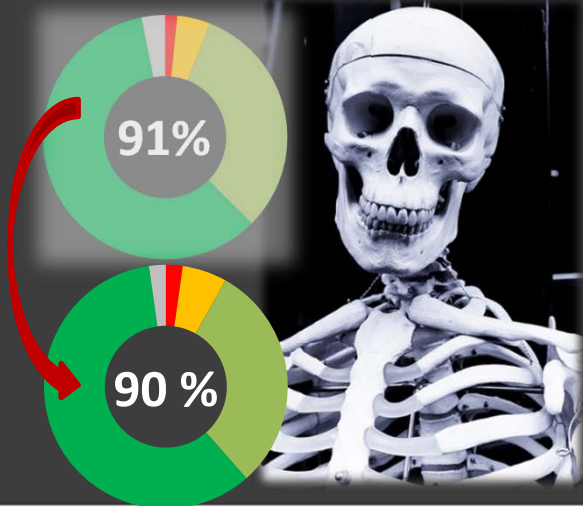
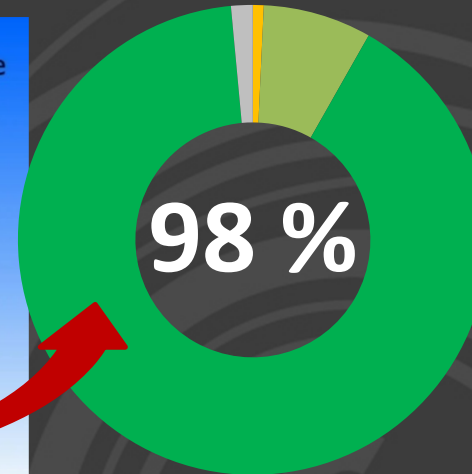
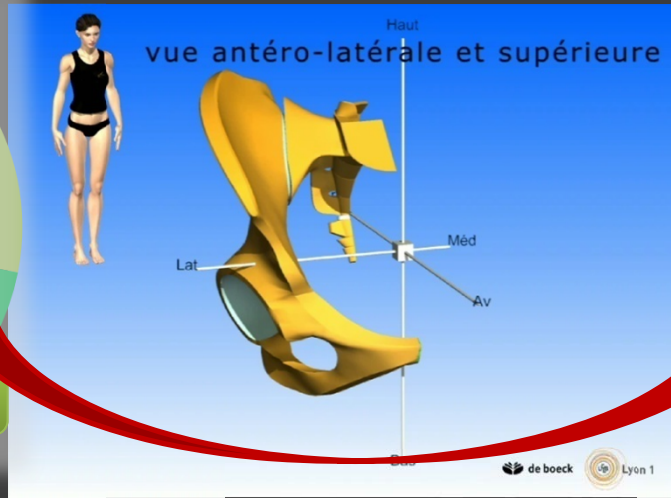
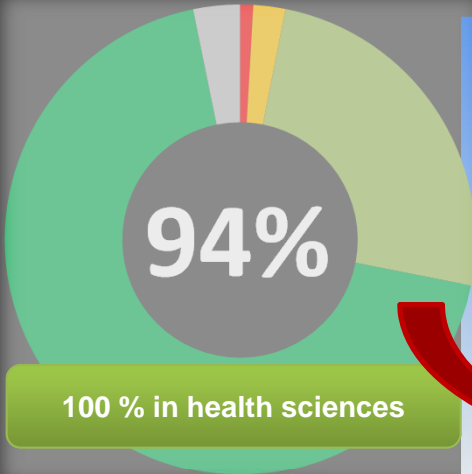


# Context

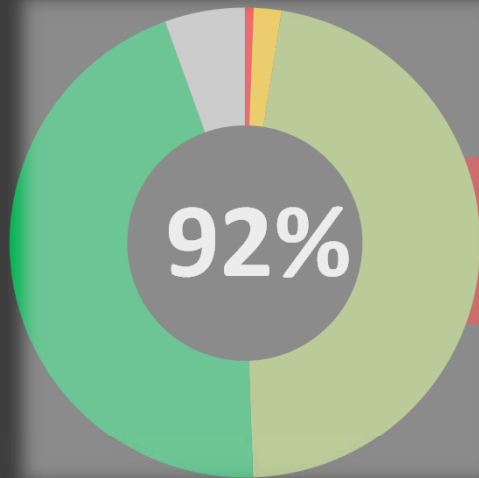
- 3 years of survey
  - 536 students (Sport Sciences, Health Sciences)
  - 2010-2011 : in progress
  - Survey during the first and the last class



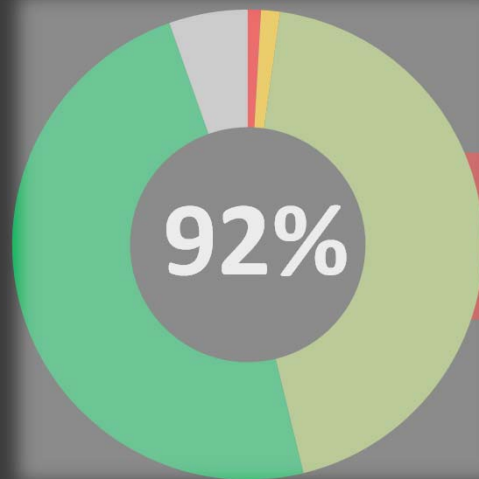
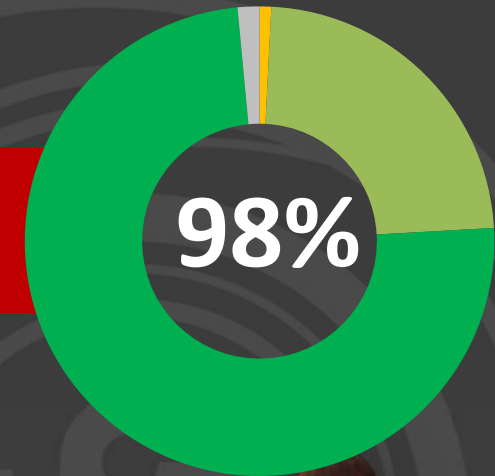
# Teaching materials



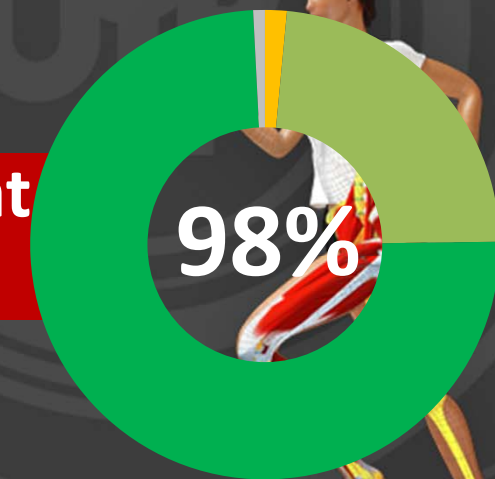
# 3D vidéos



**Better spatial orientation**



**Better understanding of what the instructor describes**



# Advantages and disadvantages of 3D





# The advantages of 3D

- meets the expectations of the students and motivates them
- enhances verbal explanations through visual scenarios
- demystifies science subjects known to be challenging
- assist in developing spatial orientation skills
- enables :
  - . progressive mental construction of objects
  - . scenarios based on habitual difficulties of the learner
  - . seeing the unseen





# The disadvantages of 3D

- videos may not be directly applicable by other teachers
- technology evolves rapidly: which one will be chosen tomorrow ?
- how to transform a fleeting understanding ?
  - . False *illusion* of understanding ? Less work ?
- a different role and posture of the instructor
  - . the pre-eminence of the video
- class scenario is tied to videos



# What is essential ?

- a graphic designer able to see the perspective of the student and of the instructor
- good instructor-graphic designer relationship
- how to simplify ? How far can you abstract ?



**Thank you for your attention**



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# La recherche



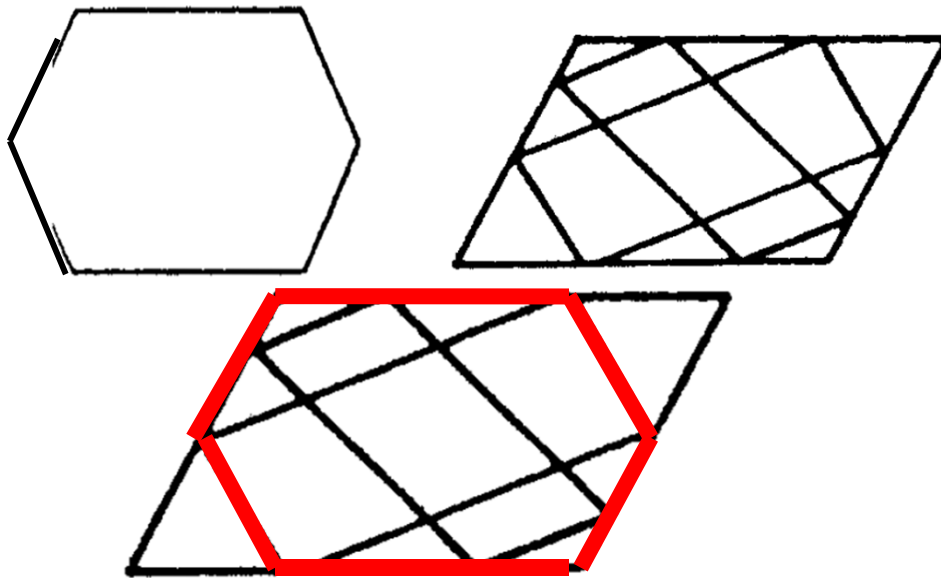
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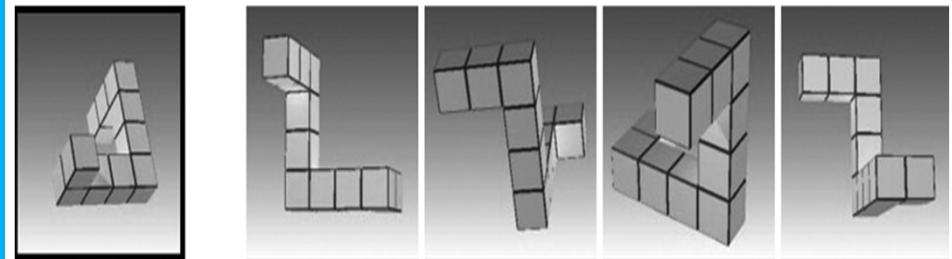
➤ Plusieurs tests pour évaluer ces capacités:

- Le VMRT (Vandenberg et Kuse, 1978)
- Le GEFT (Witkin, 1950; Oltman et al., 1971)

Group Embedded Figures Test



Mental Rotation Test



Réponse: 1<sup>ère</sup> et 4<sup>ème</sup> figures

# Etude 1

*Guillot et al. Advances in Health Sciences Education (2007) 12, 491-507*

## Objectif

Comparaison scores capacités visuo-spatiales et scores anatomie

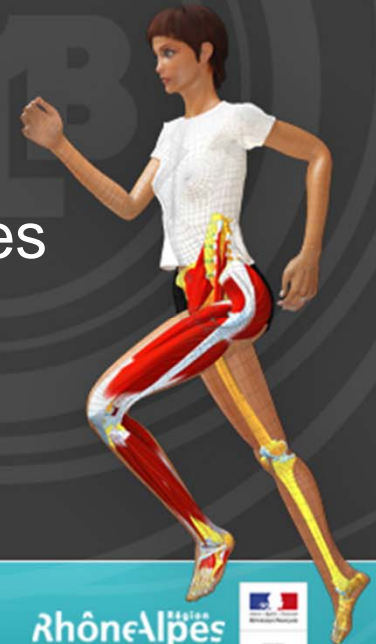
## Résultats

Corrélation positives entre les scores

➔ Bonnes capacités visuo-spatiales = réussite en anatomie

## Discussion

- Capacités visuo-spatiales favorisent l'acquisition des connaissances anatomiques
- Intégrer une éducation au repérage spatial et à la rotation mentale.





# Etude 2

Hoyek et al. *Teaching and Learning in Medicine* (2009), 21 (3), 201-206

## Objectif:

Effet de l'entraînement à la RM sur le score en anatomie et le score au VMRT

## Résultats:

Entraînement RM = bon score VMRT

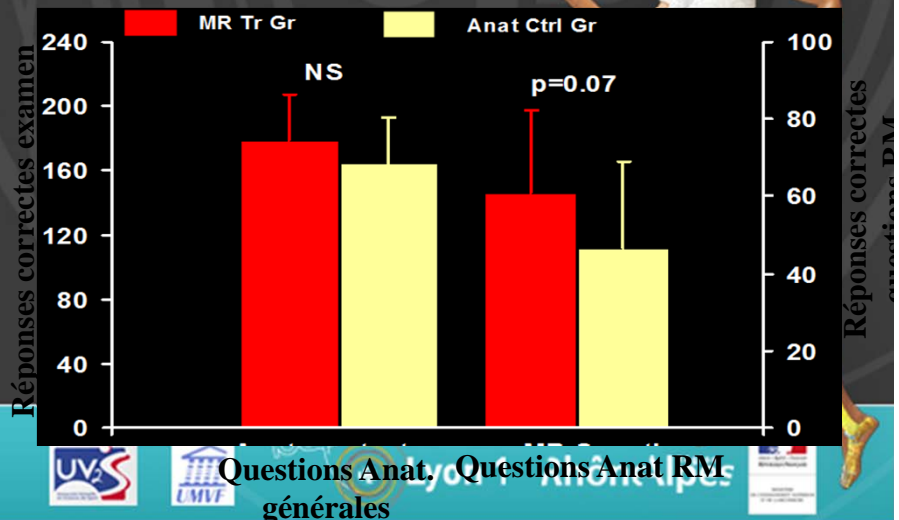
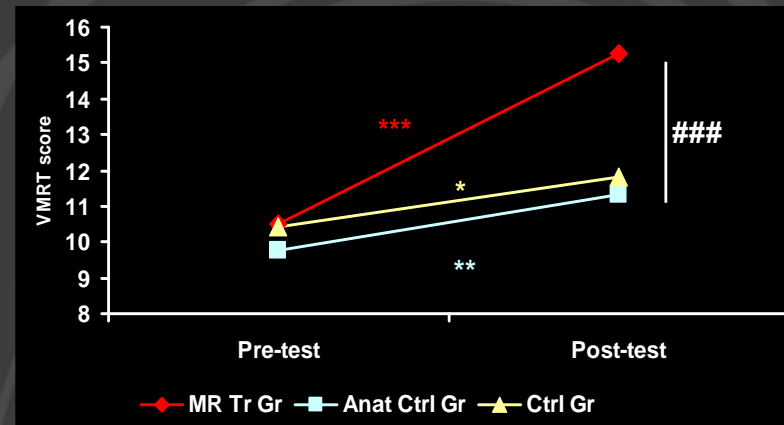


Transfert entraînement RM → VMRT

Entraînement RM = bon score Anat



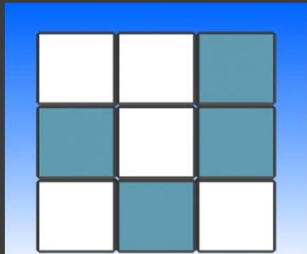
Transfert entraînement RM → Anat



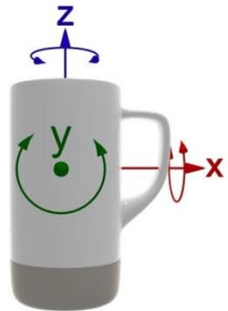
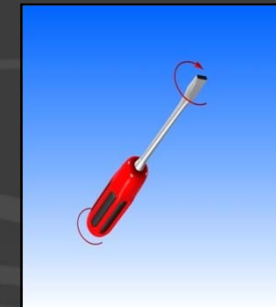
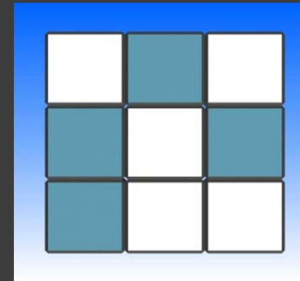
Questions Anat générales Questions Anat RM



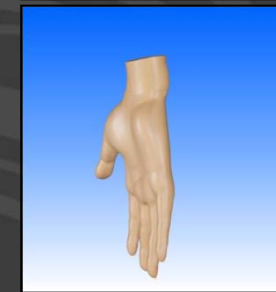
# Exercices d'entraînement à la RM:



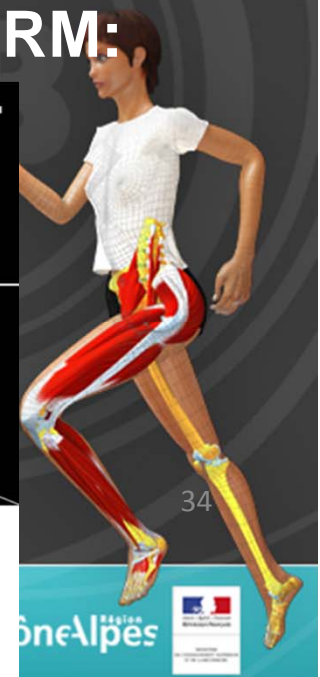
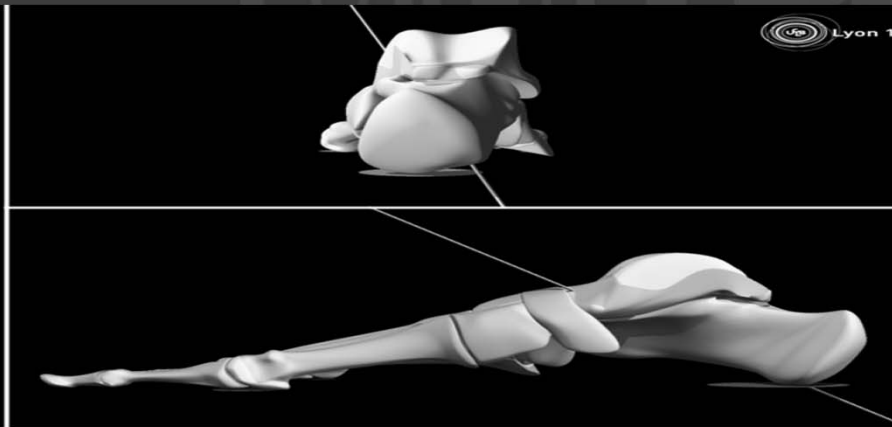
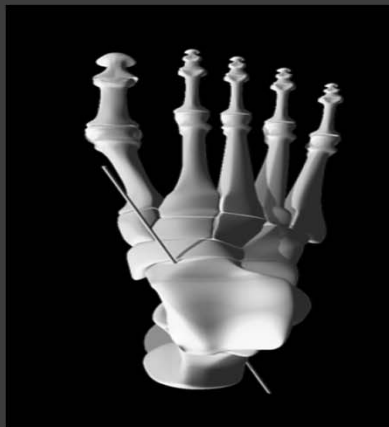
Dessinez cette forme après l'avoir tourné de 180° à droite



Dessinez ce mug après l'avoir tourné de 180° à gauche selon l'axe Y



# Exemple des questions d'anatomie nécessitant une RM:



The top and the bottom schemas on the right of the figure are respectfully:

- 1) Anterior and lateral views of the foot
- 2) Posterior and lateral views of the foot
- 3) Posterior and medial views of the foot
- 4) Anterior and medial views of the foot

# Etude 3

## Objectif:

- Etudier l'effet de l'utilisation de la 3D durant un seul TD
- Comparer le résultat de 3 groupes bénéficiant de supports visuels différents (Vidéo 3D Vs PDF 3D Vs Croquis 2D)
  - Même support écrit
  - Même évaluation
  - Support visuel différent

## Résultats:

- Les 3 groupes sont homogènes au départ (résultats Pré-test)
- Une tendance statistique en faveur des groupes PDF et vidéo!

## Discussion et limitations

- 1 TD seulement!
- Fatigue, manque de concentration, contraintes du 1er TD
- Manque d'investissement



# Future work

- 3D vs 2D
- Evaluate impact of podcasts
- Evaluate impact of 3D glasses
- Conduct study with disabled students (problem of disorientation)



[http://spiral.univ-lyon1.fr/files\\_m/M10860/WEB/site/occulomotricite.html](http://spiral.univ-lyon1.fr/files_m/M10860/WEB/site/occulomotricite.html)



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## UNITY

Intégration of MRI data

Other disciplines : physiology (circulation, respiration, muscular contraction, etc), geology, physics, chemistry, geography ...

Odontology and crâne

Développement of the site Anatomy 3D

Video : sickle cell

20 PODCASTS

LLUNETTES -

Occulomotricité: pleine page ; pour fermer, monter le pointeur en ht de l'écran puis appuyer sur le sigle deux carrés

Une partie du processus moléculaire impliqué dans la réplication du virus de l'hépatite C

