

# Implementing virtual partners for sensorimotor synchronization research

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Interpersonal coordination

Computational modelling

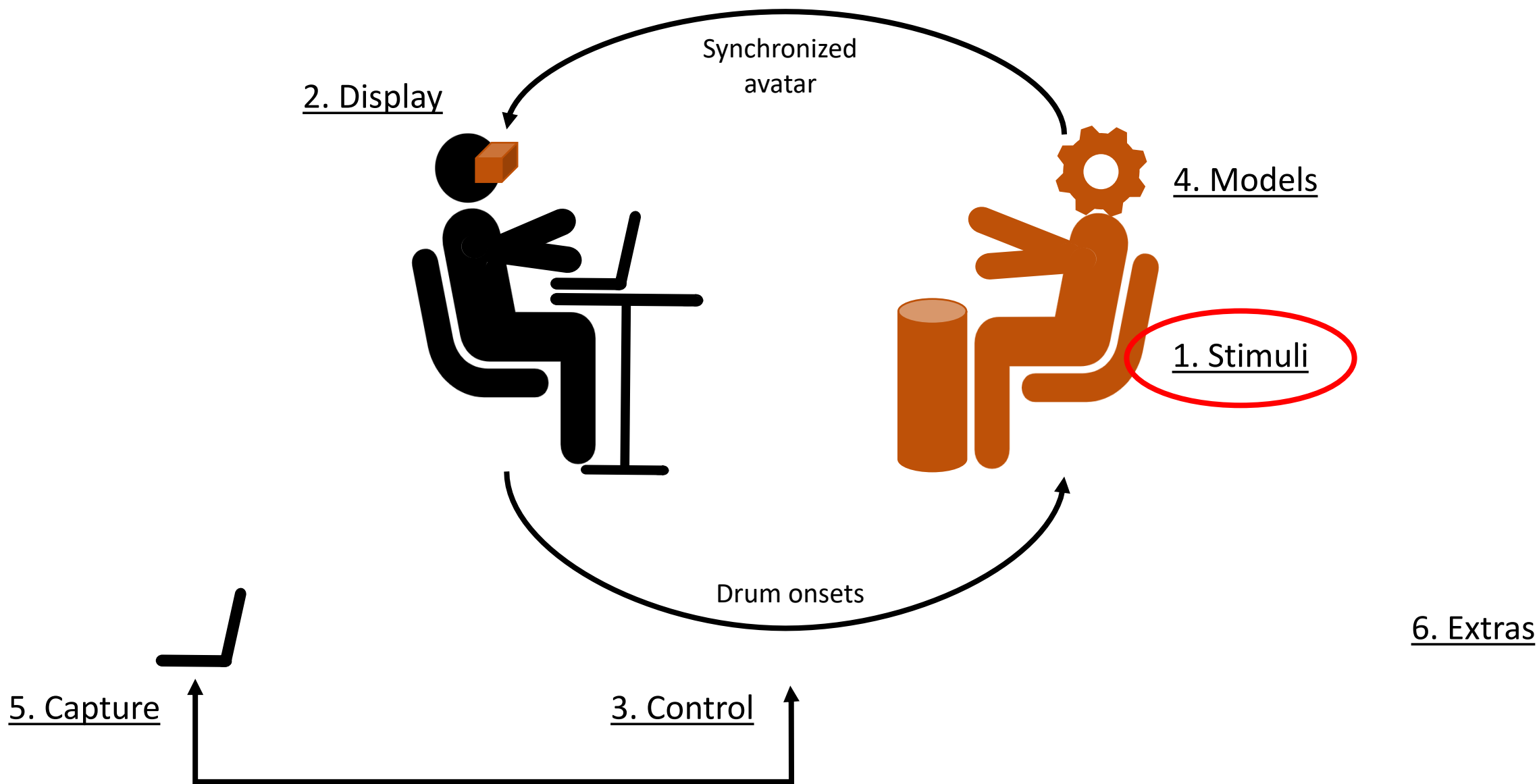
Virtual partner interaction paradigms

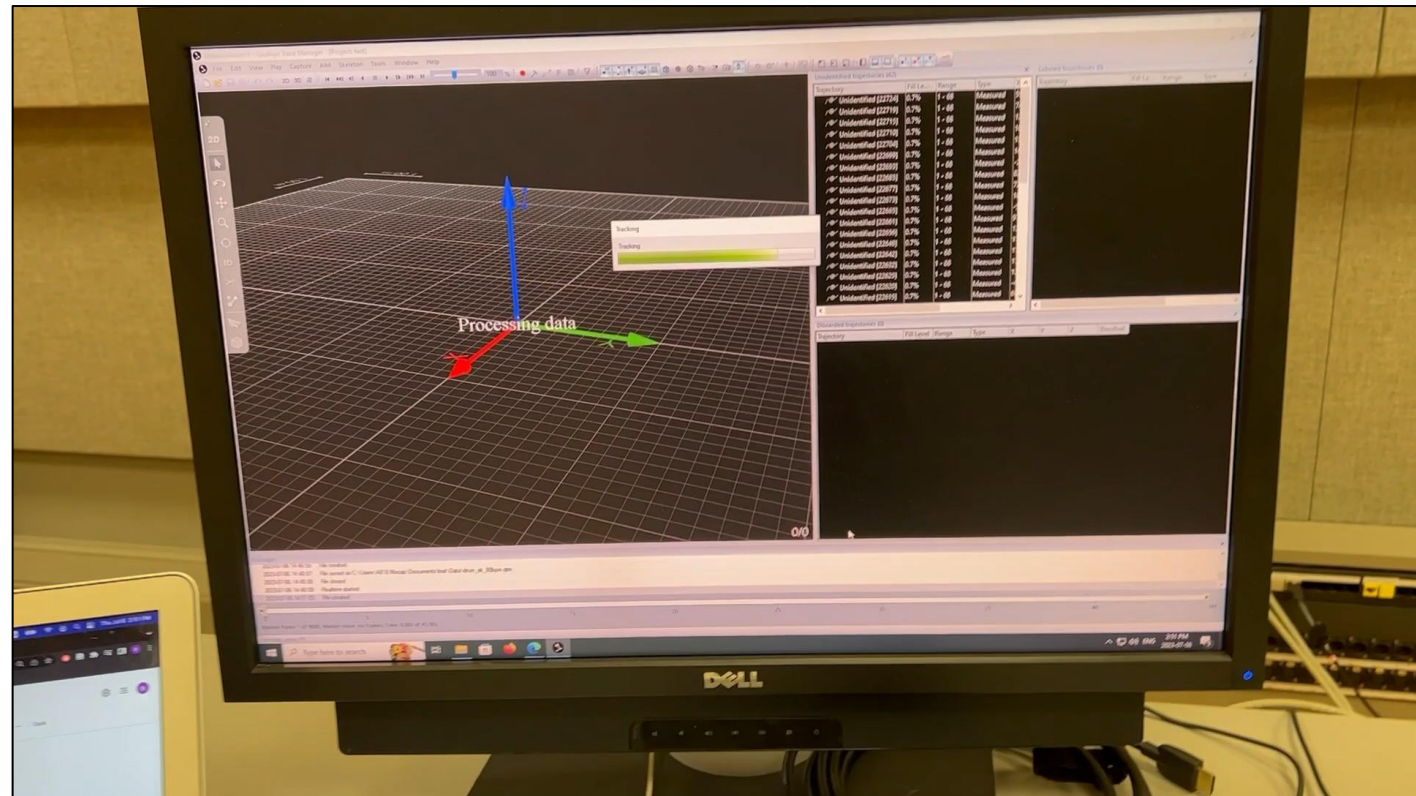
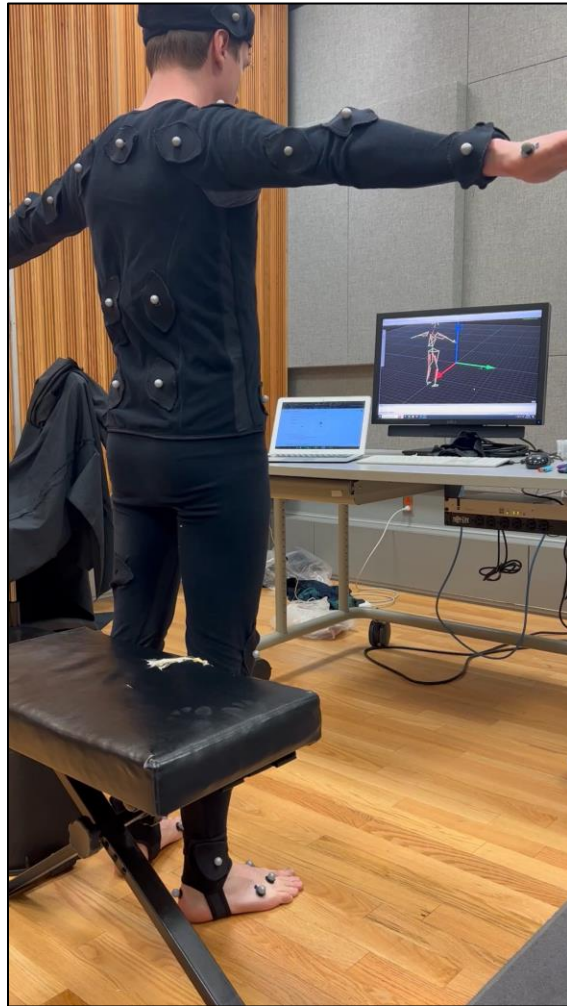
XR and embodied interaction

[Demos, AP, Palmer, C. "Social and nonlinear dynamics unite: Musical group synchrony." Trends in Cognitive Sciences (2023)]

[Kelso, JA Scott, et al. "Virtual partner interaction (VPI): exploring novel behaviors via coordination dynamics." PloS one (2009)]

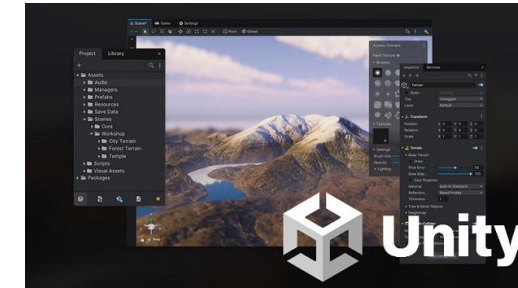
[Van Kerrebroeck, B, et al. "A methodological framework for assessing social presence in music interactions in virtual reality." Frontiers in Psychology (2021)]





## Avatars, agents, and animations

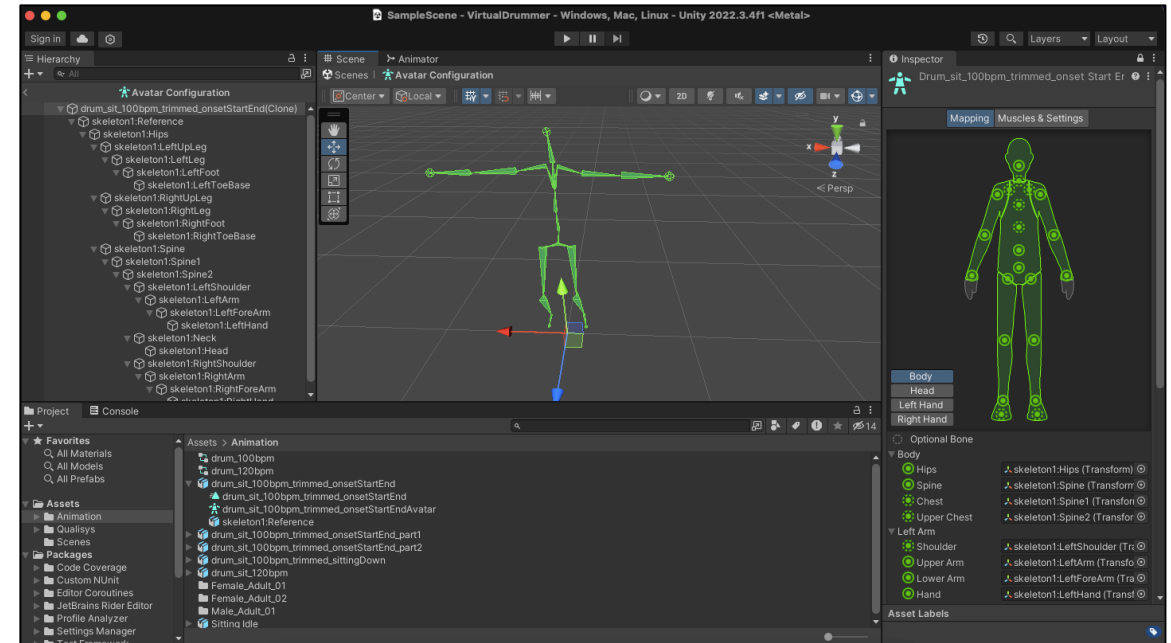
- Humanoids
- Skinning and rigging
- State-flow diagrams
- Inverse kinematics

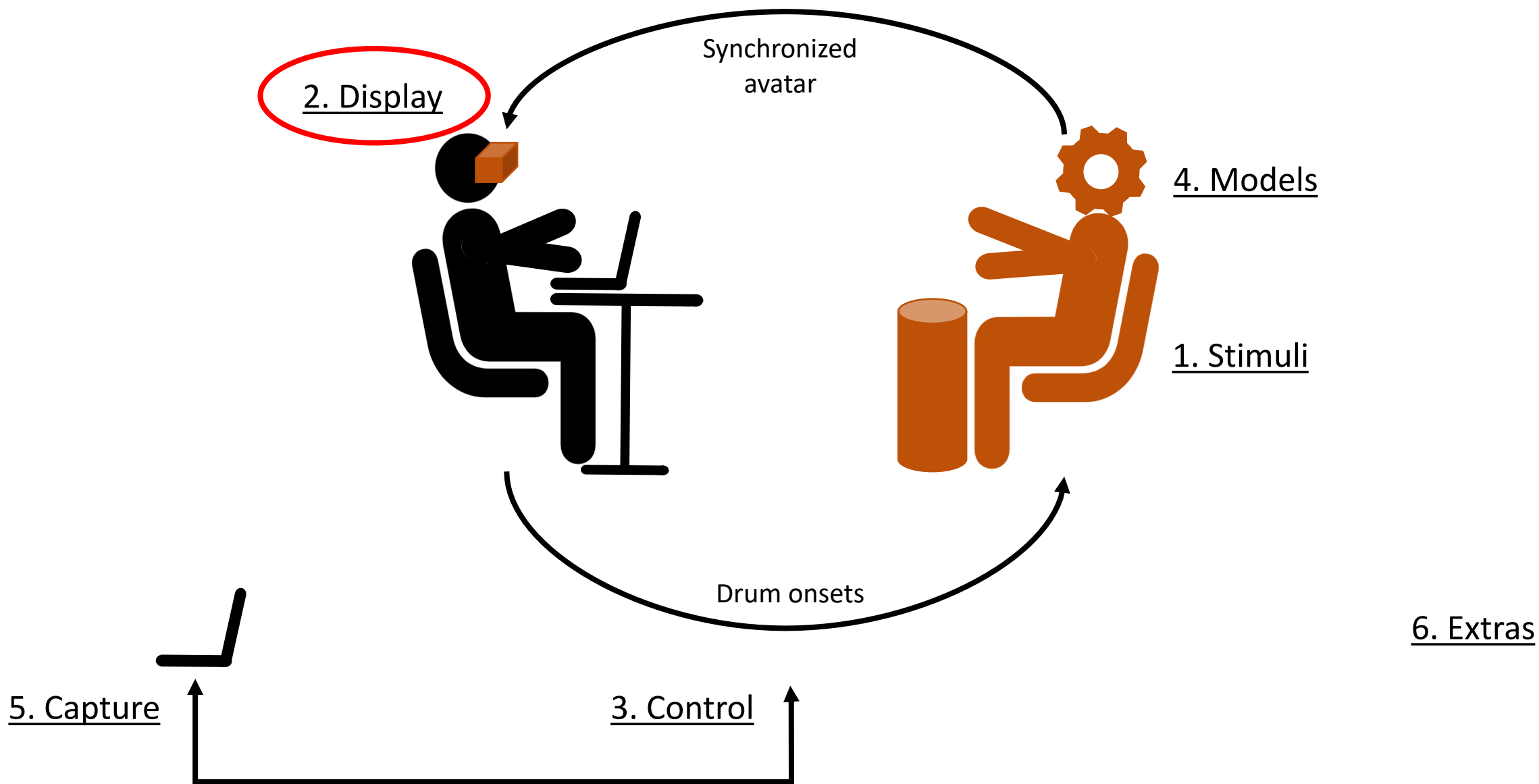


## Animation and avatar databases

- [www.github.com/microsoft/Microsoft-Rocketbox](https://www.github.com/microsoft/Microsoft-Rocketbox)
- [www.mixamo.com](https://www.mixamo.com)

## Combining animations





## Head-mounted displays

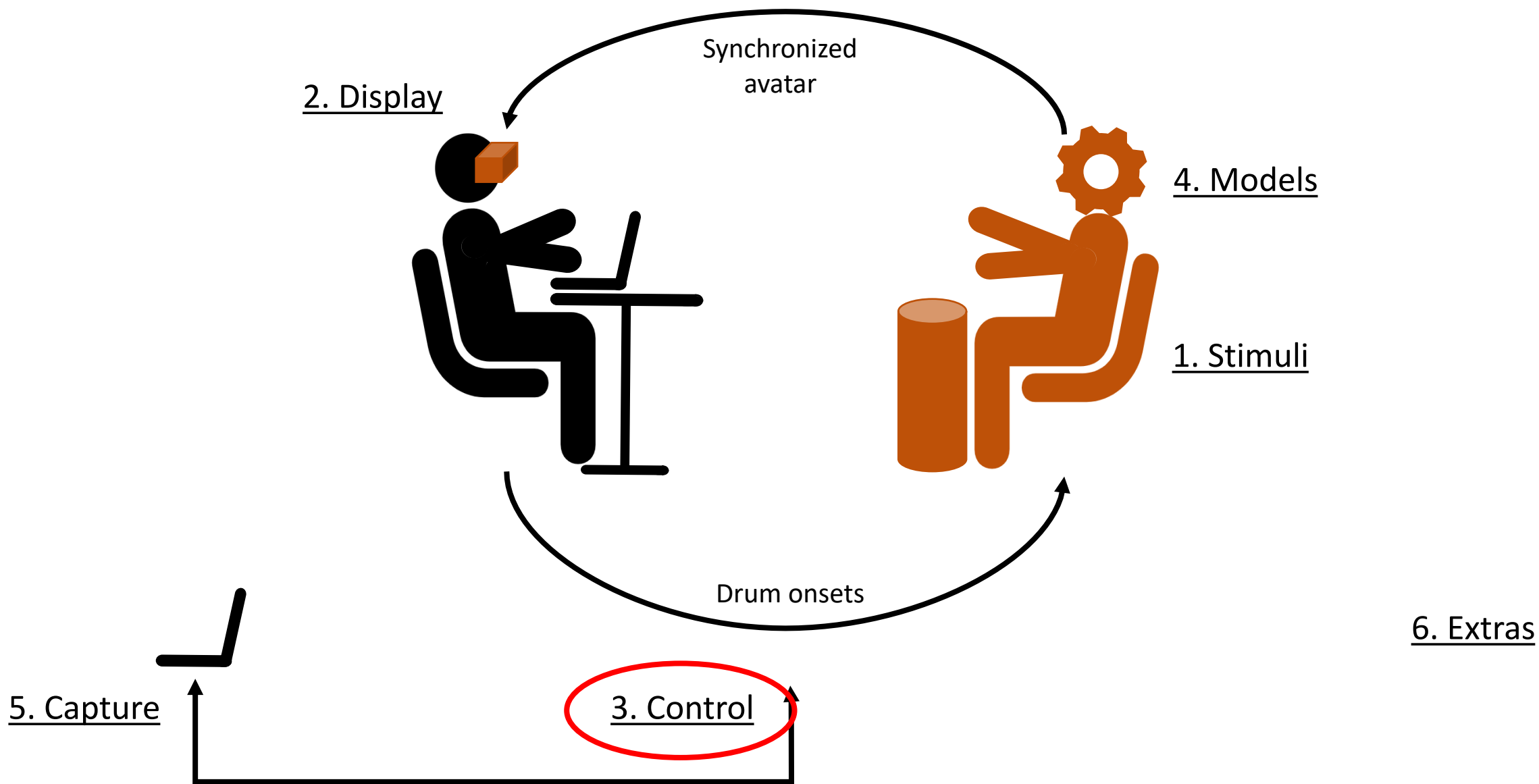
### Frameworks

- [OpenXR](#)
- Meta ([Oculus Integration SDK](#))
- Microsoft ([MRTK](#))

### Streaming, building, deploying

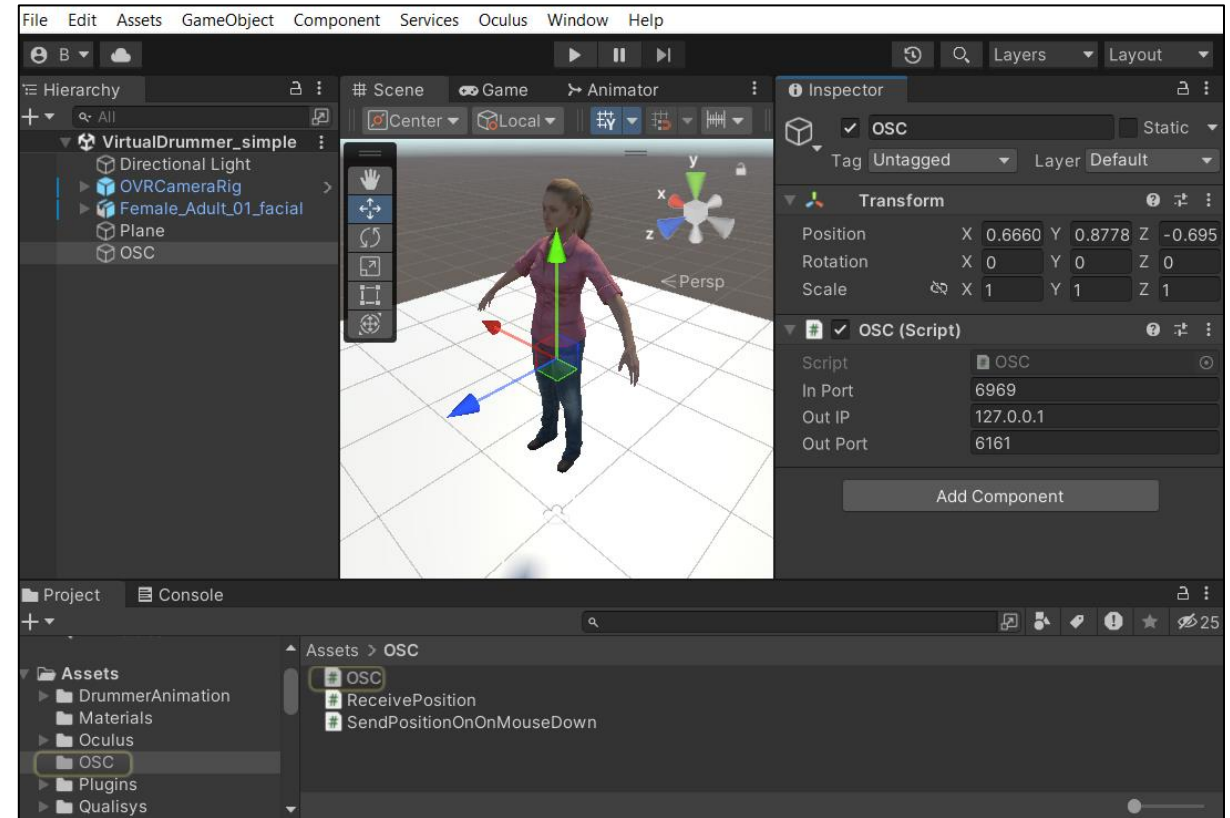
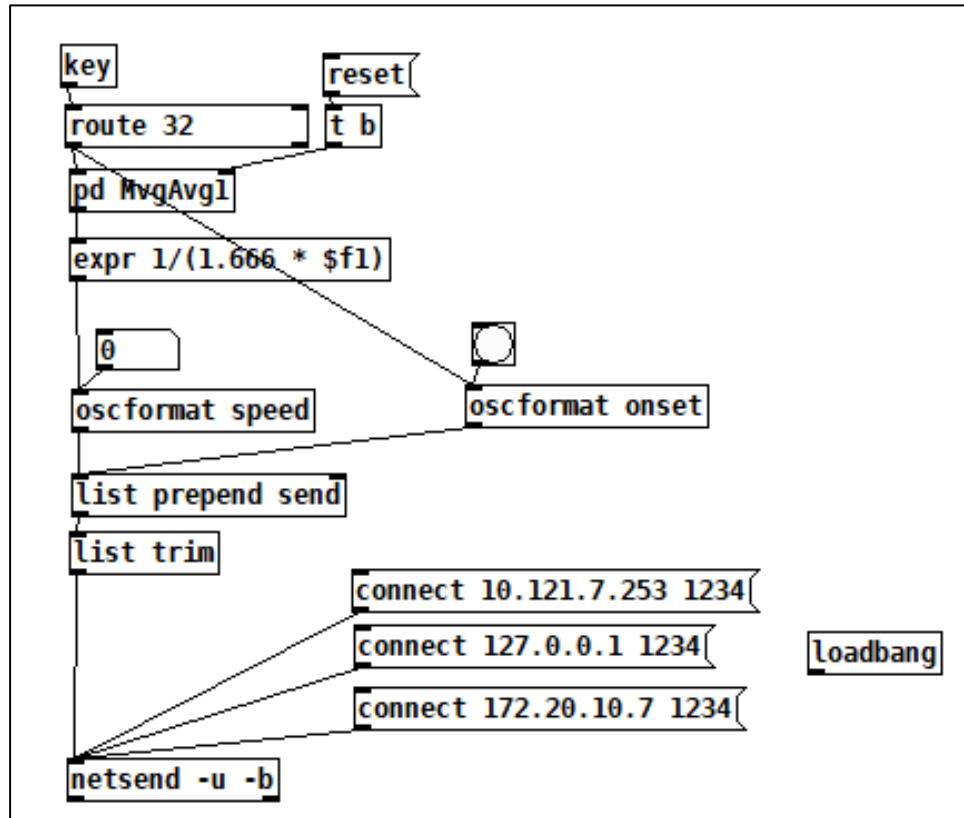
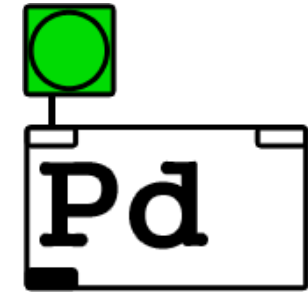
- VR-ready GPUs
- Mac and Windows (+sideloading)

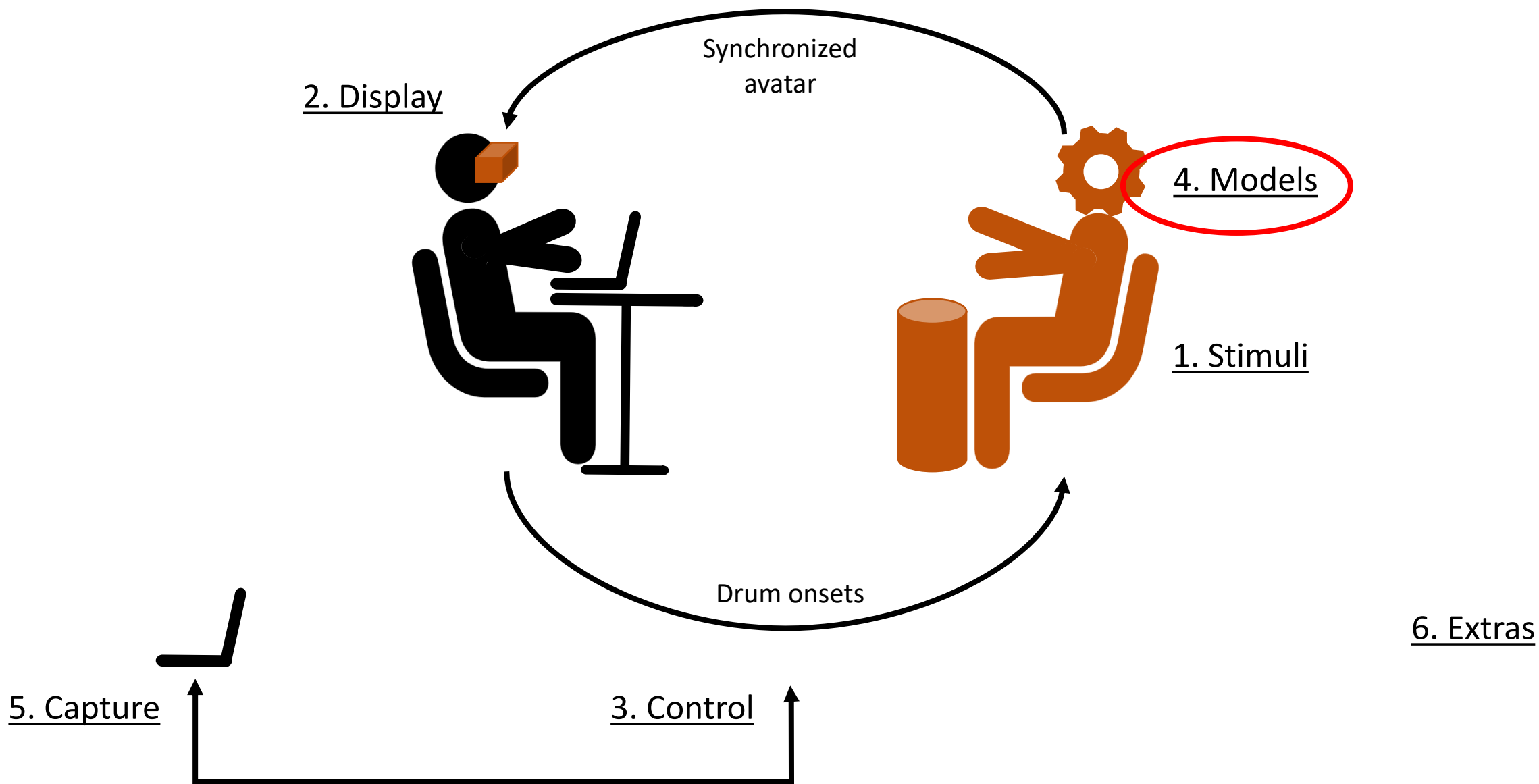






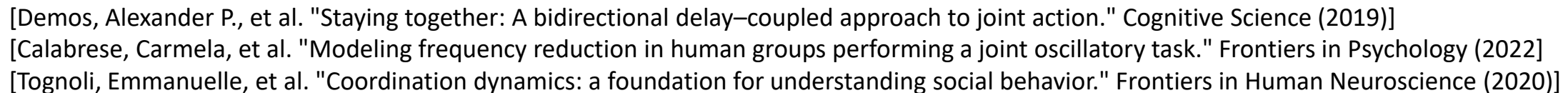
# Networking

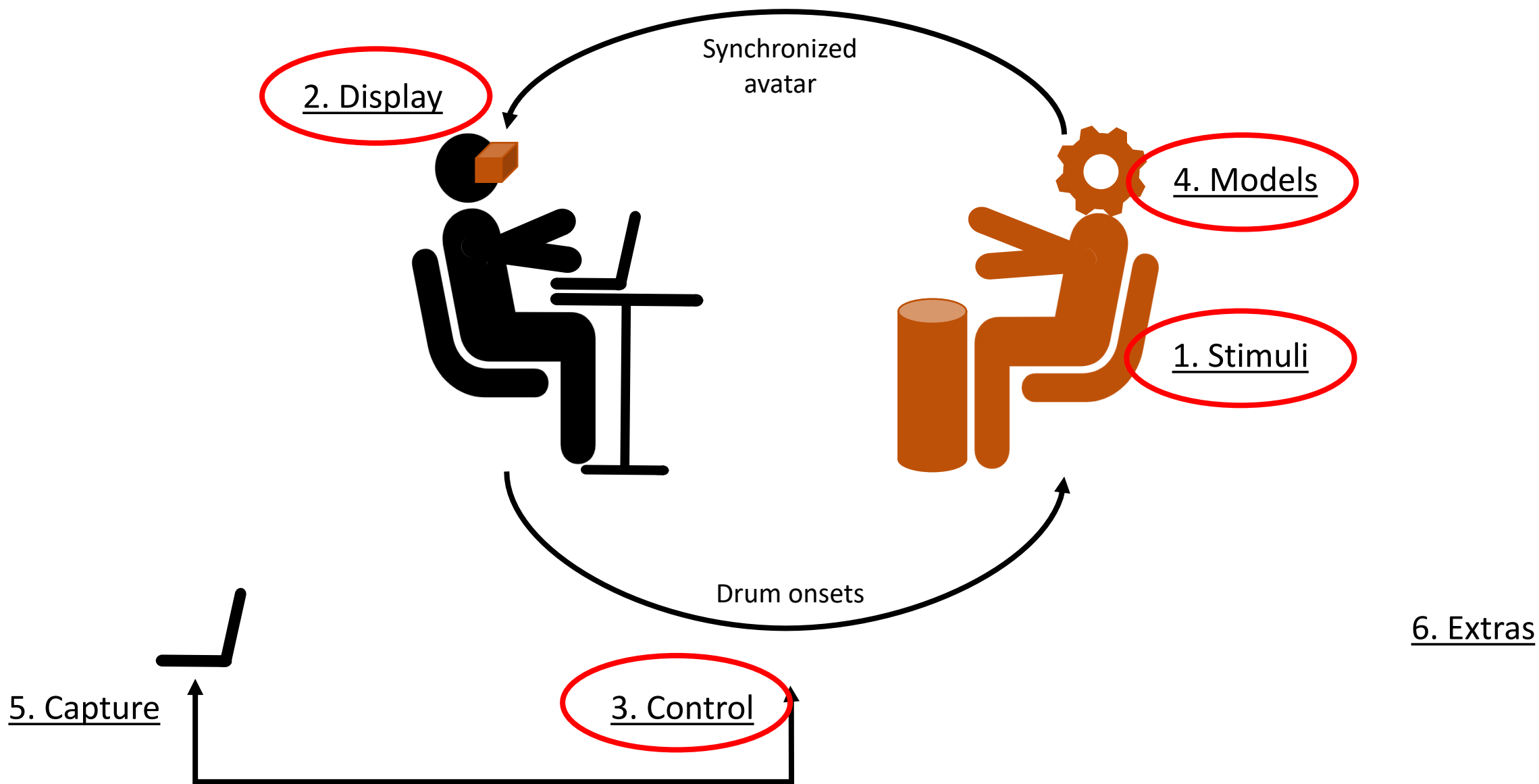




e.g. Kuramoto model

## + variations and extensions





VirtualDrummer\_oculus - VirtualDrummer\_simple - Android - Unity 2022.3.4f1 <DX11>

File Edit Assets GameObject Component Services Oculus Window Help

Hierarchy Scene Game Animator

VirtualDrummer\_simple

- Directional Light
- OVRCameraRig
- Female\_Adult\_01\_facial
- Plane
- OSC
- New Game Object
- New Game Object
- DontDestroyOnLoad

Scene View

Project Console

Clear Collapse Error Pause Editor

[17:34:21] Unable to process a controller whose SampleRateHz is 0 now.  
UnityEngine.Debug:Log (object)

[17:34:21] Unable to process a controller whose SampleRateHz is 0 now.  
UnityEngine.Debug:Log (object)

[17:34:22] [OVRManager] OnApplicationFocus(false)  
UnityEngine.Debug:Log (object)

[OVRManager] OnApplicationFocus(false)

VPLcontrol.pd\* - C:/Users/docto/OneDrive/Desktop

File Edit Put Find Media Window Help

Onset inputs (bangs)

loadbang  
listen 7562  
netreceive -u -b  
oscparse  
list trim  
route agentOnset  
t b

key  
route 32 96  
s playerOnset  
s reset

pd MvgAvg1  
expr 1/\$f1  
t f b  
0  
phasor~  
snapshot~  
expr modf(\$f1)

pd MvgAvg2  
expr 1/\$f1  
t f b  
0  
r reset  
metro 10  
t b b  
phasor~  
snapshot~  
expr modf(\$f1)

Inputs (phase)  
Coupling  
Intrinsic frequency (Hz)

0  
0  
0  
expr \$f3 + \$f2 \* sin(2 \* 3.14159 \* \$f1) / (2 \* 3.14159)  
0 Agent freq

cyclone/delta~  
cyclone/lessthan~ -0.5  
cyclone/edge~  
Agent onset (bang)

r playerOnset  
tabplay~ sample-1-1  
pack 0 50  
line~  
loadbang  
read -resize Sounds/EweTalking.wav sample-1-1  
soundfiler array define sample-1-1

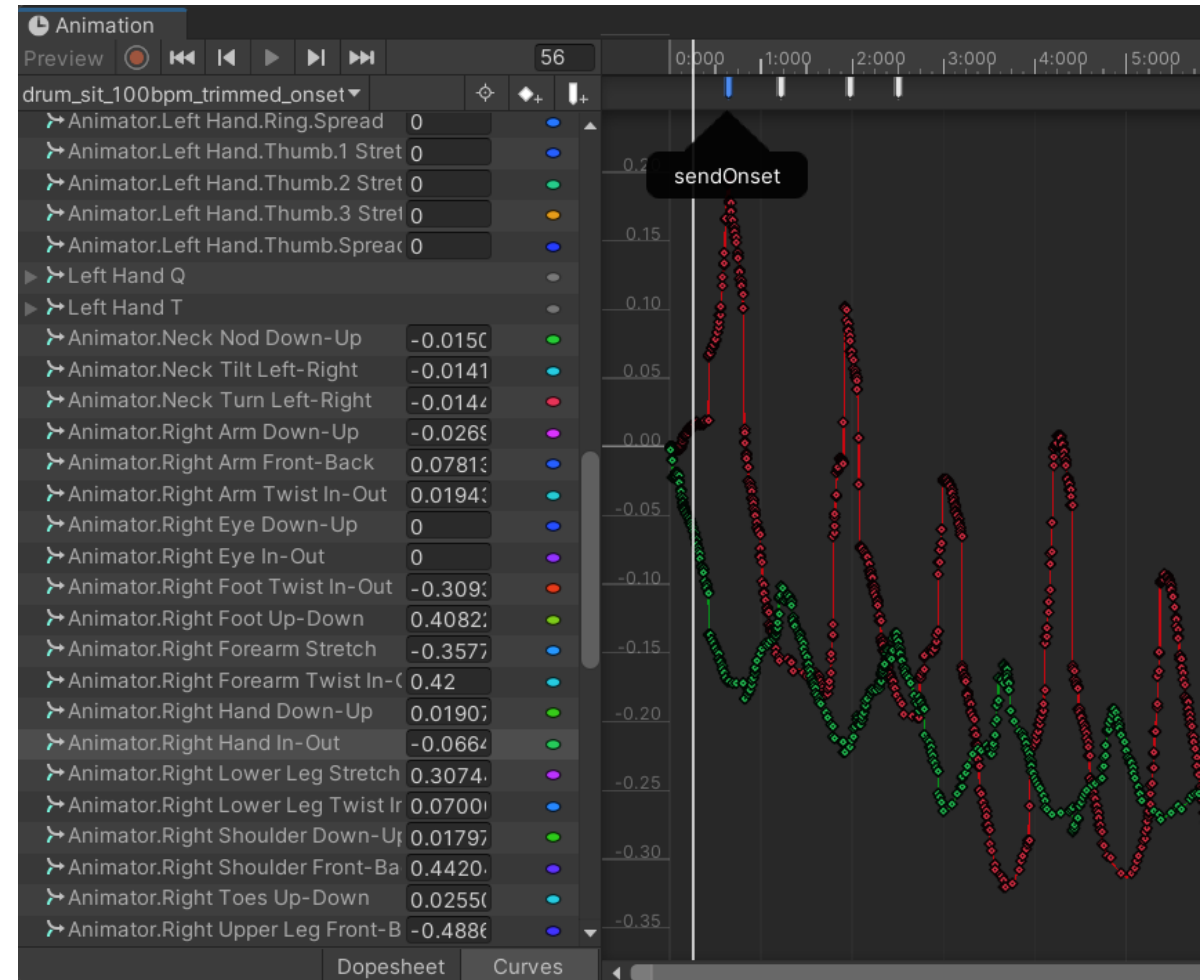
oscformat speed  
oscformat phase  
list prepend send  
list trim  
connect 10.121.7.253 1234  
netsend~u~b  
connect 127.0.0.1 1234

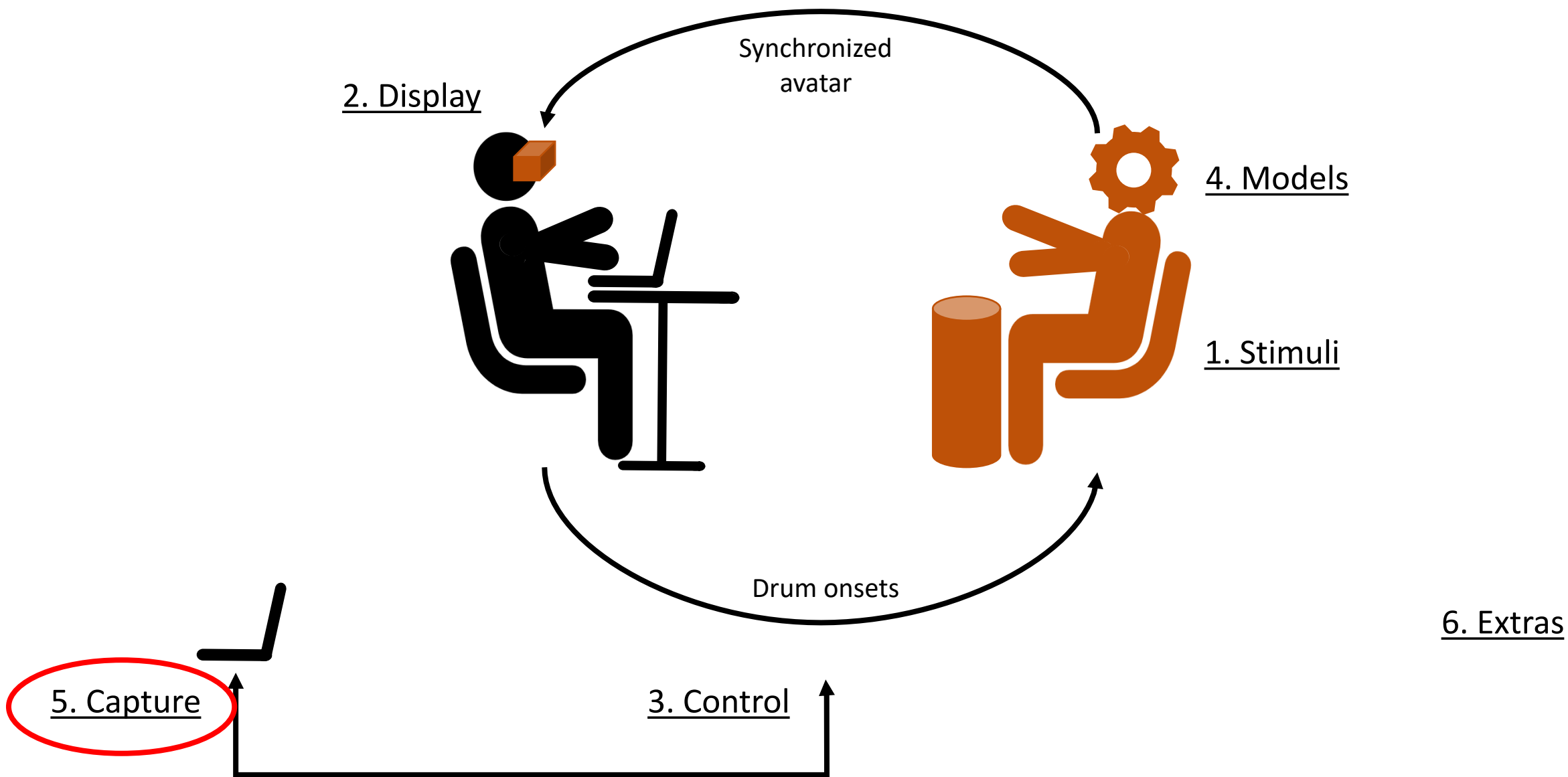
# Latency and synchronization

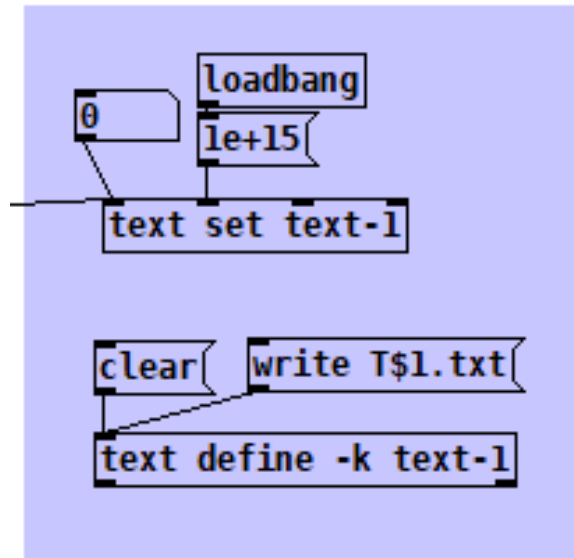
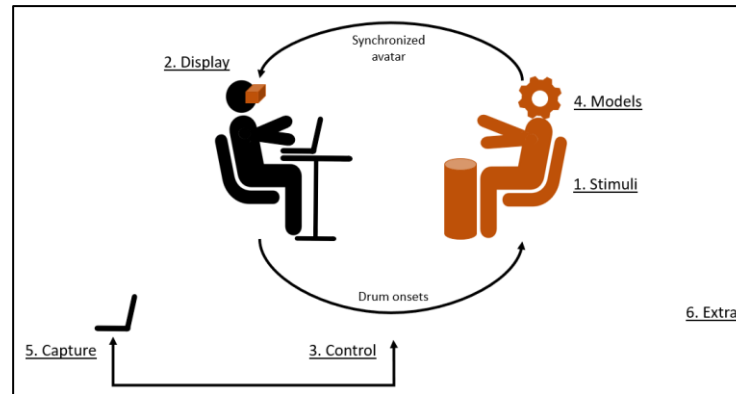
- Pd → Unity
  - Single cycle animation
  - Multiple cycle animation
- Unity → Pd
  - Events in mocap timeseries

Latencies in ...

drum pad, processing, (wireless)  
streaming to HMD, audio latencies





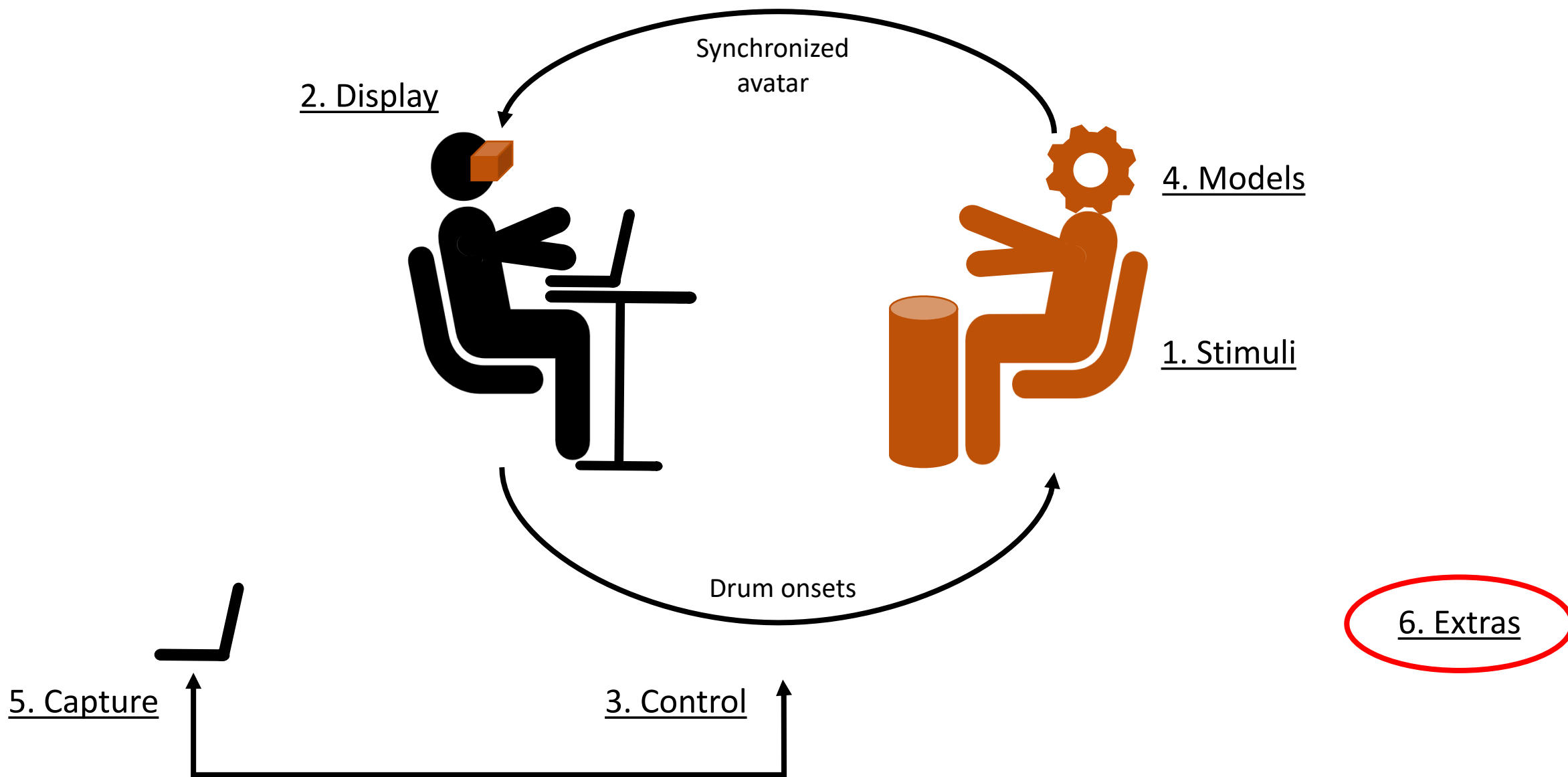


```

Assembly-CSharp
RecordData
1  using System;
2  using System.Collections;
3  using System.Collections.Generic;
4  using System.IO;
5  using UnityEngine;
6
7  0 references
8  public static class RecordData
9  {
10     private static StreamWriter _sw;
11     private static string _path = string.Concat(Application.dataPath, "/../", "filename1.csv");
12     private static string _header = string.Concat("trialname", Environment.NewLine);
13
14     0 references
15     public static void Initialize()
16     {
17         _sw = System.IO.File.CreateText(_path);
18         _sw.Close();
19
20         if (!File.Exists(_path))
21         {
22             _sw = System.IO.File.CreateText(_path);
23             _sw.WriteLine(_header);
24             _sw.Close();
25         }
26         else
27         {
28             System.IO.File.AppendAllText(_path, _header);
29         }
30
31     0 references
32     public static void LogOutput(string unityTime, float onset)
33     {
34         string _line2write = string.Concat(unityTime, ",", onset, Environment.NewLine);
35         File.AppendAllText(_path, _line2write);
36     }
37 }

```





## 6. Extra

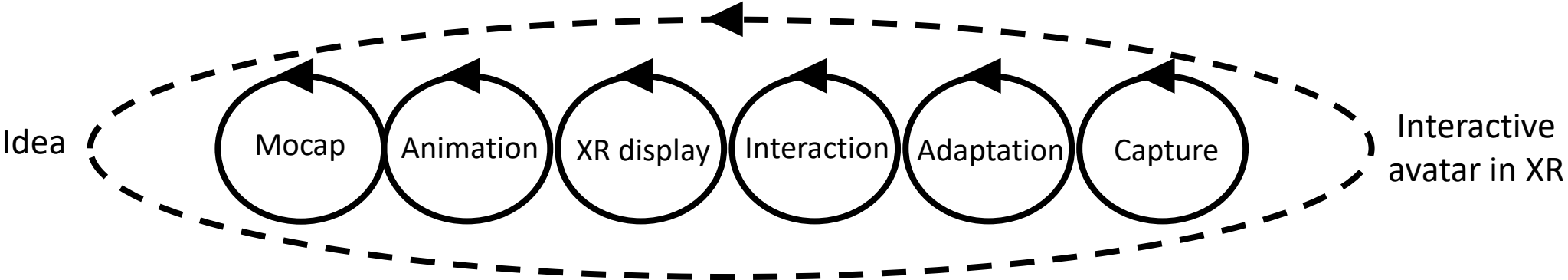
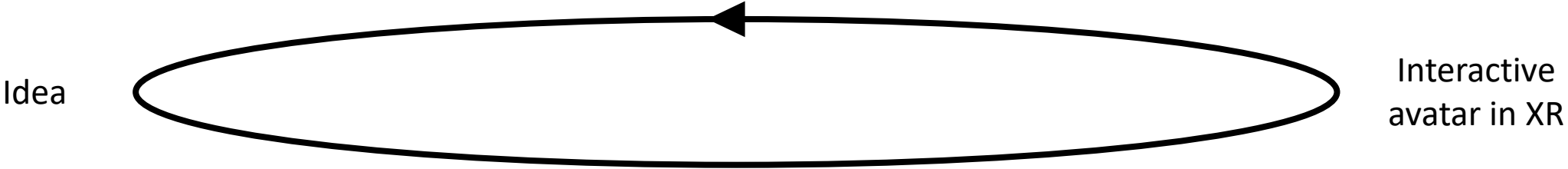
- Real-world alignment
- Multi-user
- Spatial/immersive audio
- Capture, (bio)feedback
  - (Neuro)physiology, eye gaze, action logs, ...
- Use-cases?
  - Group dynamics [Demos 2023]
  - Mirroring paradigms [Gonzalez-Franco 2010]
  - Body swapping [De Oliveira 2016]

[Demos, Alexander P., and Caroline Palmer. "Social and nonlinear dynamics unite: Musical group synchrony." *Trends in Cognitive Sciences* (2023)]

[Gonzalez-Franco, Mar, et al. "The contribution of real-time mirror reflections of motor actions on virtual body ownership in an immersive virtual environment." *2010 IEEE virtual reality conference (VR)*]

[De Oliveira, et al. "Virtual body swap: a new feasible tool to be explored in health and education." *2016 XVIII Symposium on Virtual and Augmented Reality (SVR)*]

# Iterate in short and rapid cycles



[www.github.com/bvk0/virtualDrummer](https://www.github.com/bvk0/virtualDrummer)

Questions, ideas, feedback?

Contact me on *LinkedIn* or *bavo.vankerrebroeck@mail.mcgill.ca*