SCUBALANCE

Optimisation de stimuli visuels induisant des réponses posturales en environnement virtuel

B.Toussaint-Malard, P.Laguillaumie, A.Decatoire, A.Marchand-Arnold, M.Billot, F.Danion, R.Tisserand

cerca

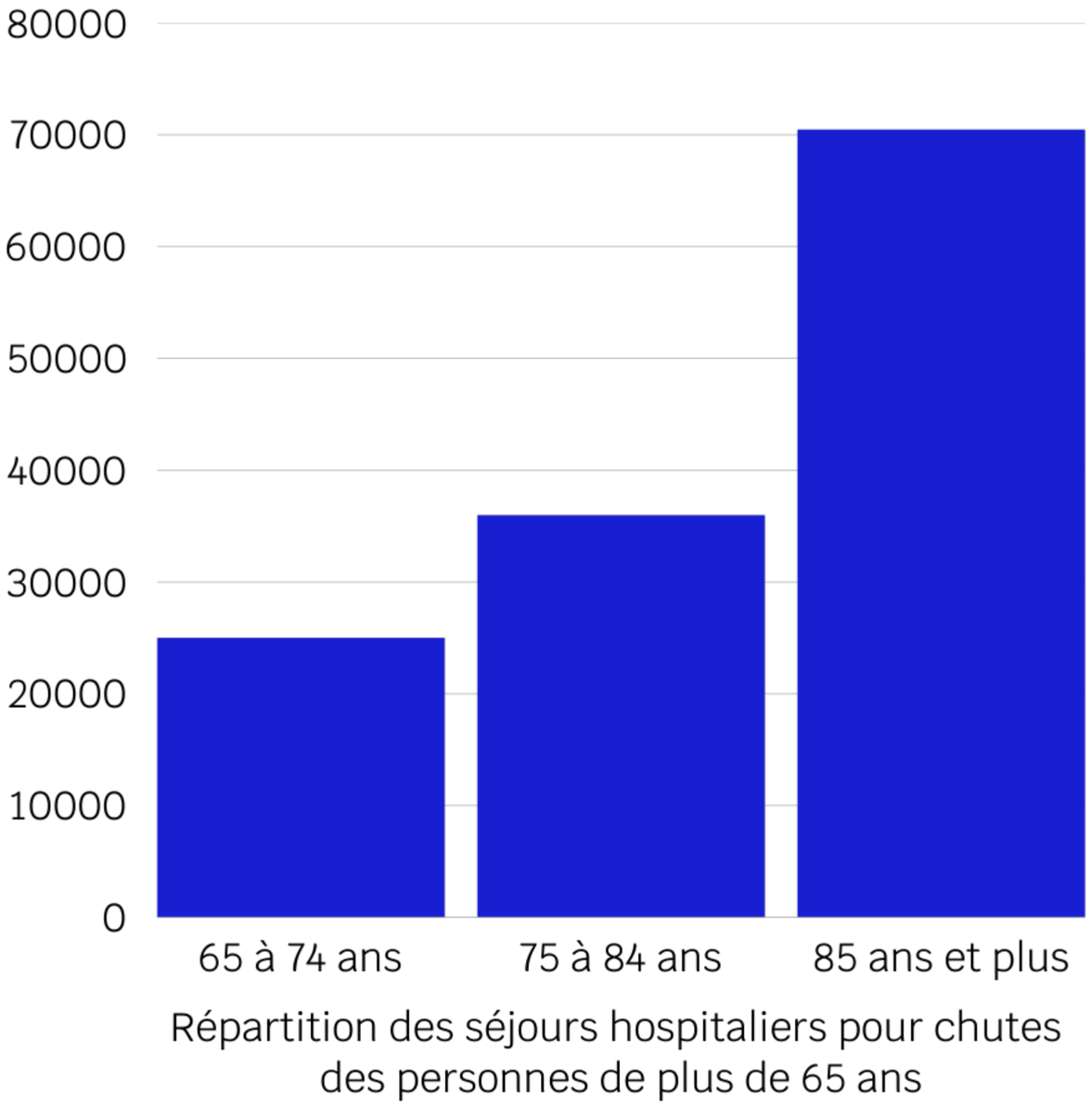
Institut Pprime
Recherche en physique et ingénierie

anr

cnrs

05/06/25

Enjeu de santé publique et politique



Répartition des séjours hospitaliers pour chutes des personnes de plus de 65 ans

Axe 1 : Repérer les risques de chute et alerter

Axe 2 : Aménager son logement pour éviter les risques de chute

Axe 3 : Des aides techniques pour la mobilité faites pour tous

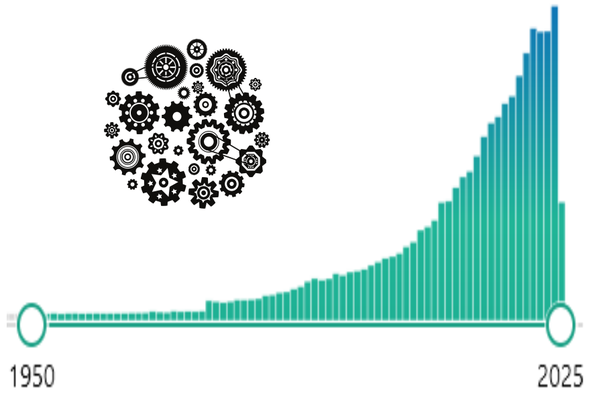
Axe 4 : L'activité physique, meilleure arme antichute

Axe 5 : La téléassistance pour tous

Chutes, Organisation Mondiale de la Sante, 2021 ; Plan antichute des personnes âgées, Ministère chargé de l'autonomie, 2022

Axe 1 : Repérer les risques de chute et alerter

Degré de priorité élevé aux travaux de recherche sur les chutes et en mettant en place des mesures efficaces pour réduire les risques

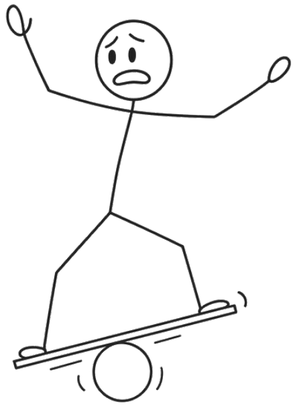


Comprendre les mécanismes liés à la chute

Chutes, Organisation Mondiale de la Sante, 2021 ; PubMed, 2025

Axe 1 : Repérer les risques de chute et alerter

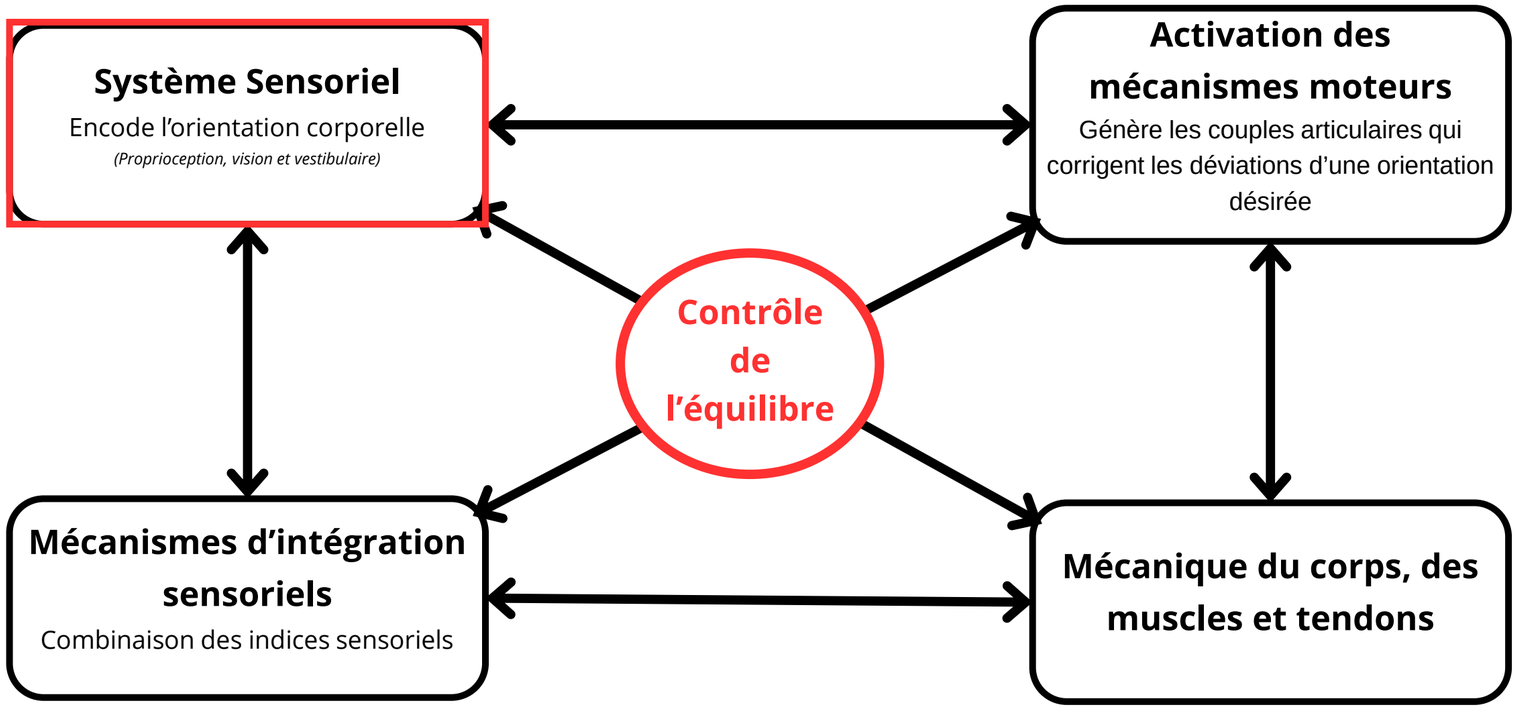
Hof, Gazendam et Sinke, 2004



Deux conditions :

- **“Statique” :** Projection verticale du Centre de Masse (CoM) se situe dans la base de support (BoS)
- **“Dynamique” :** Si CoM ne se situe pas dans la BoS mais que la vitesse est dirigée vers celle-ci, l’équilibre peut-être atteint

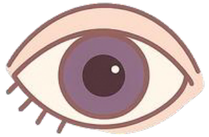
Le contrôle de l’équilibre est organisé selon :
“closed-loop feedback-control system”



Peterka, 2002

Implementation of a Central Sensorimotor Integration Test for Characterization of Human Balance Control During Stance

Peterka et al., 2018

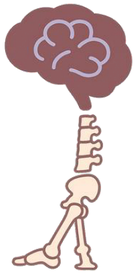


Système Visuel

22%

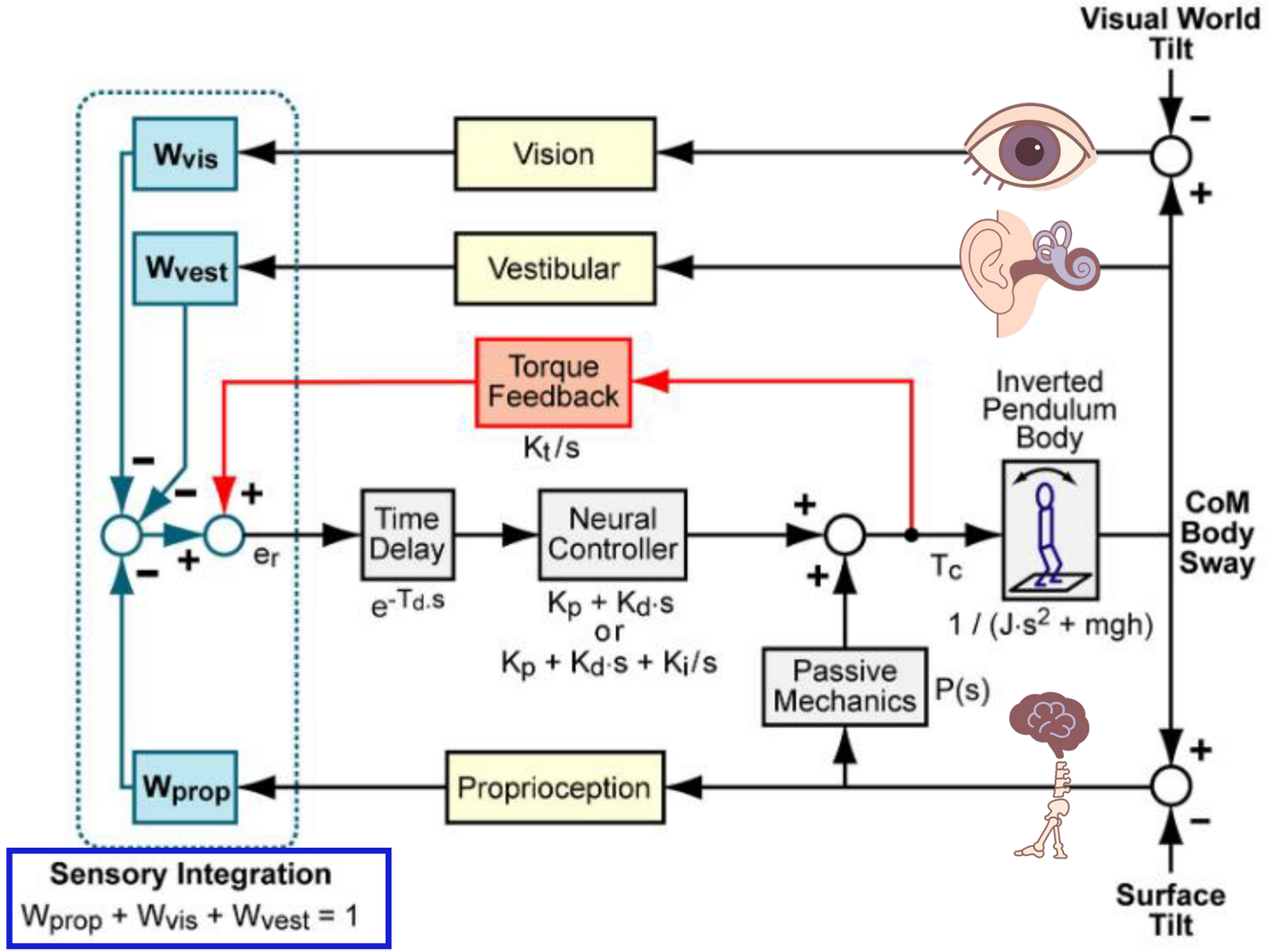
Système Vestibulaire

50%



Système Proprioceptif

28%

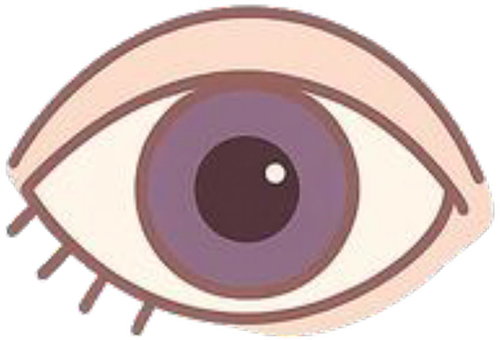


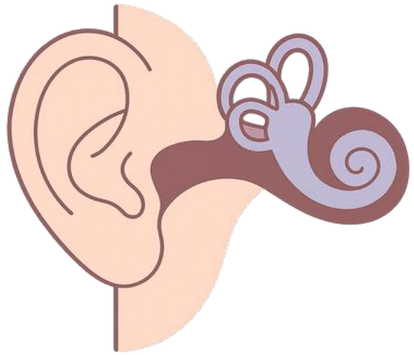
Valeurs non contractuelles

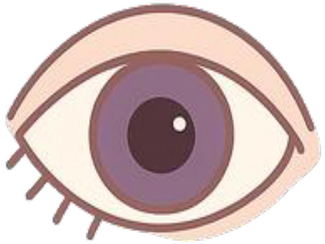
Objectif général

Evaluer la contribution des systèmes sensoriels dans le contrôle de l’équilibre durant les phases de transitions

Sous-Objectifs





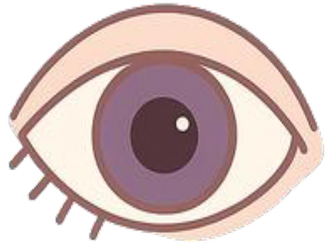


Comment perturber le système visuel pour obtenir des réponses posturales ?

Environnement

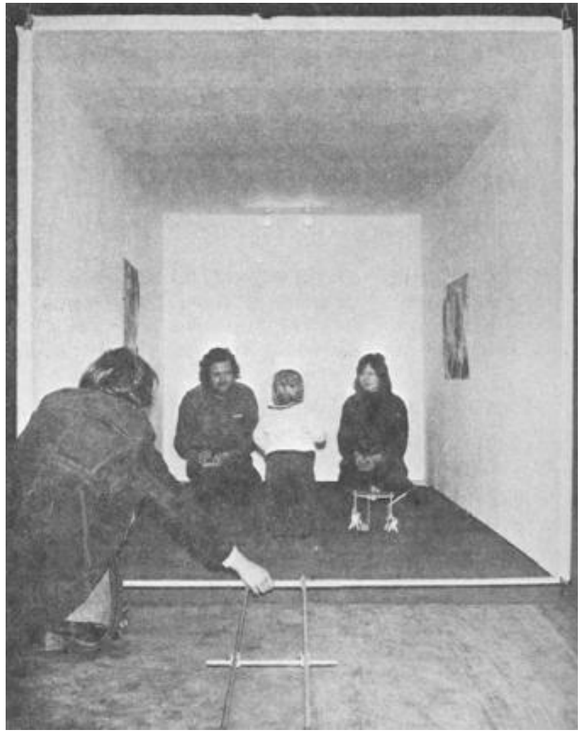
Type de Stimulus

Paramètres du Stimulus



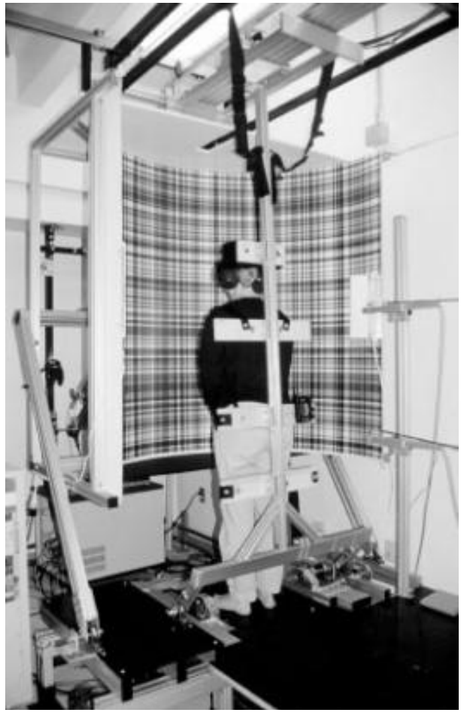
Environnement

Unity

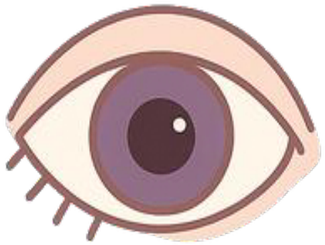


(Lee & Aronson, 1974)

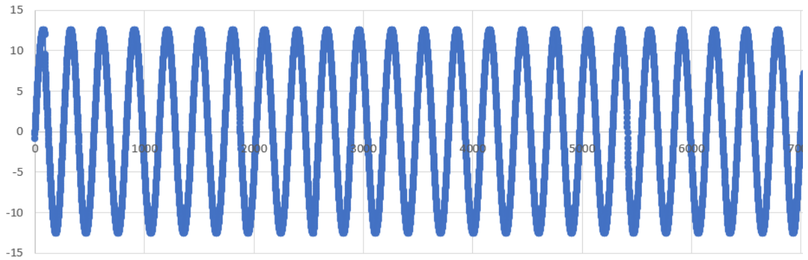
(Delbes, 2022)



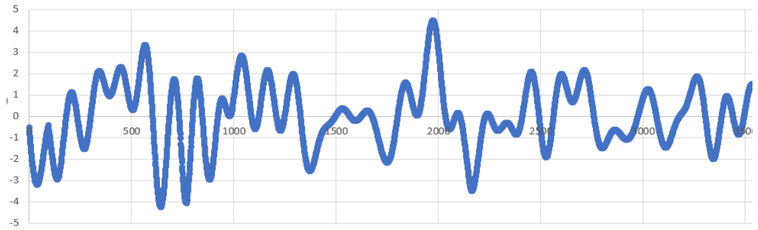
(Peterka, 2002)



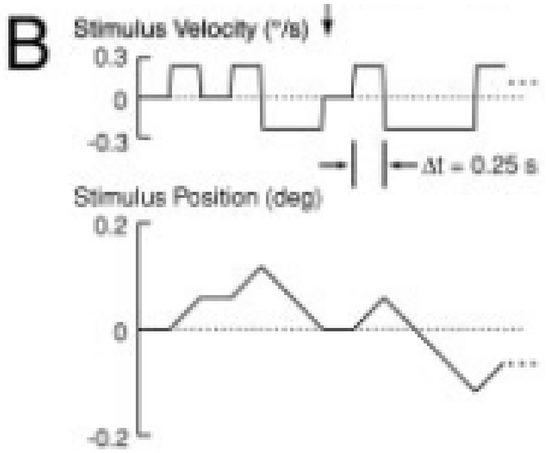
Type de Stimulus



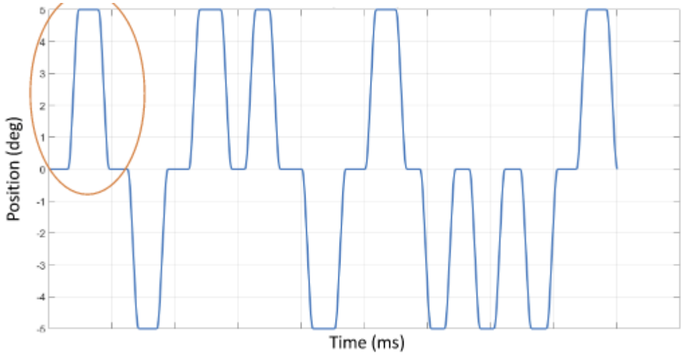
(Van Asten et al., 1988)



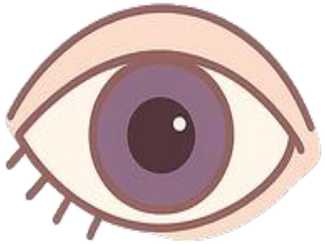
(Martelli et al., 2019)



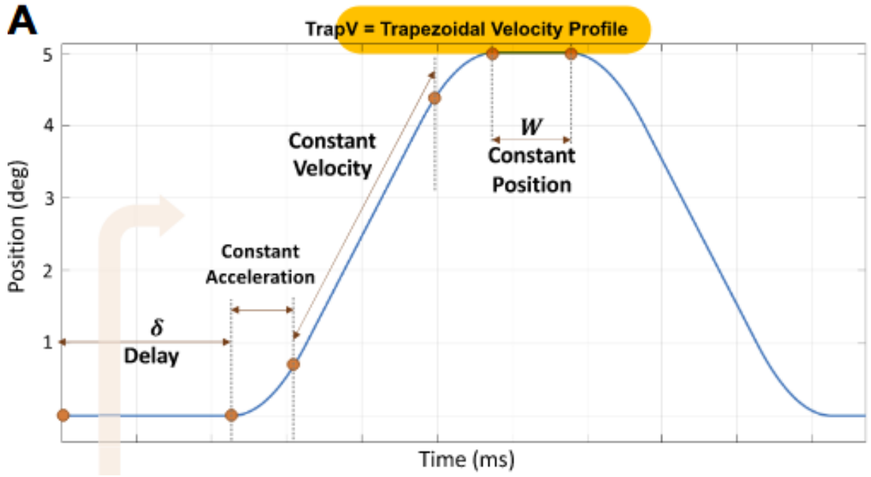
(Peterka, 2002)



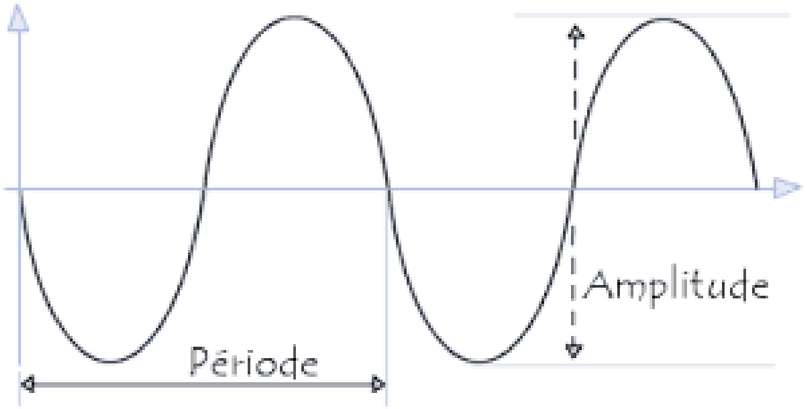
(Mohebbi et al., 2022)

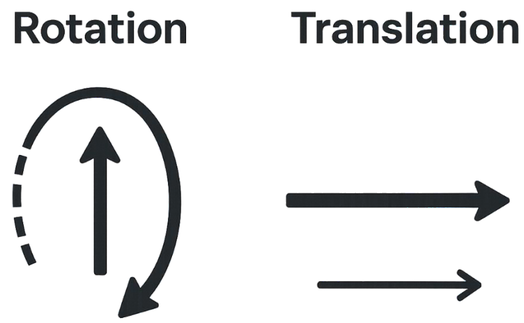


Paramètres du Stimulus



(Mohebbi et al., 2022)





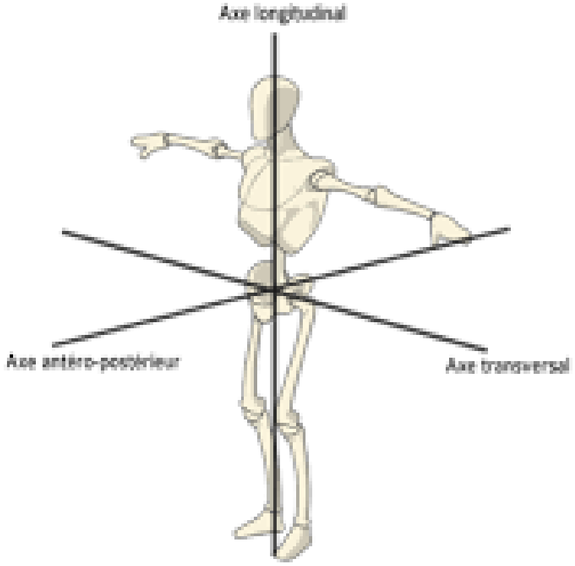
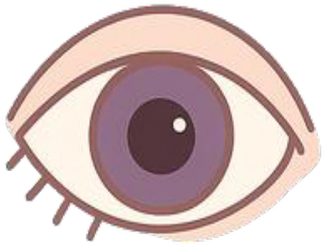


Figure 2 : Axes anatomiques (crédit photo sci-sport.com)

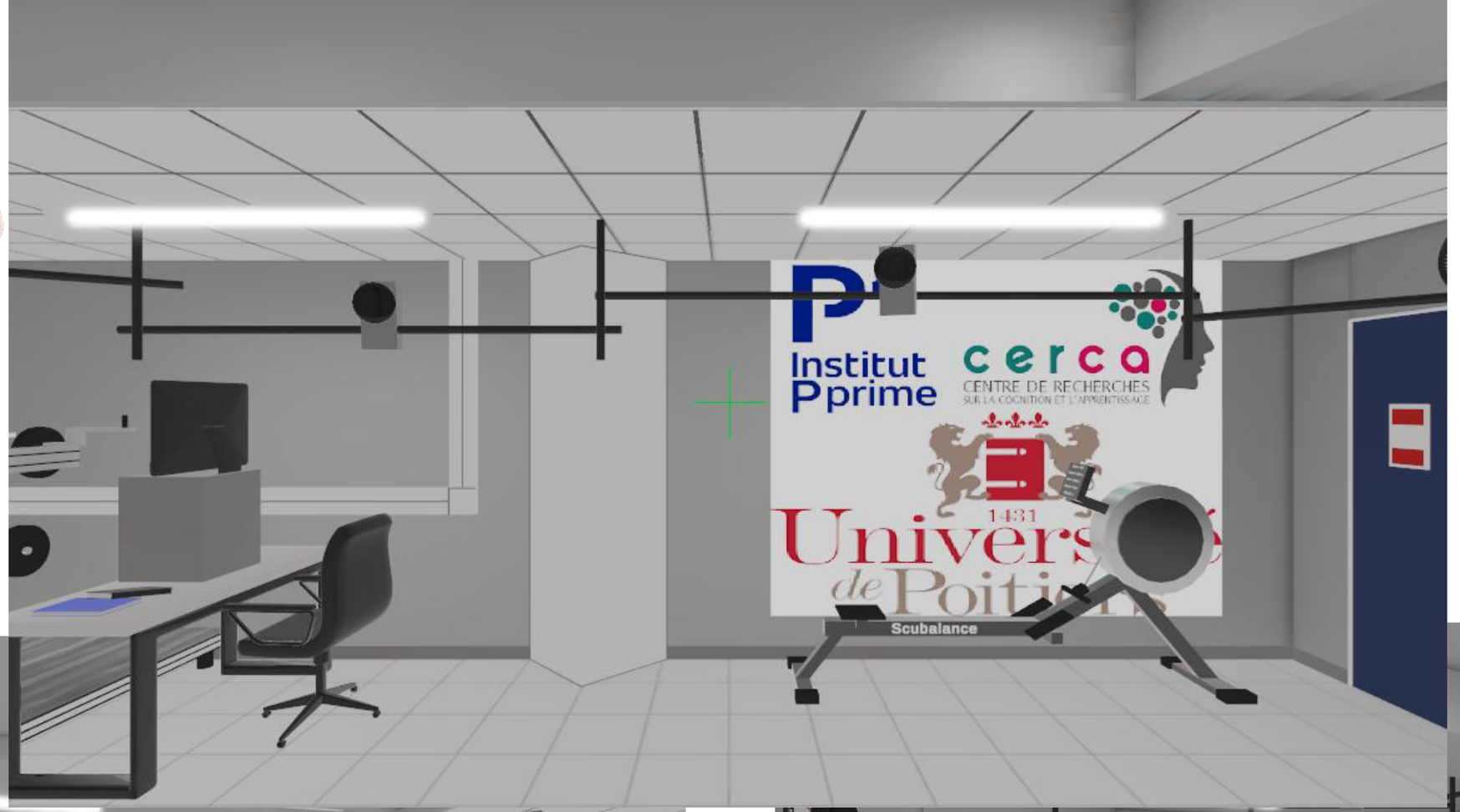


Concrètement ?

Environnement

Stimulus

Traitement et Protocole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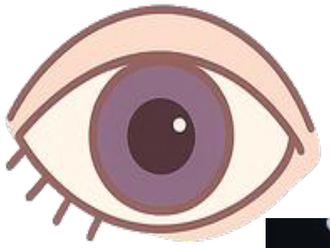
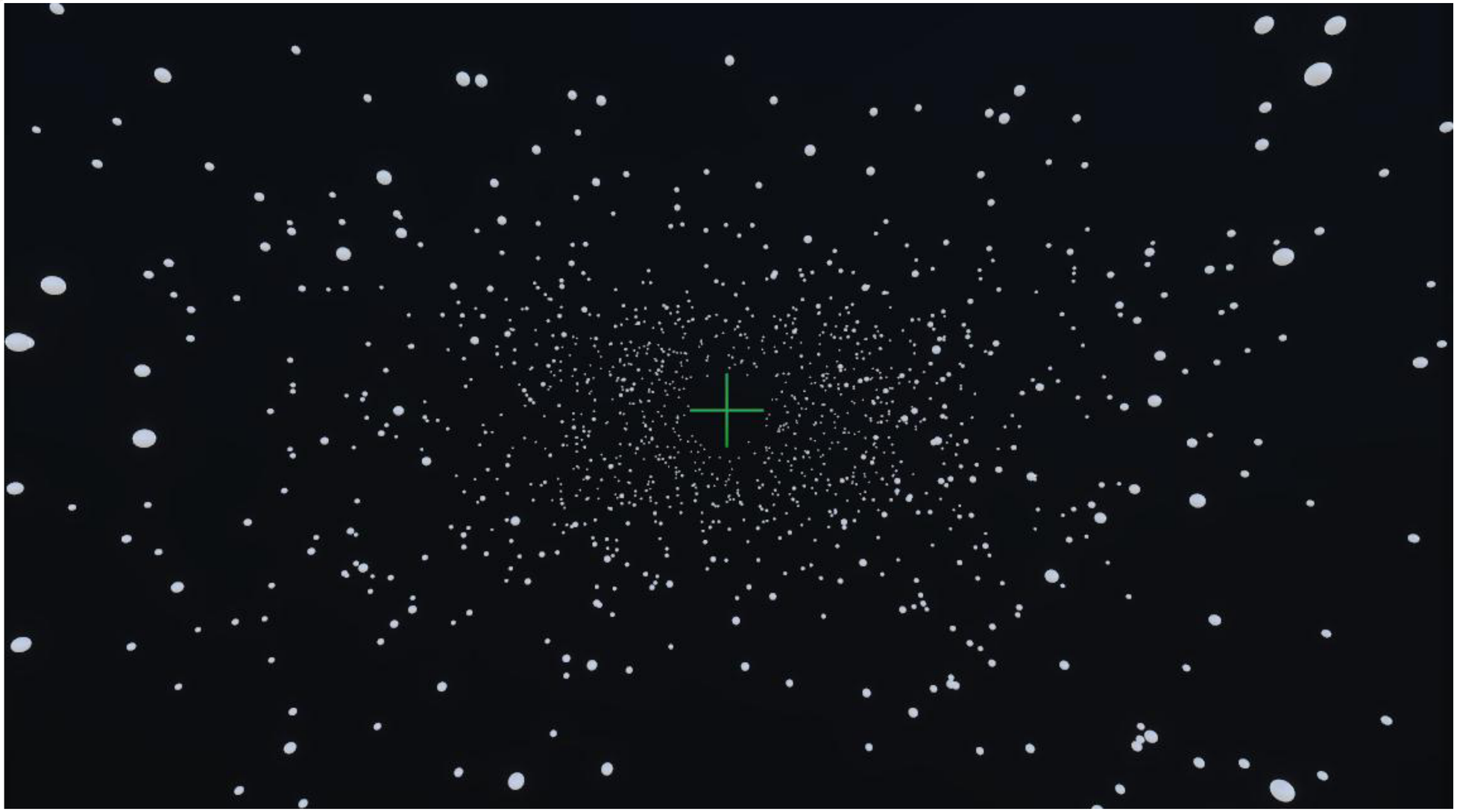
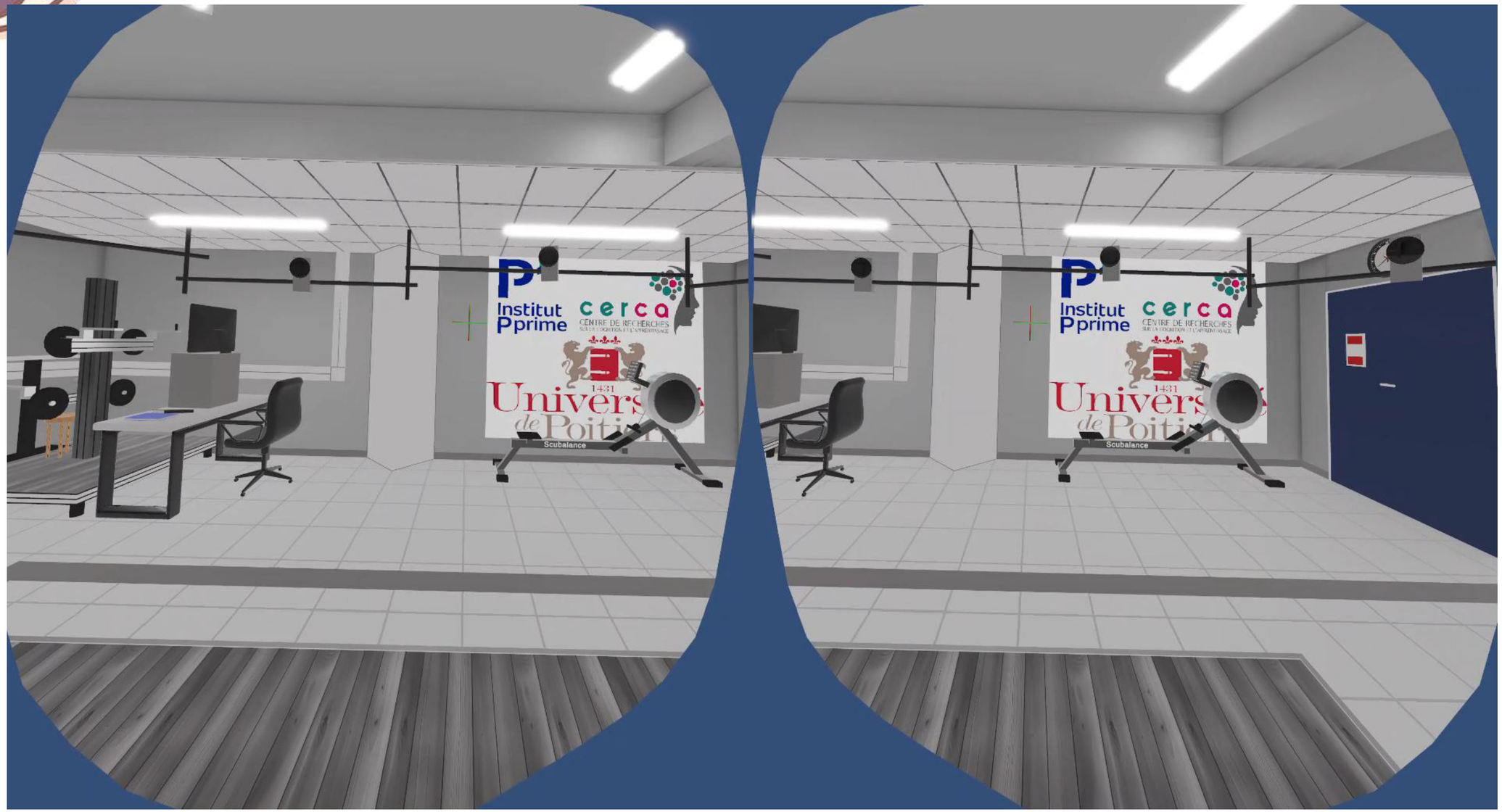
Pprime
cerca
CENTRE DE RECHERCHES
SUR LA COGNITION ET L'APPRENTISSAGE
1431
Scubalance

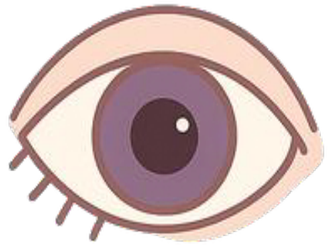


Création de deux environnemens selon la littérature pour comparer leurs effets

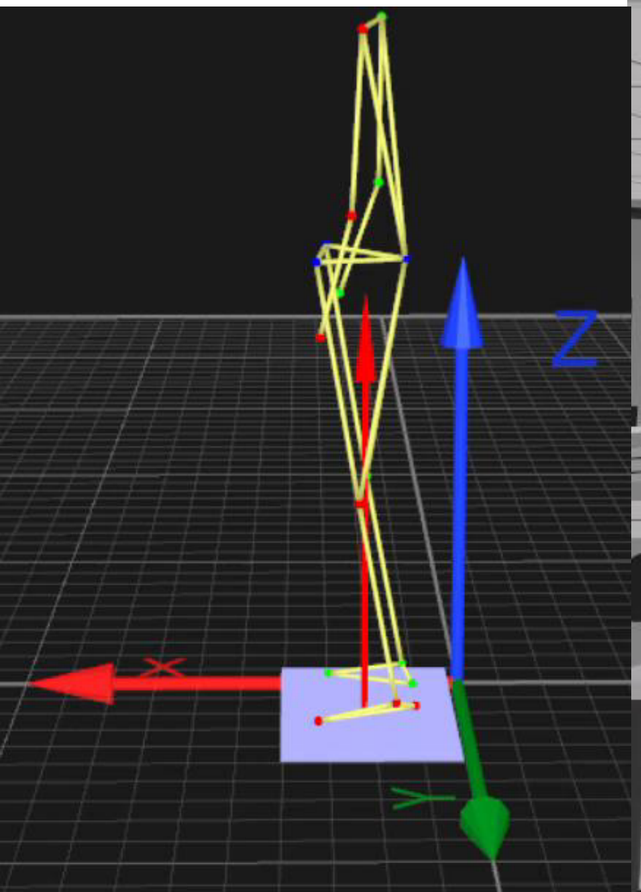


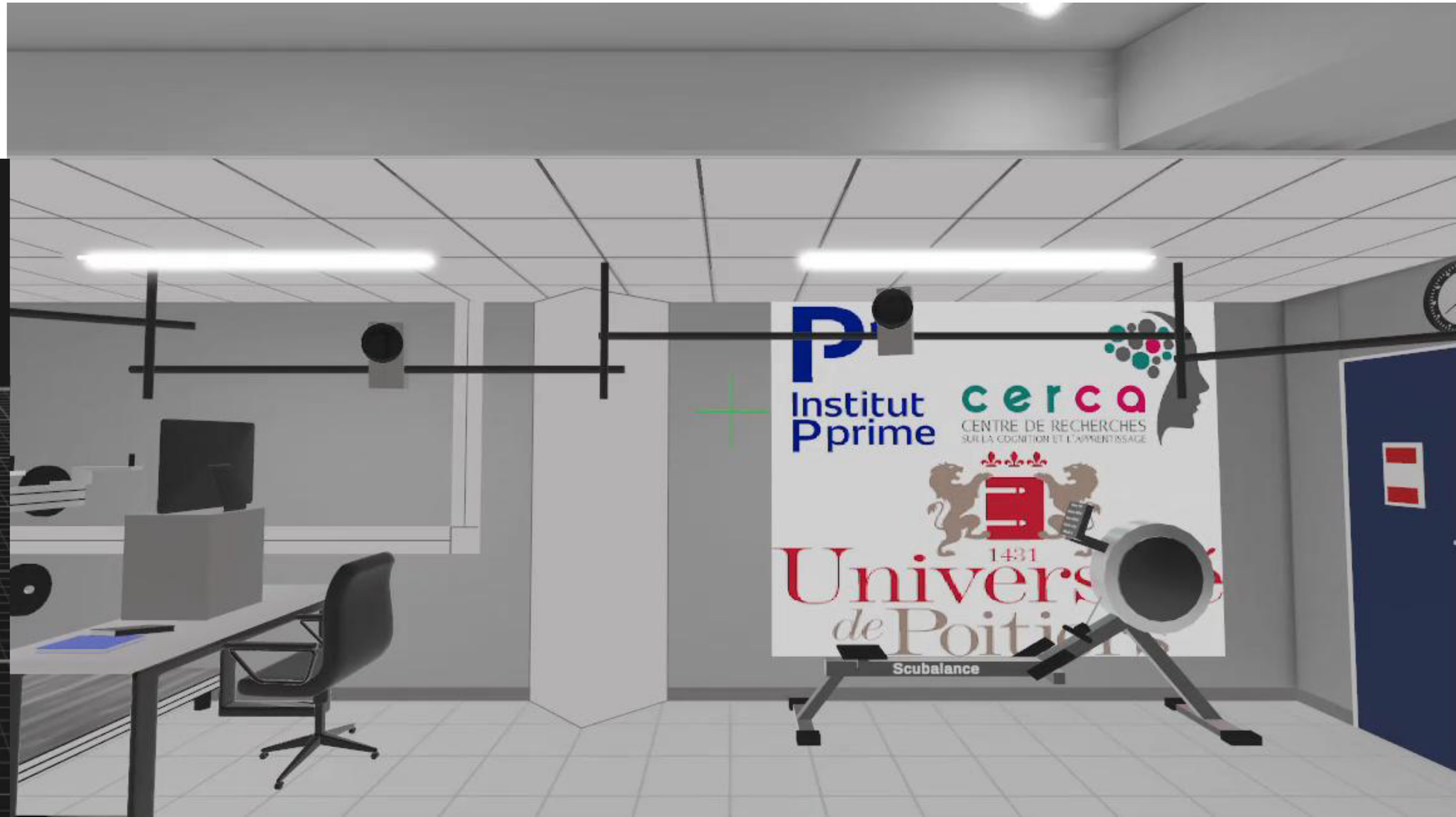
Création de 4 stimuli par environnement pour comparer leurs effets



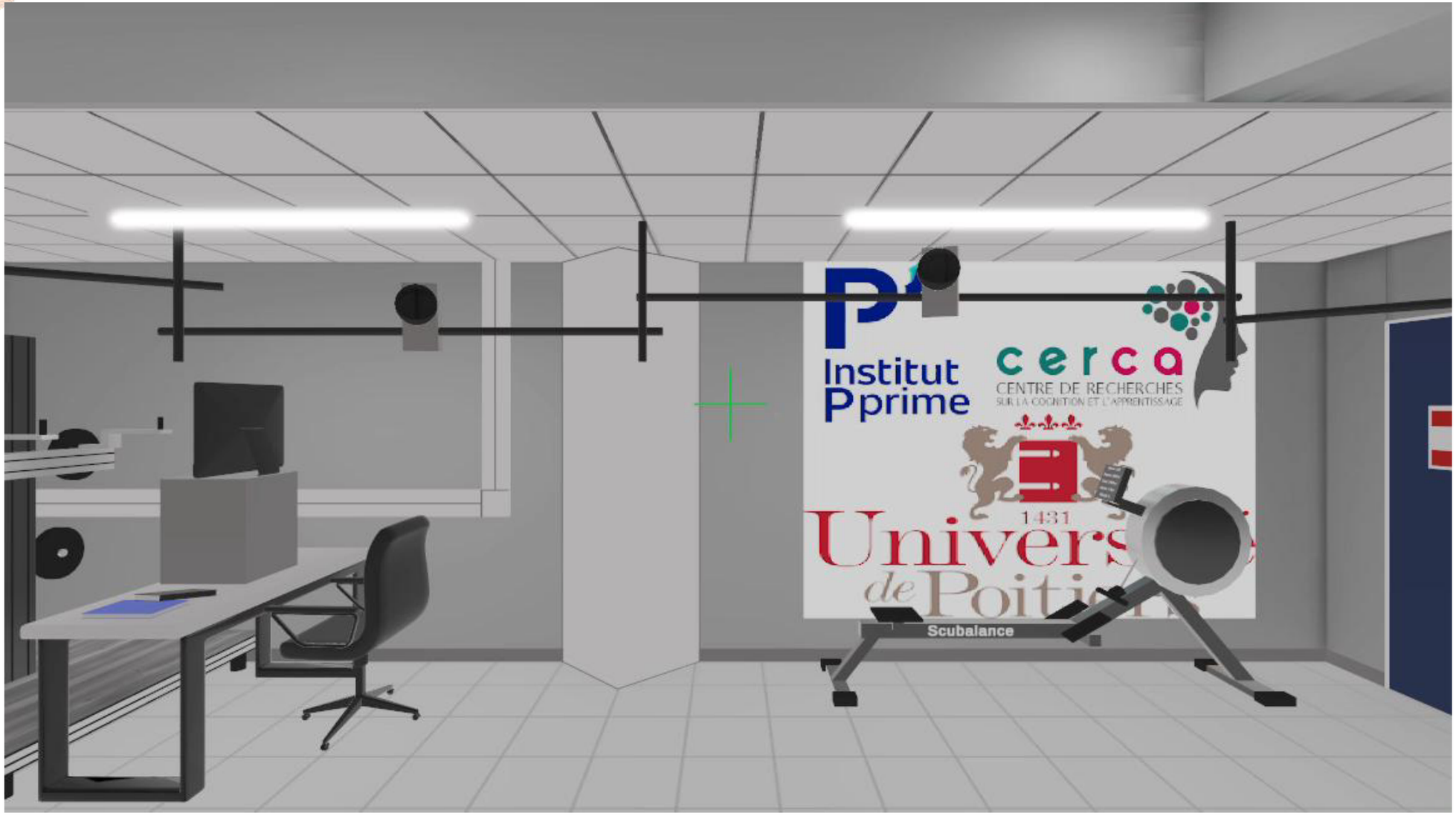


Création de 4 stimuli par environnement pour comparer leurs effets

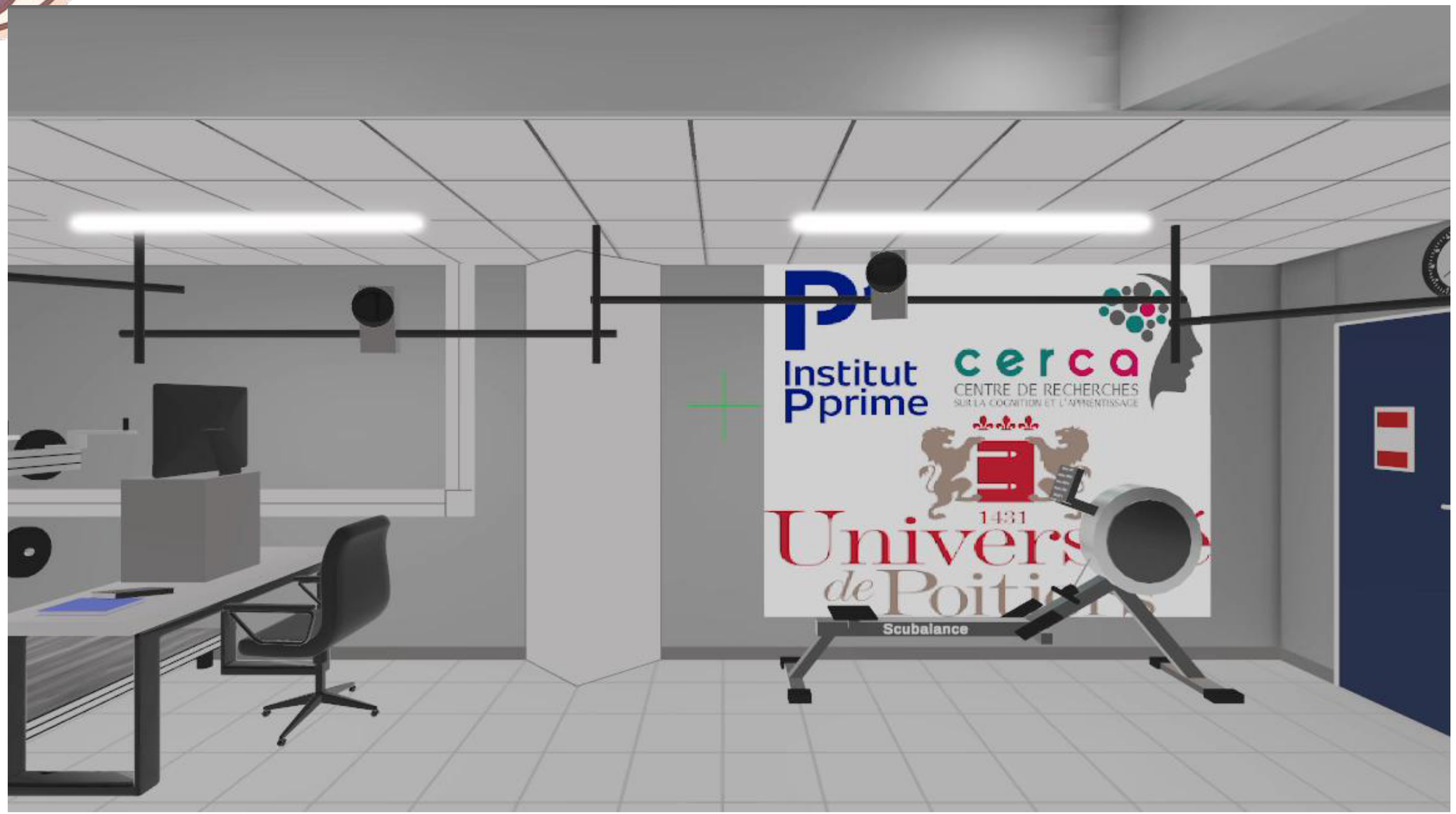




Création de 4 stimuli par environnement pour comparer leurs effets



Création de 4 stimuli par environnement pour comparer leurs effets

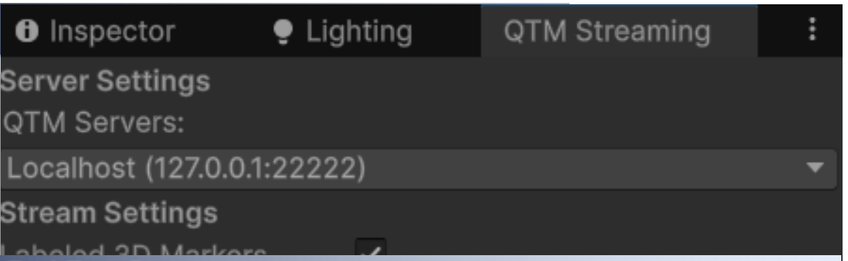


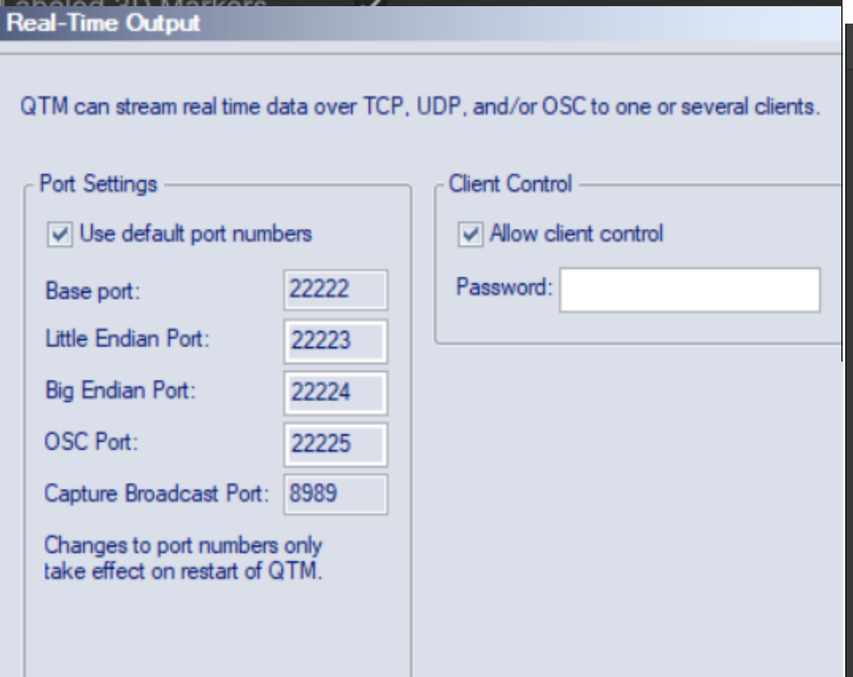
Comment synchroniser les différents systèmes (RV et MOCAP) pour analyser les données obtenues ?

QUALISYS

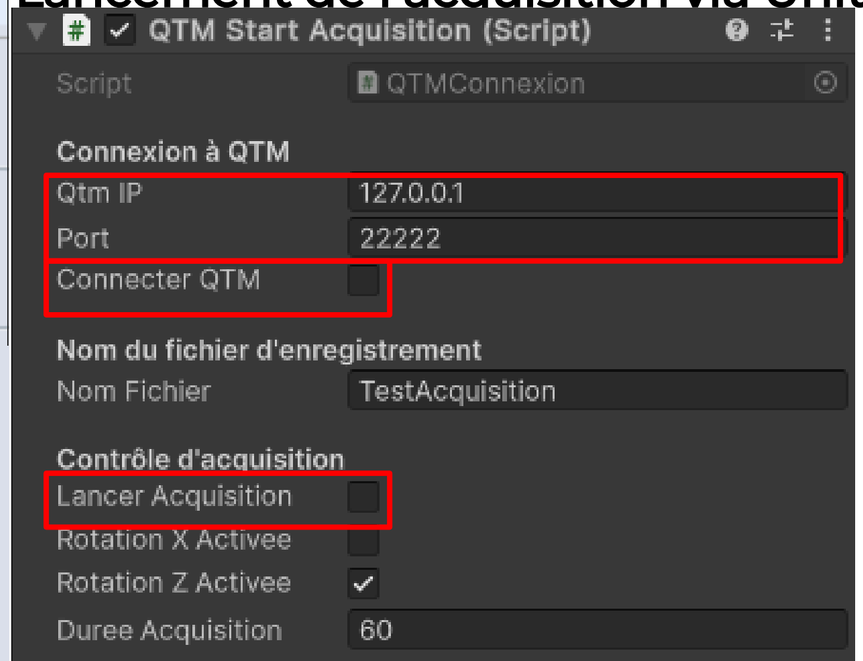
Qualisys Unity SDK

Unity

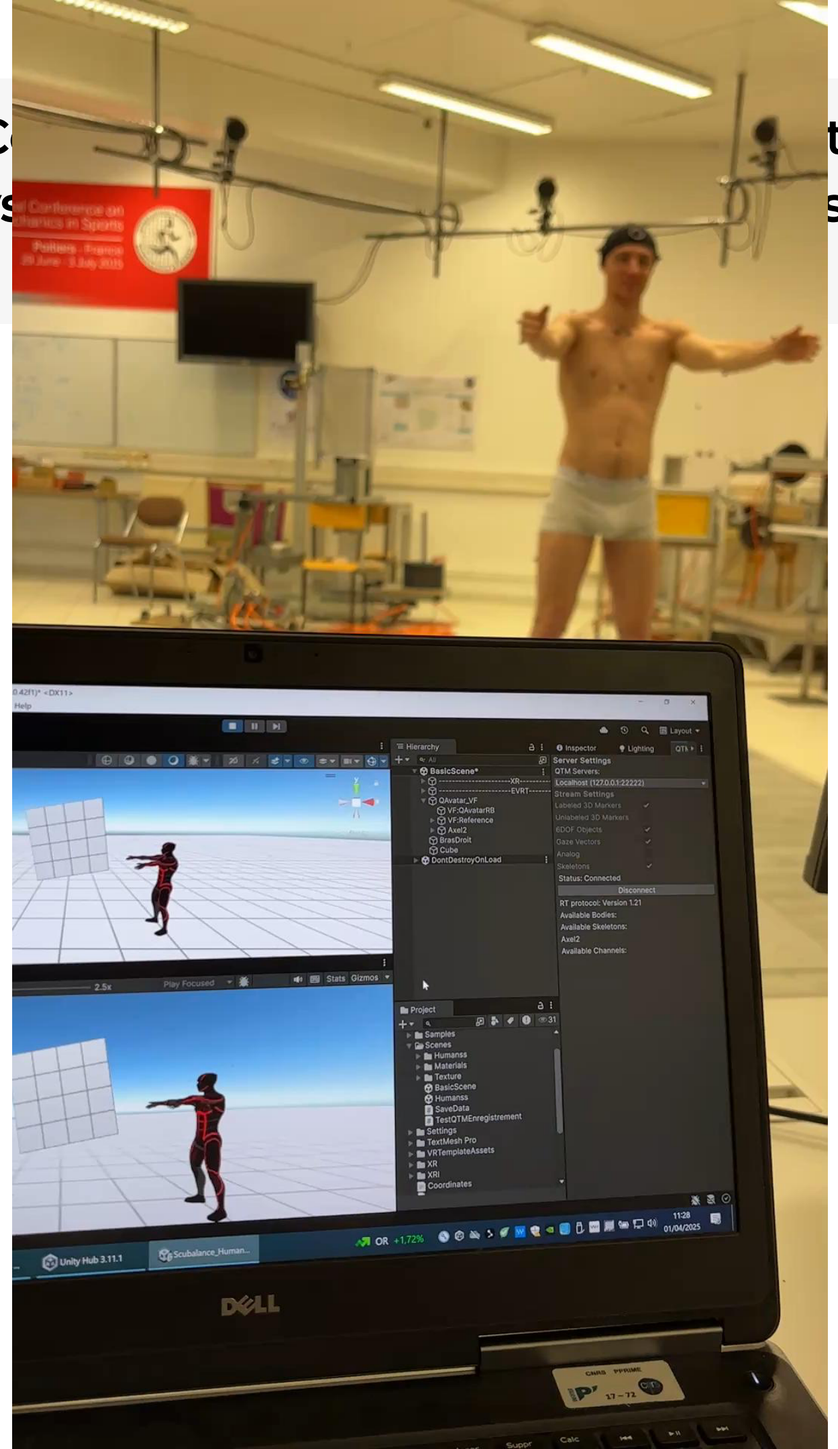




Lancement de l'acquisition via Unity

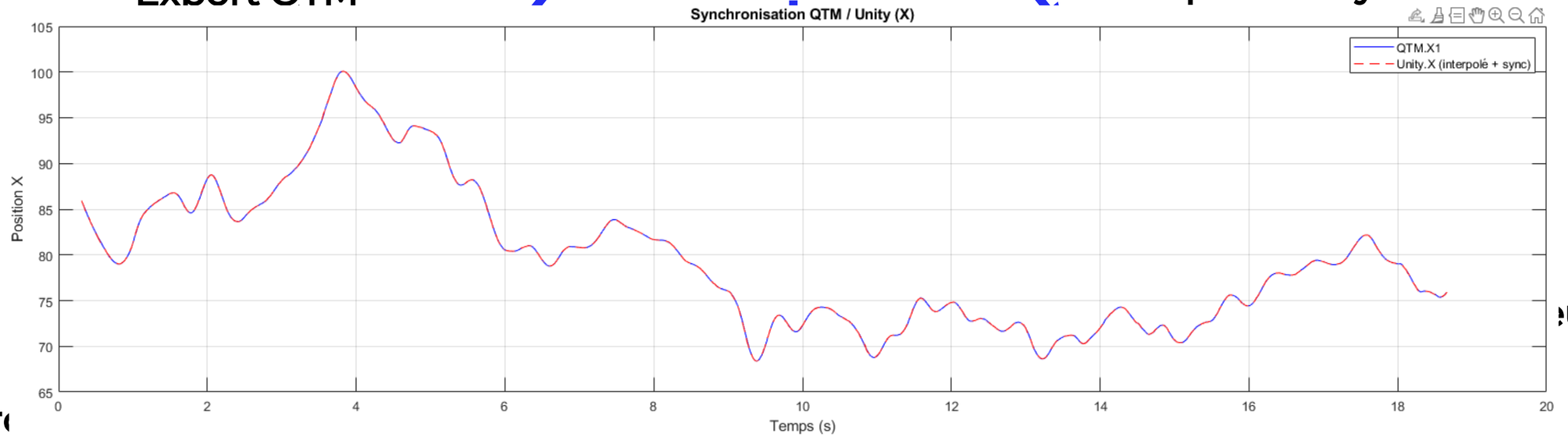


C ts
sys ser


Hierarchy
Inspector
Lighting
Server Settings
QTM Servers:
Localhost (127.0.0.1:22222)
Stream Settings
Labeled 3D Markers
Unlabeled 3D Markers
6DOF Objects
Gaze Vectors
Analog
Skeletons
Status: Connected
Disconnect
RT protocol: Version 1.21
Available Bodies:
Available Skeletons:
Axel2
Available Channels:
Project
Play Focused
Stats
Gizmos
Unity Hub 3.11.1
DELL

Export QTM

Export Unity



For

```
QTM : 100.00 Hz | Unity : 62.53 Hz
Décalage estimé : -31 échantillons (-0.310 s)
Différence moyenne absolue : 0.02 mm | Ecart-type de la différence : 0.03 mm
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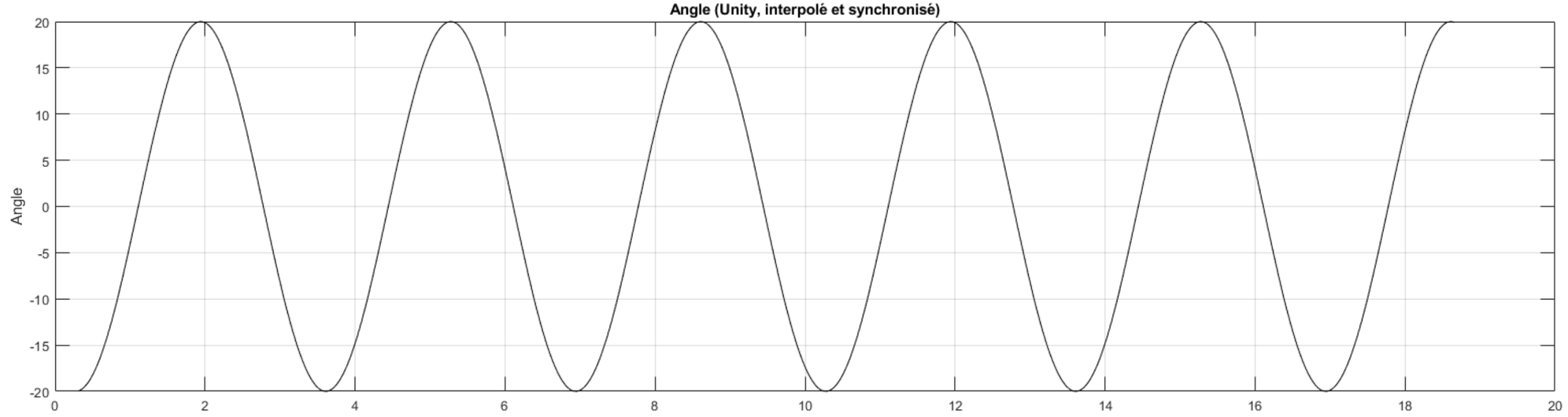
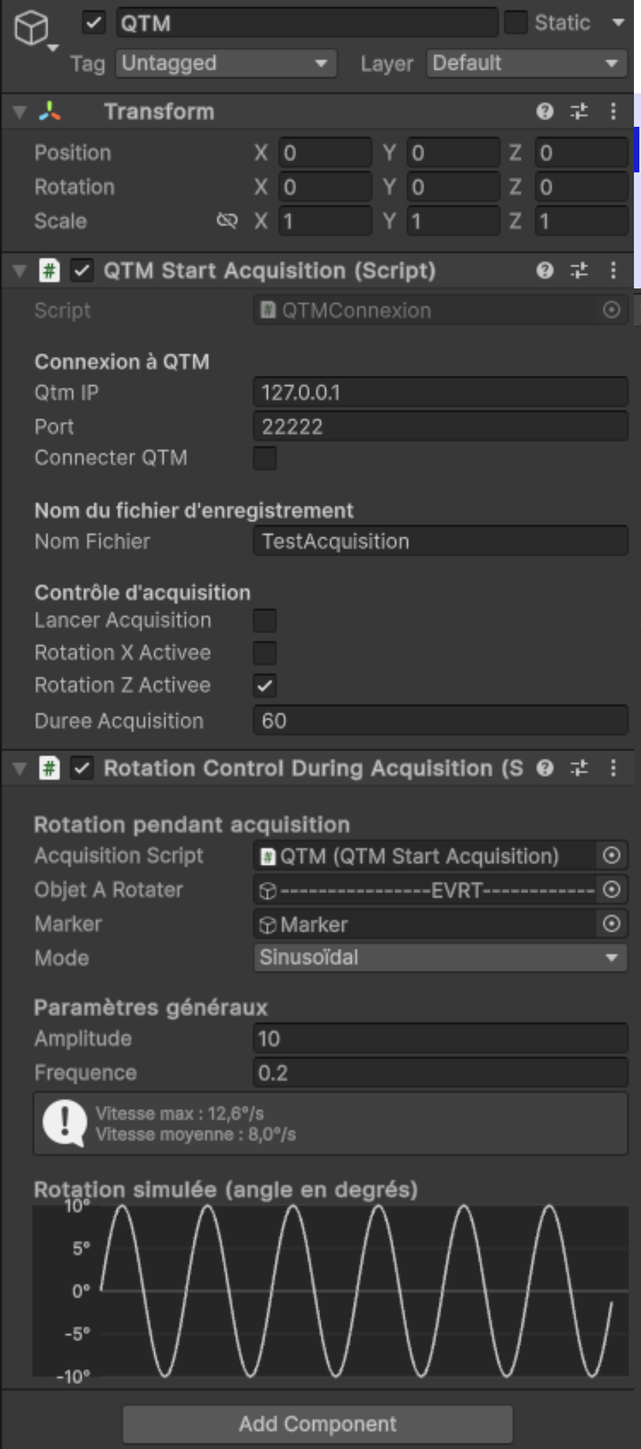
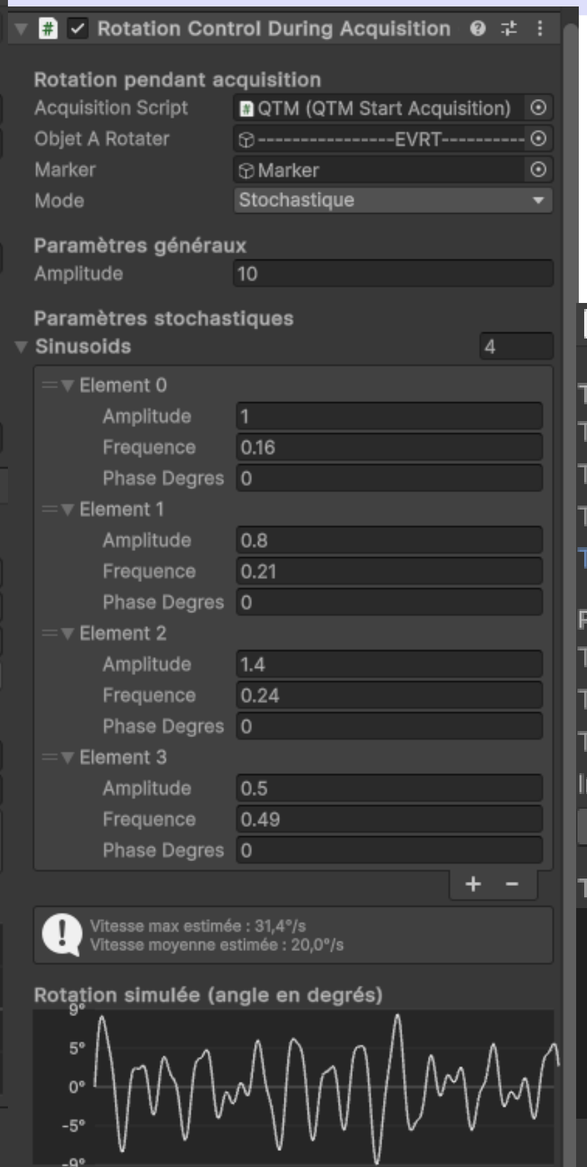
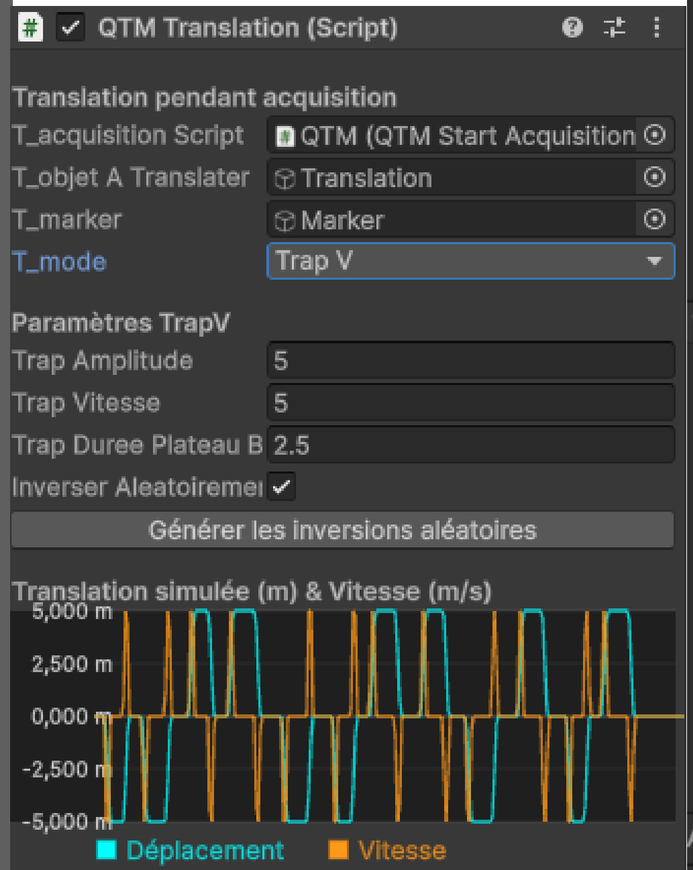
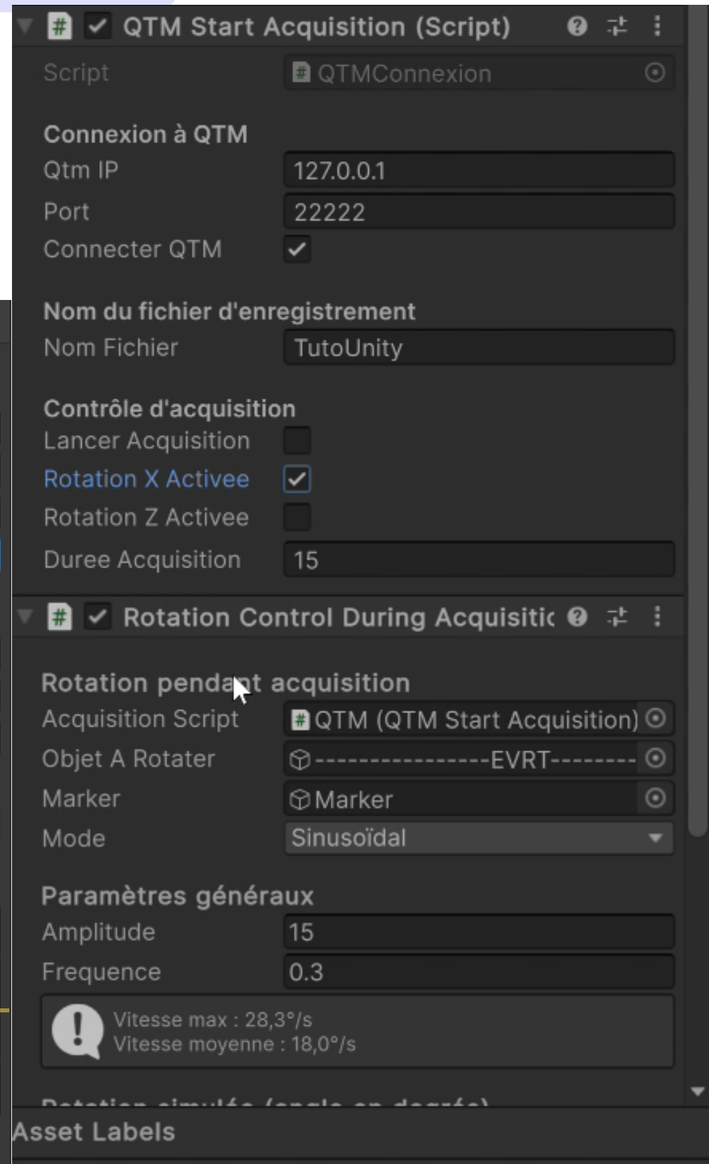


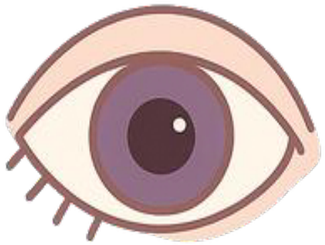
Interface dans Unity facilement utilisable pour paramètrer les stimuli



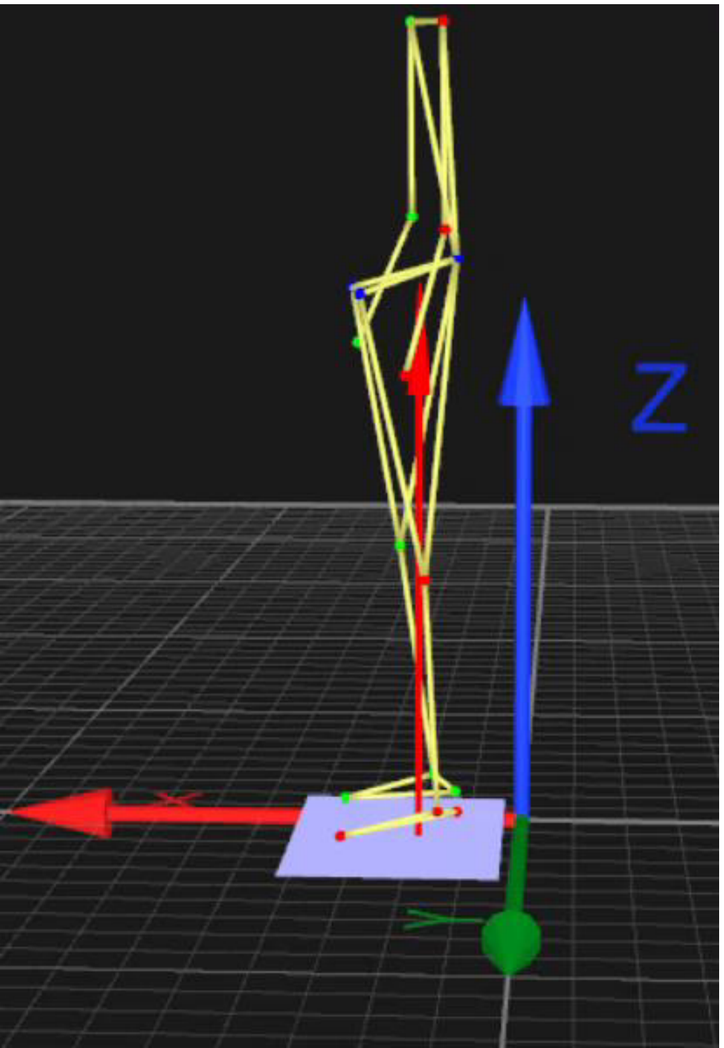


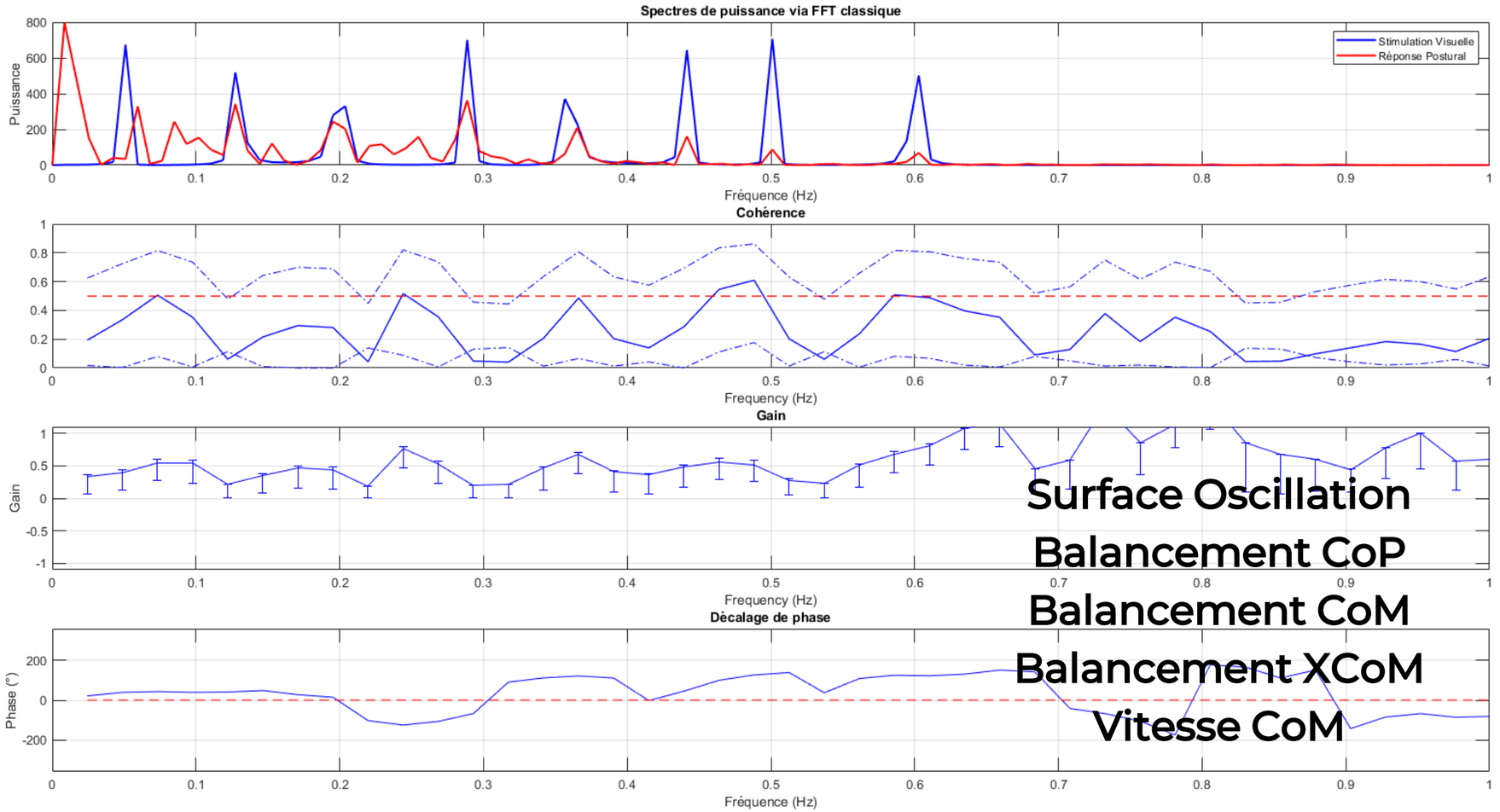




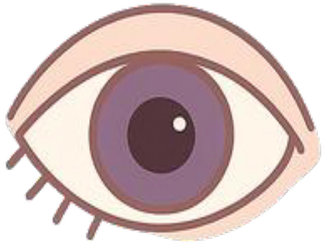


Routine de traitement pour exploiter les données reliant stimulus visuel et réponses posturales

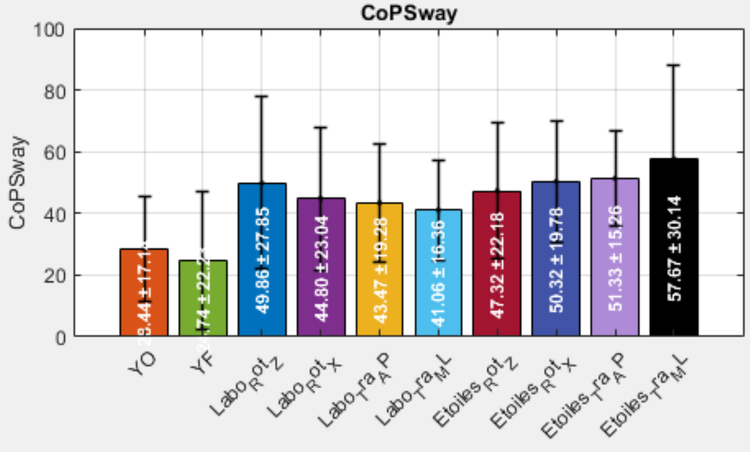


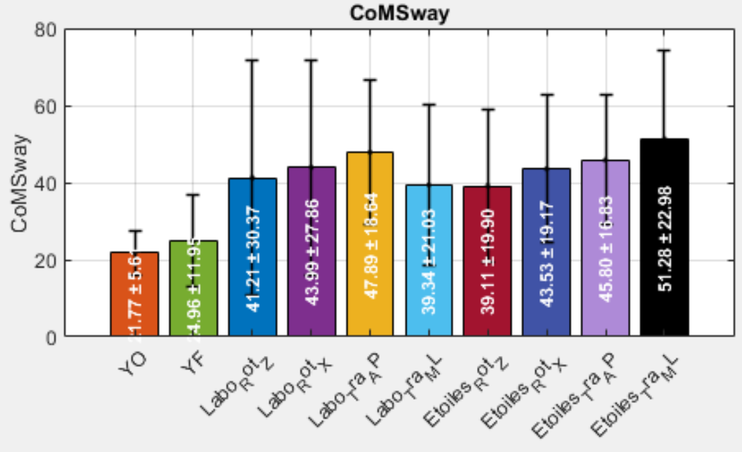


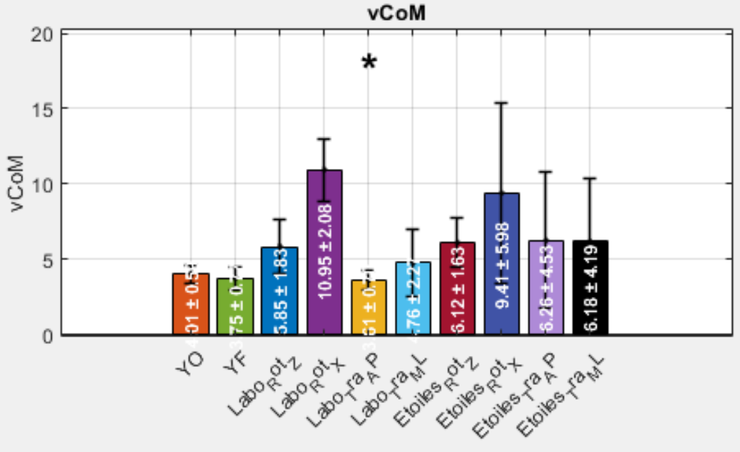
Surface Oscillation
Balancement CoP
Balancement CoM
Balancement XCoM
Vitesse CoM

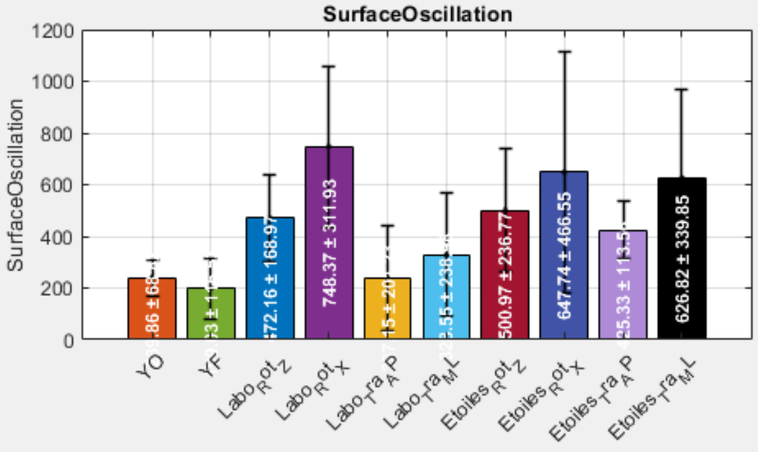


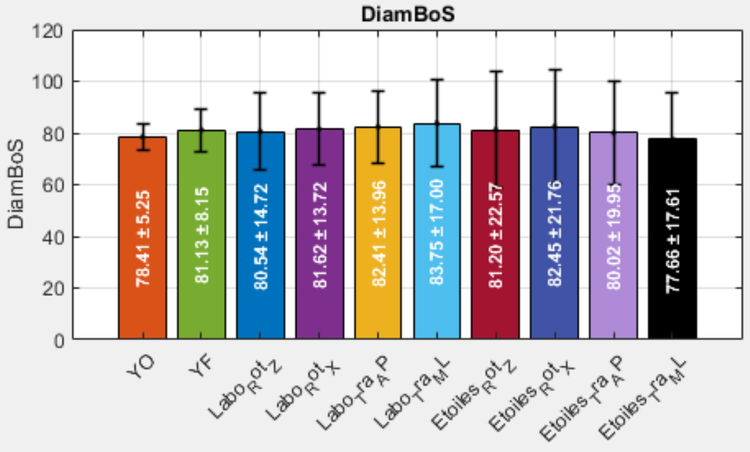
Routine de traitement pour exploiter les données reliant stimulus visuel et réponses posturales











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Optimisation de stimuli visuels induisant des réponses posturales en environnement virtuel

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