

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

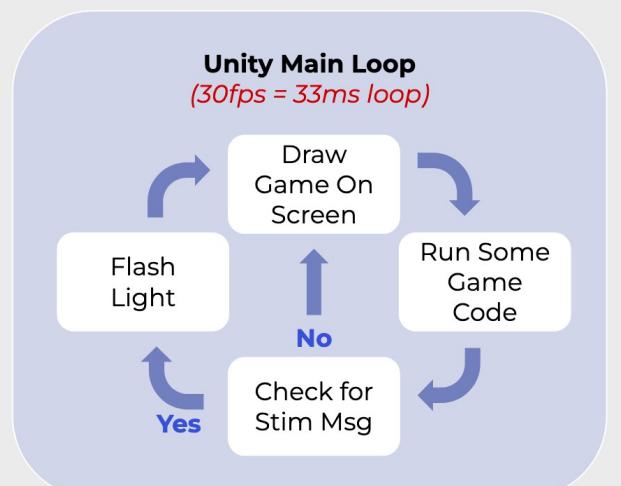


Safe Threads Facilitate Closed-Loop Stimulation

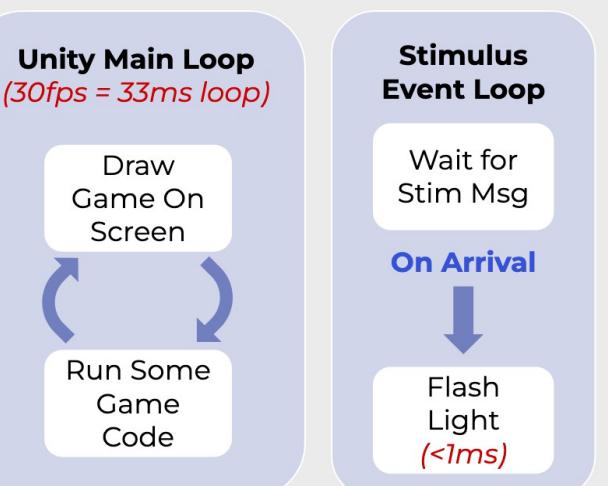
Closed-loop systems are infeasible in standard Unity due to variable frame rates in a single loop.

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**.

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

Experiment Programming Library Comparison

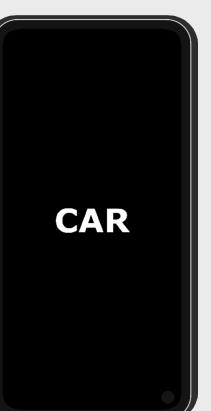
	PsyForge	UXF 2.0	PandaEPL	jsPsych	PsychoPy
Language	C# / Unity	C# / Unity	Python	JavaScript	Python
2D Support	✓	✓	✓	✓	✓
3D Support	✓	✓	✓	✓	
Cross-Platform	Desktop, Mobile, Online, & VR	Desktop, Mobile, Online, & VR	Desktop	Desktop & Online	Desktop & Online
Easy & Safe Multi-Threading	✓				
Closed-Loop 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,

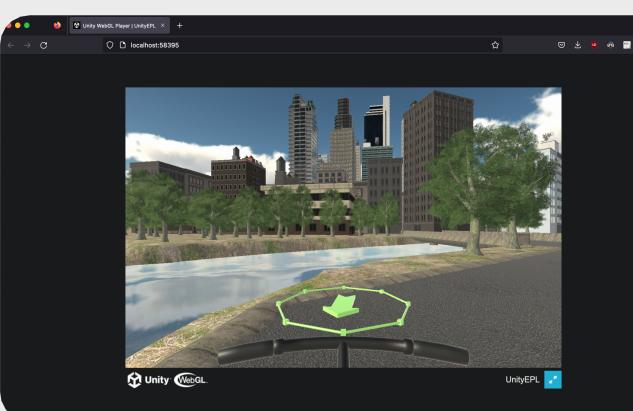
Cross-Platform Releases

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

Mobile



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);
}
```