

PsyForge – Easy, Modern, Real-time, 2D/3D Experiment Design

James P. Bruska
Bruska Technologies LLC



Bruska Tech

Tech Solutions for
Psychology and Neuroscience

Limitations of Experiment Programming Libraries

- Libraries only use 1 of the 8-32 compute cores in modern computers
- Lack of prebuilt 3D game components
- Standard Unity cannot reliably support closed-loop systems due to its design
- Many lack <1ms event reaction time
- We use threaded event loops to utilize all cores, react with <1ms precision, and enable reliable closed-loop experiments
- We also provide many prebuilt game components for 2D & 3D experiments

Example Experiment



Experiment Programming Library Comparison

| | PsyForge | UXF 2.0 | PandaEPL | jsPsych | PsychoPy |
|-----------------------------|-------------------------------|-------------------------------|----------|------------------|------------------|
| Language | C# / Unity | C# / Unity | Python | JavaScript | Python |
| 2D Support | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3D Support | ✓ | ✓ | ✓ | ✓ | ✓ |
| Cross-Platform | Desktop, Mobile, Online, & VR | Desktop, Mobile, Online, & VR | Desktop | Desktop & Online | Desktop & Online |
| Easy & Safe Multi-Threading | ✓ | | | | |
| Closed-Loop Support | ✓ | | | | ~ |
| Logging | ✓ | ✓ | ✓ | ✓ | ✓ |
| Experiment Startup Screen | ✓ | ✓ | ✓ | | |
| Prebuilt Game Components | ✓ | | | ✓ | ✓ |

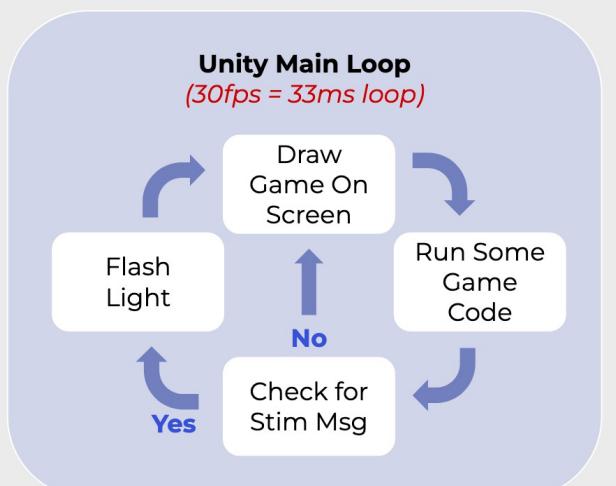
Prebuilt Game Components: Language switching, EEG alignment, Experiment launch screen, Word presentation system, Config system, Math distractor, Questionnaire,

Safe Threads Facilitate Closed-Loop Stimulation

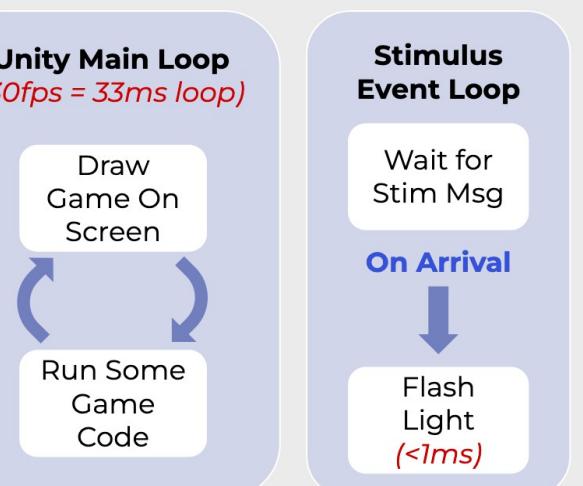
Closed-loop systems are infeasible in standard Unity due to variable frame rates in a single loop.

Imagine trying to flash an external light when EEG is in the positive rising portion (25%) of a 12Hz alpha wave.

Standard Unity



UnityEPL 3.0



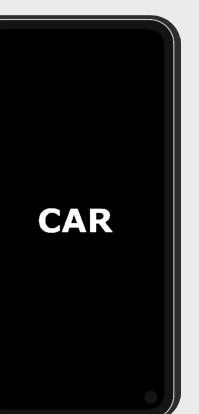
Standard Unity at 30fps? **NO**. 25% of 12Hz is 20ms.

Standard Unity at 60fps? **MAYBE**. Frame rate can vary
UnityEPL 3.0 at any fps? **YES**.

Cross-Platform Releases

Unity can easily deploy to desktop, mobile, online, and even virtual reality headsets.

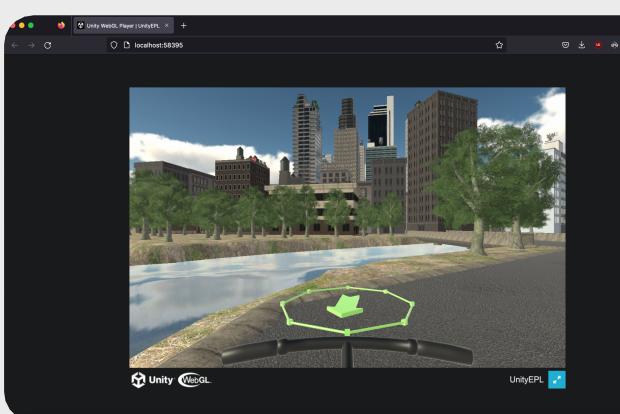
Mobile



ERROR

Could not connect to NetworkInterface.
Please check if your device is connected to the internet.

Online



Conclusions

- Ability to create 2D and 3D closed-loop experiments
- Sub-millisecond reaction time to events
- Several prebuilt game components for 2D and 3D experiment creation
- Easily deployable to desktop, mobile, online, and VR
- All the benefits of the Unity ecosystem
- Open-source (GPLv3) & extendable

<https://github.com/pennmem/UnityEPL>

```
protected async Task ClosedLoopVideo() {
    await manager.videoControl.SelectVideoFile(Config.dataPath, fileExtensions);
    await manager.textDisplayer.PressAnyKey("Start Video", "Press a button to play the video");
    await manager.lightController.StartClosedLoop(manager.videoControl.videoLength);
    await manager.videoControl.PlayVideo();
    var loggingMsg = new Dictionary<string, object> { { "length", manager.videoControl.videoLength } };
    manager.eventReporter.ReportScriptedEvent("Video Info", loggingMsg);
}
```

References

Peirce, Journal of Neuroscience Methods, 2007; de Leeuw, Behavior Research Methods, 2015; Stoet, Behavior Research Methods, 2016; Geller et al., Behavior Research Methods, 2007; Solway et al., Behavior Research Methods, 2013; Del Grosso et al., Behavior Research Methods, 2019; Vasser et al., BMC Psychology, 2017; Brookes et al., Behavior Research Methods, 2020