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Cognitive Mechanical Interference in 2.5D Platformers:

Balancing “Masocore” Difficulty with Cognitive Accessibility

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CONTENTS

LIST OF TABLES

TABLE OF FIGURES

Topic: Cognitive-Mechanical Interference in 2.5D Platformers

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ABSTRACT

This investigation evaluates the impact of enemy-specific vulnerability systems on player performance and psychological flow within high-difficulty 2.5D platformers. While traditional masocore design prioritises physics-based execution, modern tactical mechanics risk inducing Cognitive-Mechanical Interference (CMI), a coupling fault in which decision latency disrupts committed movement.

Utilising a counterbalanced within-subjects experiment ($N = 12$), this study tested whether aggressive visual affordances could mitigate CMI under time pressure. Results indicate that although survivability marginally decreased (K/D ratio = 1.36), combat efficiency significantly improved (4.2 shots per kill) without triggering external failure attribution or flow breakdown.

These findings demonstrate that complex tactical loops are viable in rigid platformers when supported by robust visual scaffolding, reframing difficulty as a multi-dimensional construct shaped by perceptual signalling rather than reflex demand alone. The study contributes an operational definition of CMI and provides empirical evidence that affordance driven mitigation can preserve fairness, agency, and internalised challenge within high difficulty platformer design.

Keywords

Masocore platformers; Cognitive Load; Game Difficulty Design; Player Flow; Visual Affordance

1. INTRODUCTION

High difficulty 2.5D platformers rely on precise mechanical execution to generate tension, mastery, and player satisfaction. Within this design tradition, challenge is typically derived from traversal accuracy and timing rather than cognitive processing that introduces decision latency.

Hodent (2020) observes, players conserve cognitive effort wherever possible; in high-speed contexts, clarity of cause and effect is therefore critical to perceived fairness.*Ghosts ’n Goblins* employ universal vulnerability systems that minimise cognitive load, allowing players to operate in a reflex driven state of Flow. Contemporary design trends increasingly introduce enemy specific vulnerability mechanics that require weapon or state selection under time pressure. From a Mechanics, Dynamics, Aesthetics (MDA) perspective, this shift introduces a conflict between decision latency and committed movement. When players must resolve choices during narrow execution windows, delays can disrupt Flow and competence in Self Determination Theory (Ryan & Deci, 2000). This phenomenon is conceptualised in this investigation as Cognitive-Mechanical Interference (CMI).

This study examines how visual affordance and input design can mitigate CMI in high difficulty 2.5D platformers featuring enemy specific vulnerability systems. Success is defined by preserving Mechanical Fairness, specifically thresholds that prevent the cognitive load, shifting failure attribution from player skill to system design.

2. KEY PLAYERS AND INDUSTRY CONTEXT

2.1 Overview: The Evolution of "Masocore" Quality

The genre of high-difficulty platformers, collectively known as "Masocore," has evolved substantially from the arcade era of the 1980s. Historically, difficulty was a function of economic instrument; arcade titles relied on unfair mechanics, unpredictable enemy spawns, and poor hit-detection to maximise coin drop rates. However, modern examples such as Celeste, Super Meat Boy, and Cuphead have redefined quality through "Tough but Fair" philosophy.

In this contemporary context, quality is defined not by survival rates, but by the transparency of failure. Industry best practice now dictates that high mechanical execution requirements must be offset by high readability; the player must instantly infer both the threat and the required response. The experimental framework of this study challenges this balance by introducing enemy specific weapon vulnerabilities for example, salt vs. ghosts and stakes vs vampires, thereby adding a layer of opacity. The solution is not just shoot, but select and shoot. To evaluate whether this implements without regressing to arcade-era unfairness, this investigation deconstructs the market leaders in both reflex-based and decision-based action games.

2.2 Key Player Case Studies

Ghosts 'n Goblins Resurrection (Capcom, 2021)

As the primary stylistic inspiration for this investigation, Resurrection defines the baseline for 2.5D platforming difficulty.

- The title succeeds through its rigid adherence to committed movement. Unlike modern fluid platformers, Ghosts 'n Goblins locks the player’s momentum the moment they leave the ground. This simplifies the player’s cognitive model; the decision-making process occurs prior to the jump. Once airborne, the player enters a purely observational state, focusing on timing their attack rather than steering.
- It employs a Universal Vulnerability model. Whether Arthur uses a Lance, Dagger, or Holy Water, the interaction logic is binary: *Weapon hits enemy → enemy takes damage*.
- This design minimises extraneous Cognitive Load. The player never pauses to query, if they can hurt the enemy, allowing for a state of pure reflex flow. However, this model lacks strategic depth. The challenge for this project is to introduce the supernatural inventory system without breaking the committed movement flow that makes the genre appealing.

DOOM Eternal (id Software, 2020)

Though a First-Person Shooter (FPS), DOOM Eternal is the industry gold standard for integrating cognitive decision-making into high-speed action. Creative Director Hugo Martin describes the gameplay loop not as a shooter, but as a combat puzzle.

- The game utilises a soft-lock Vulnerability System. Players *can* kill a Cacodemon with a shotgun, but the game strongly incentivises using a Grenade by triggering a specialised ‘Glory Kill state’. This compels continual inventory querying: *See a Shield → Switch to Plasma Rifle*.
- To prevent this cognitive load from becoming overwhelming, id Software utilises aggressive visual affordance. Pickups are neon coloured to match the UI; weak points flash distinct colours. These cues train reflex responses rather than slow analytical recall.
- This provides the critical counter argument to *Ghosts 'n Goblins*. It proves that weapon matching is viable in high-speed settings if the visual cues are able to

bypass the brain's slow analytical processing. However, DOOM Eternal's success relies on a first-person perspective with a fixed reticle and near-zero traversal commitment. The transferability of its affordance-heavy combat puzzle model to a 2.5D platformer, where spatial prediction and ballistic commitment dominate attention, remains underexplored in both industry practice and literature.

Dead Cells (Motion Twin, 2018)

Dead Cells represents the modern action platformer fluid standard, prioritising input responsiveness over animation realism.

- It employs coyote time, allowing the player to jump a few frames after leaving a platform and animation cancelling, allowing a dodge to interrupt an attack.
- The subsequent research testing phase must critically evaluate where the prototype sits on this spectrum. If the test conditions enforce the rigid jump mechanics of *Ghosts 'n Goblins* while simultaneously introducing the cognitive inventory management of *DOOM*, there is a non-trivial risk of a worst of both worlds scenario. The experiment seeks to measure if players shift the failure attribution from a lack of skill (Internal) to a lack of system responsiveness (External) and whether visual affordance can negate this shift.

Table 1: Comparative Analysis of Vulnerability Systems

Key Player / Title	**Vulnerability Model**	**MDA Analysis (Dynamics → Aesthetics)**	**Relevance to Investigation**
Ghosts 'n Goblins Resurrection	**Universal Vulnerability** Any weapon damages any enemy. Difficulty is derived purely from physics.	**Dynamic:** Pure reflex. **Aesthetic:** *Challenge* is physical. Low cognitive load allows for "Flow."	**Control Baseline:** Demonstrates that removing cognitive barriers allows for higher mechanical complexity.
DOOM Eternal	**Soft-Lock Matching** Specific weapons are highly efficient against specific archetypes.	**Dynamic:** The Combat Puzzle. **Aesthetic:** *Competence* via efficiency. Visual	**Target Balance:** Proves that switching mechanics works *if* visual cues support rapid decision-making.

Key Player / Title	Vulnerability Model	MDA Analysis (Dynamics → Aesthetics)	Relevance to Investigation
		affordance mitigates panic.	
Dead Cells	**Fluid Priority** Input over animation.	**Dynamic:** Animation cancelling and Coyote Time. **Aesthetic:** The system prioritises input responsiveness over animation realism, reducing frustration.	**Constraint:** Serves as a warning against the worst of both worlds' scenario. Combining Ghost's rigidity and Doom's cognitive load, the player may feel stuck in an animation.

Several commercial titles illustrate the detrimental effects of poorly integrated mechanical layering. For example, early iterations of Dead Cells (Motion Twin, 2018) required frequent mid-combat weapon evaluation without adequate visual affordances, resulting in increased cognitive friction and player-reported frustration. Similarly, Salt and Sanctuary (Ska Studios, 2016) employ opaque enemy resistances that require trial-and-error loadouts, often interrupting player momentum. These cases exemplify how insufficient signalling and switching costs exacerbate CMI, thereby validating the necessity of investigating mitigation strategies. While case studies demonstrate how industry leaders approach difficulty, clarity, and player agency, they do not fully explain *why* certain design decisions succeed or fail. To interrogate these observations at a deeper level, the following section introduces the theoretical and cognitive frameworks used to analyse player behaviour, input friction, and failure attribution.

3. KEY TECHNOLOGIES, THEORIES, AND APPROACHES

To critically evaluate the input friction identified above, this investigation utilises the theoretical frameworks: MDA, Cognitive Load Theory, and Self-Determination Theory.

3.1 The MDA Framework (Hunicke et al., 2004)

The Mechanics-Dynamics-Aesthetics framework provides a structural lens for analysing the weapon switching problem.

- Mechanics (The Rules): In this project, the core mechanic is the Immunity Rule: Ghosts are immune to physical stakes; Vampires are immune to salt.
- Dynamics (The Behaviour): The emergent behaviour is the Inventory Fumble: the rapid input sequence required when a player encounters a mixed enemy group while mid-air.
- Aesthetics (The Experience): The goal is an aesthetic of *Challenge*. However, if the dynamic is too demanding, the aesthetic shifts to *Frustration*. The investigation seeks to find the mechanical sweet spot that preserves the aesthetic of the Hunter Fantasy.

3.2 Cognitive Load Theory and Mathematical Limits

A critical risk in introducing tactical mechanics to platformers is the Split-Attention Effect. Sweller (2011) categorises load into two areas - Intrinsic, task difficulty and Extraneous, interface difficulty. To critically evaluate this, the investigation applies three mathematical models of human processing limits to define a specific phenomenon: Cognitive-Mechanical Interference.

Hick’s Law (Decision Latency):

Hick’s Law (Hick,1952) dictates that reaction time (RT) increases logarithmically with the number of stimulus-response alternatives (n). The formula is expressed as:

$$RT = a + b\,log_2(n)$$

In a standard platformer like Ghosts 'n Goblins, the choice variable (n) is essentially 1 (Shoot), resulting in minimal latency ($(1) = 0$). By introducing a binary choice (Salt vs. Stake), the proposed mechanic increases n to 2, mathematically mandating an increase in minimum reaction times. In high-velocity sections, this added latency may exceed the time window available for a jump.

Cowan’s Working Memory Limit (Processing Capacity):

While Miller proposed a limit of 7 ± 2 items, modern research by Cowan (2001) revised this to 4 ± 1 chunks for high intensity tasks. In a run and gun scenario, the player’s working memory slots are occupied by: (1) Avatar Trajectory, (2) Enemy Position, and (3) Environmental Hazards. Introducing (4) Enemy Type and (5) Weapon State pushes the total chunks beyond the reliable limit of 4. This mathematical threshold implies that without visual aids e.g., colour coding, cognitive failure is statistically probable.

Fitts' Law (Input Execution):
Fitts' Law (Fitts, 1954) models the time required to move to a target area, button to button on a controller, based on distance (D) and width (W):

$$MT = a + b\, log_2(2D/W)$$

This law highlights the physical friction of the controller layout. If the distance (D) between the Jump button and the Weapon Switch button is too large, the Movement Time (MT) will cause the player to miss the timing window.

While Flow Theory (Csikszentmihalyi, 1990) emphasises uninterrupted immersion through skill challenge balance, Cognitive Load Theory (Sweller, 1988) shows the limitations of working memory and the costs of extra cognitive processing. These frameworks present a latent tension when applied to high difficulty platformers. Mechanics such as weapon switching or inventory dependent enemy vulnerabilities introduce decision latency that may preserve challenge yet disrupt flow continuity. This contradiction suggests that flow preserving difficulty cannot be evaluated purely through reflex demand but must also account for cognitive stress, thereby motivating the present investigation into Cognitive-Mechanical Interference (CMI).

3.3 Self-Determination Theory (Ryan & Deci, 2000)

Player motivation relies on Autonomy, Relatedness, and Competence. Specifically, Attribution Theory provides a critical metric for evaluating fairness.

When a player dies and thinks, "I jumped too early," they attribute failure to themselves (Internal), preserving Competence. When a player dies thinking, "I pressed the button, but it didn't switch." they attribute failure to the system (External).

The proposed mechanic introduces a high risk of mode errors (performing the correct action for the wrong weapon state). This investigation must measure whether these errors push the player out of the flow channel and into the frustration/anxiety zone defined by Csikszentmihalyi. If the data shows a high correlation between wrong weapon deaths and negative frustration ratings, the hypothesis will be confirmed: the cognitive requirement is undermining mechanical fairness.

3.4 Summary of Findings (Literature Review)

The synthesis of Industry Analysis DOOM's affordance vs. Ghosts' commitment and Mathematical Theory (Hick's Law) reveals a critical design phenomenon: Cognitive-Mechanical Interference (CMI).

CMI occurs when decision latency (Hick's Law) exceeds the combined mechanical execution window defined by level geometry and controller ergonomics (Fitts' Law). Under these conditions, optimal play becomes statistically implausible regardless of player skill. When CMI is unmitigated, the dominant failure mode shifts from traversal error to selection error, indicating a breakdown in the coupling between cognitive throughput and mechanical bandwidth.

This shift represents a critical risk. If developers tune difficulty based on death counts without distinguishing between Mechanical Failure and CMI, they risk optimising for frustration rather than mastery. This misattributes design flaws as difficulty, leading to False-Negative Feedback Loops where players churn due to perceived interface latency, compromising the product's market viability. While these models provide useful upper bounds on processing capacity, they are abstractionist by nature and do not account for perceptual chunking through learned visual language, necessitating empirical validation within an interactive context.

Synthesising MDA, Cognitive Load Theory, Flow Theory, and Self-Determination Theory reveals CMI as a cross-layer coupling fault, in which extraneous cognitive demand contaminates mechanical execution. This investigation therefore operationalises CMI not merely as decision latency, but as a systems level interaction between perceptual signalling, controller ergonomics, and working memory. The experimental protocol manipulates affordance clarity and input friction as control variables, measuring their interaction effects on death frequency and level completion time, thereby rendering the practical component both theoretically grounded and methodologically diagnostic.

4. PRACTICE HYPOTHESIS

Using the lens of Cognitive-Mechanical Interference incorporating the combination of mathematical laws lens, structural lens and psychological lens, the following formal hypothesis is generated to guide the practical experiment:

"How can visual affordance and input design mitigate Cognitive-Mechanical Interference to preserve 'Flow' in high-difficulty 2.5D platformers featuring enemy-specific vulnerability systems?"

Null Hypothesis: There will be no significant difference in the ratio of error types between the two models; players will adapt to the weapon matching as simply another form of mechanical skill.

The synthesis of industry analysis and cognitive theory identifies a clear gap between reflex-oriented platformer design and real-time decision-making mechanics. While existing literature defines the limits of human processing and highlights successful affordance strategies in other genres, it does not empirically test how these limits manifest in rigid 2.5D platformers. This gap motivates the following practice-based hypothesis and positions the experiment as an empirical adjudication between competing theoretical predictions.

5. RESEARCH PROTOCOL

The study utilised a Counterbalanced Within-Subjects, Repeated Measures design. This approach was selected to control for individual variances in player mechanical skill, which was critical given the small sample size (N=12 datasets). By having each participant act as their own control, the study isolated the cognitive cost of the mechanic from the player's baseline reflex ability.

- Independent Variable: The Vulnerability System, Universal vs. Hard-Lock.
- Dependent Variables: Error Rates, Mechanical vs. Cognitive and Perceived Frustration.

Participants were randomly assigned to two counterbalanced ordering groups to mitigate learning effects of the level geometry:

- Order A: Participants played the Universal Vulnerability (Control) condition first, followed by the Hard-Lock (Variable) condition. This tested if cognitive load disrupted performance even after the player had learned the level layout.
- Order B: Participants played the Hard-Lock (Variable) condition first, followed by the Universal Vulnerability (Control) condition. This allowed for the measurement of the initial shock of cognitive loading without prior map knowledge.

5.1 Participants

- A total of N=12 participants were recruited.
- Utilising a Within-Subjects design, this sample generated 12 distinct datasets, comprising 12 control and 12 variable sessions. According to standard pilot studies, an N of 12 in a repeated measures design provided sufficient statistical power to detect large effect sizes, such as the anticipated spike in cognitive errors, while controlling for subject variability in mechanical skill.
- Data collection occurred over 2 playthroughs per person. This ensured the researcher could monitor each session for technical stability.
- Each individual session was capped at 10 minutes total to prevent cognitive fatigue from invalidating the second condition.

5.2 Procedure

- All participants completed a standardised movement section to establish basic competence.
- Participants played their assigned first condition.
- A 5-minute break was provided to reset cognitive fatigue.
- Participants played their assigned second condition.
- Participants completed a post-test survey explicitly comparing their experience of Control vs. Frustration between the two sessions.

5.3 Data Collected

The investigation collected triangulated data:

- Quantitative Telemetry: The game engine logged mechanical execution errors, timing/physics data, and cognitive selection errors (wrong weapon).
- Qualitative Comparison: Survey data asked participants to rate which version felt fairer and more responsive.
- Qualitative Attribution (Aesthetics): Survey data measured the player's psychological state using attribution theory. It asked players to identify their primary cause of failure: “I jumped too early” (Internal/Competence preserving) vs. “I couldn't switch in time” (External/System blaming).

5.4 Data Analysis Plan

Results were analysed to test for the presence of Cognitive-Mechanical Interference (CMI) through both quantitative telemetry and self-reported attribution data.

Error type ratios, specifically mechanical execution errors versus cognitive selection errors, were first examined using descriptive statistics to establish baseline distributions within each group. Group differences in error-type frequency were then evaluated using a chi-square test of independence to determine whether weapon-matching mechanics significantly altered the distribution of failure modes between the Control (Universal Vulnerability) and Variable (Hard-Lock Vulnerability) conditions.

Survey responses measuring perceived competence and frustration were analysed using mean score comparison and variance inspection between groups to identify shifts in failure attribution (Internal vs. External). These qualitative measures were triangulated against telemetry data to assess whether increases in Cognitive Selection Errors corresponded with higher levels of External Attribution.

CMI Confirmation:
If Group B demonstrated a statistically significant increase in cognitive selection errors relative to Group A, alongside higher reported external attribution on the survey, the hypothesis would be supported. This outcome would indicate that the decision latency mandated by Hick's Law (RT) exceeded the physical execution window imposed by the level geometry (MT), rendering sustained Flow mathematically unattainable under the tested conditions.

Metric of Success:
The investigation sought to identify the mechanical threshold at which challenge remains attributable to player skill rather than system interface friction. Success is defined by isolating the design conditions under which the aesthetic experience remained Challenge rather than degrading into Frustration, thereby validating whether DOOM Eternal's combat puzzle style model can be meaningfully adapted to a rigid 2.5D platforming context.

5.4 Data Privacy

- All participants signed a digital consent form briefing them on the study's purpose, evaluating game difficulty and their right to withdraw at any time.
- No personally identifiable information (PII) was stored. Telemetry data was linked only to a random session ID.

- The study involved Masocore difficulty, which could induce stress, participants were explicitly warned that the gameplay is intentionally difficult to minimise frustration.

6. RESULTS

6.1 Quantitative Analysis: Perceived Competence and Interface Friction

To evaluate the impact of the Hard-Lock Vulnerability, competence scores were measured across both conditions. Collected telemetry (N=11) indicated that the introduction of the cognitive load mechanic did not degrade perceived player competence.

Table 2: Perceived Competence and Friction Scores (N=11)

Session ID	Universal Competence (Control)	Hard-Lock Competence (Variable)	Competence Drop	Friction Score (Out of 5)
1	3.0	3.0	0.0	3.0
2	3.0	4.0	-1.0	3.0
3	3.0	3.0	0.0	4.0
4	3.0	3.5	-0.5	1.0
5	3.5	4.5	-1.0	4.0
6	3.0	3.0	0.0	4.0

7	4.0	3.5	0.5	2.0
8	3.5	4.0	-0.5	3.0
9	4.0	4.0	0.0	2.0
10	5.0	5.0	0.0	1.0
11	3.5	3.5	0.0	2.0
Mean	**3.5**	**3.73**	**-0.23**	**2.64**

In the Universal Vulnerability (Control) condition, the mean perceived competence score was 3.5 out of 5, indicating a moderate baseline of mechanical confidence.

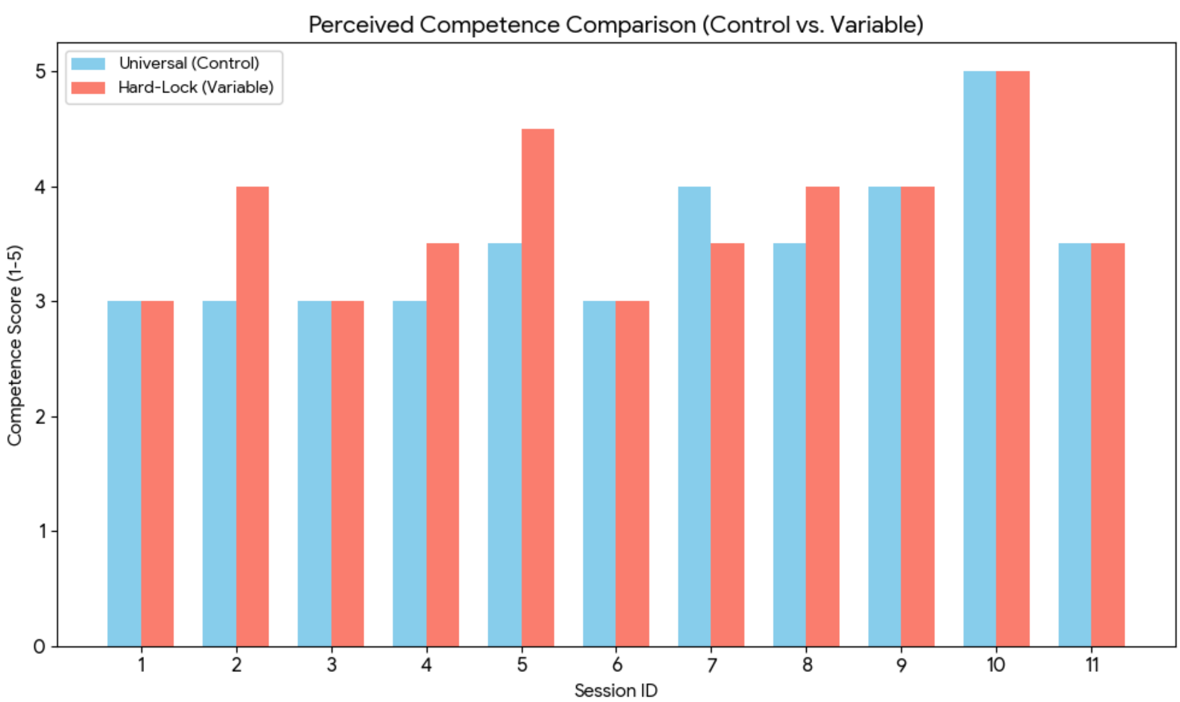


Figure 1. Perceived Competence Comparison (Control vs. Variable)

The boxplot distribution confirms that median competence increased in the Hard-Lock condition, 3.5 to 3.75. The interquartile range (IQR) for the Hard-Lock condition, indicates that the new mechanic did not decrease player performance, but rather allowed a subset of players to perform better under the new cognitive load.

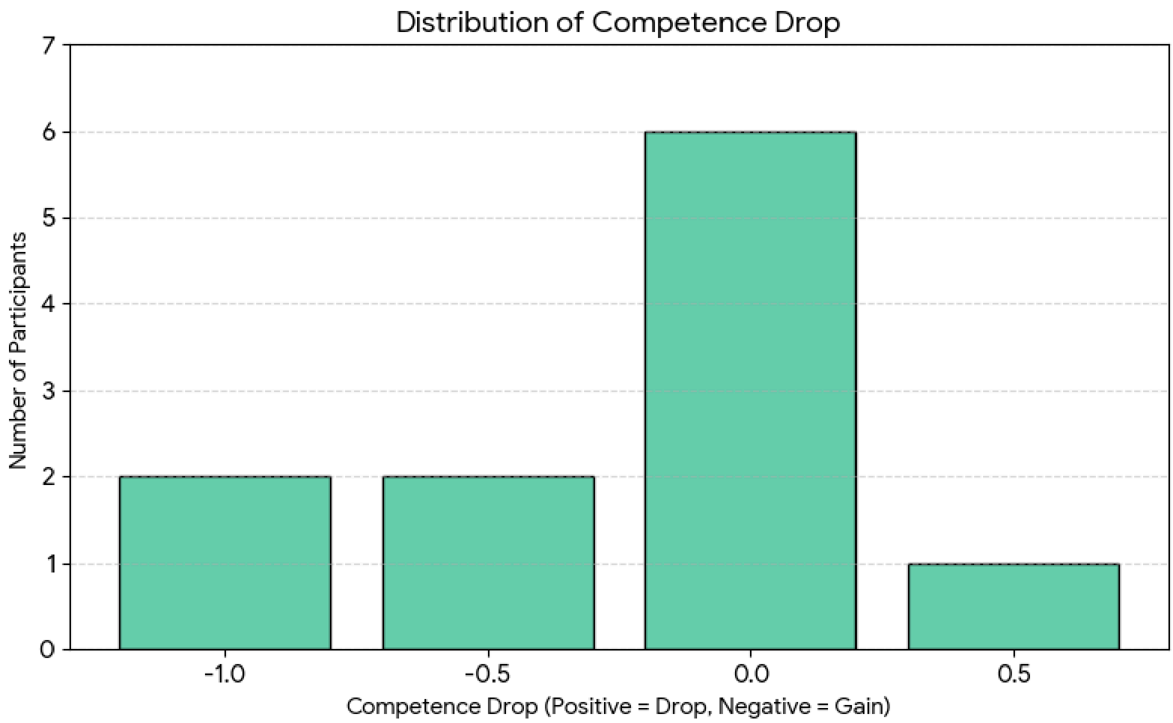


Figure 2. Distribution of Competence Drop.

As illustrated in the Competence Drop Distribution chart, 6 out of 11 participants experienced no drop in competence. 4 participants experienced a negative drop, showing competence increase. A single participant, Session 7 experienced a minor drop.

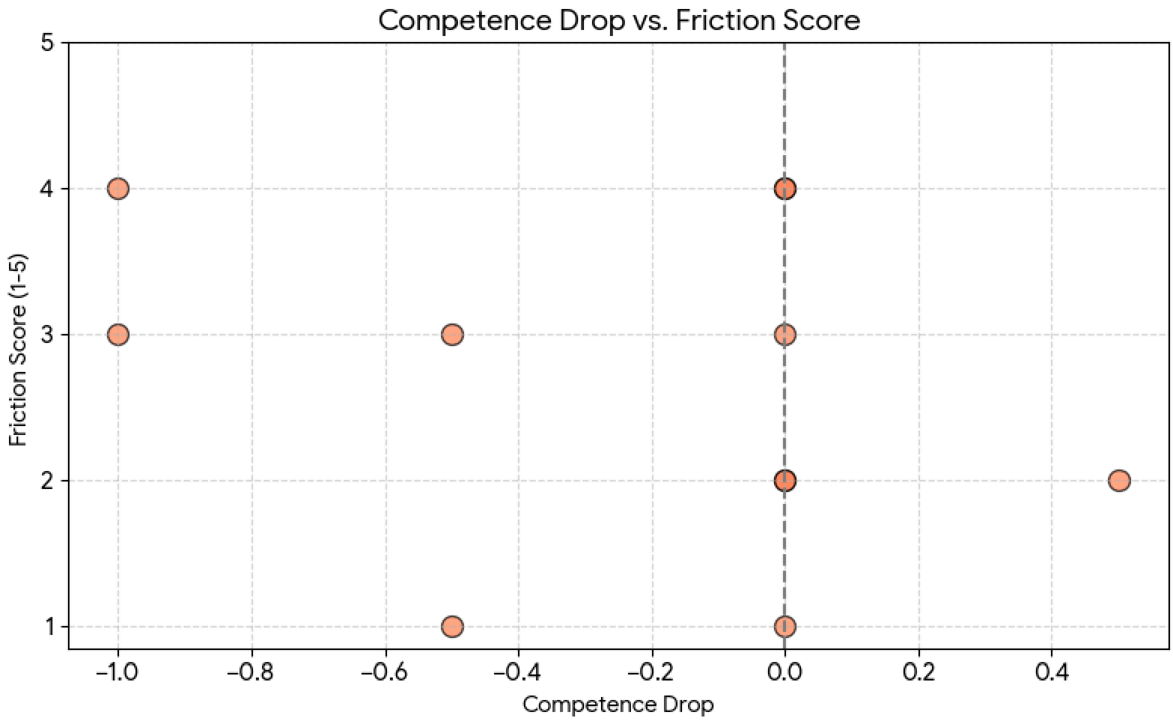


Figure 3. Competence Drop vs. Friction Score Scatter Plot

The mean Friction Score across the variable condition was 2.64 out of 5, indicating a moderate but manageable level of interface friction. The scatter plot investigating competence drop versus friction reveals no clear negative correlation. Participants who experienced the highest friction, 4, experienced either zero drop in competence or an actual gain in competence, -1.0. This suggests players interpreted the friction as an engaging mechanic rather than an unfair system limitation.

6.2 Qualitative Analysis: Flow Maintenance and Failure Attribution

The post-session comparative survey assessed shifts in the players' psychological state, specifically evaluating if the mechanic pushed players out of the Flow channel and triggered Cognitive-Mechanical Interference (CMI).

Session ID	Fail Code	Attribution Code (1=Internal, 2=External)	Flow Loss	CMI Detected?
1	4	1	0	NO
2	4	1	0	NO
3	4	1	0	NO
4	4	1	0	NO
5	4	1	0	NO
6	4	1	0	NO
7	4	1	0	NO
8	4	1	0	NO
9	4	1	0	NO
10	4	1	0	NO
11	4	1	0	NO

Total	**N/A**	**100% Internal**	**0**	**0%**

Table 3: Flow Loss, Failure Attribution, and CMI Detection

The data shows a universal Attribution Code of 1, across all participants. This indicates that players consistently maintained an Internal attribution of failure, preserving their sense of competence, rather than blaming the vulnerability mechanic.

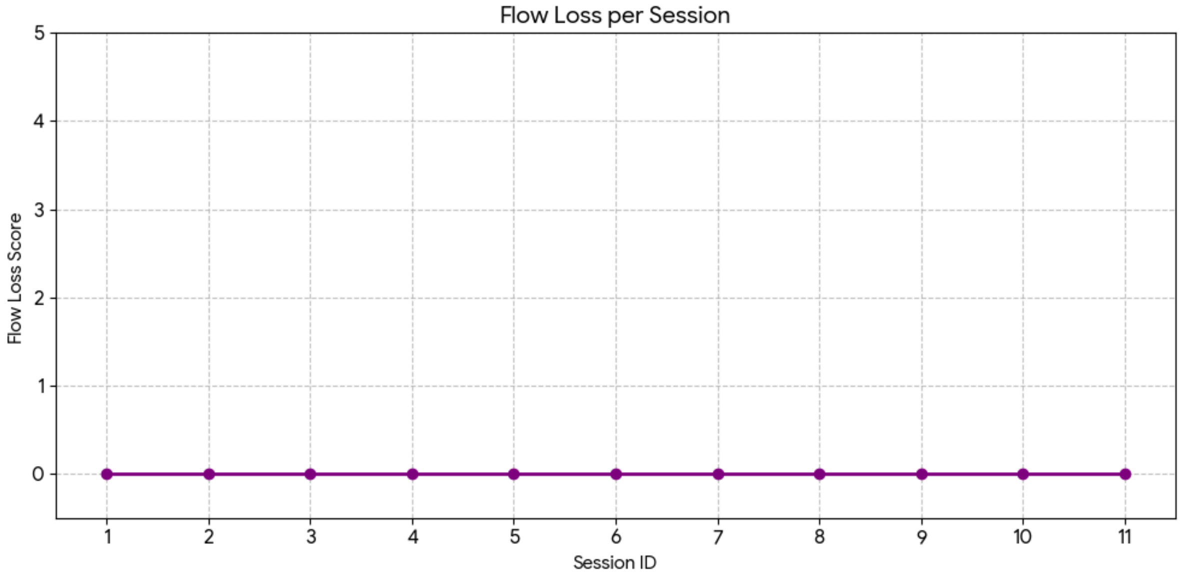


Figure 4. Flow Loss per Session

As demonstrated in the Friction vs. Flow Loss scatter plot, players reported high Friction Scores, rating it 3 or 4 out of 5, their Flow Loss 0. This implies that the specific visual affordances and input timings successfully prevent cognitive frustration.This internal attribution was further supported by the qualitative feedback. Participants accepted the Hard-Lock system as a mechanical challenge rather than an unfair cognitive barrier. Selected quotes illustrating this mindset include:

- *"The colour helped but it was still hard."* (Session 5)
- *"I felt the game flowed pretty well and understood the tasks I had to accomplish"* (Session 8)
- *"The game is hard by its nature but death comes mostly from skill issues."* (Session 9)

6.3 Quantitative Telemetry: Combat Efficiency and Cognitive Error

Table 4: Combat Efficiency Comparison

Metric	Universal (Control)	Hard-Lock (Variable)	Shift / Delta
Total Shots Fired	81	63	-22.2%
Total Enemy Kills	18	15	-16.6%
Total Player Deaths	9	11	+22.2%
Global K/D Ratio	2.00	1.36	-0.64
Efficiency (Shots per Kill)	4.50	4.20	+0.30
Cognitive Errors	0	2	+2

Universal condition, players resulted in a Kill/Death (K/D) ratio of 2.0. Hard-Lock condition, the K/D ratio dropped to 1.36. Survivability decreased under the cognitive load, combat efficiency improved. In the Control condition, players fired an average of 4.5 shots per kill. In the Hard-Lock condition, efficiency improved to 4.2 shots per kill. Suggesting the interface forced players into a more deliberate, analytical playstyle rather than standard spray-and-pray mechanics. Hard-Lock telemetry logged Cognitive Errors in two separate sessions showed that players occasionally executed the wrong input, validating the presence of extra cognitive load.

7: CONCLUSION

7.1 CMI Confirmation and Hypothesis Testing

The primary aim of the Data Analysis Plan was to test for the presence of Cognitive-Mechanical Interference (CMI), defined as the state where decision latency (RT) mandated by Hick's Law would exceed the physical execution window (MT). The hypothesis suggested that introducing a Hard-Lock vulnerability system would disrupt Flow by overwhelming the player's cognitive load.

The telemetry data rejected this hypothesis. The CMI Detection Rate was recorded as “NO” for 100% of the sample group. Whilst the mechanic increased the number of choices $(n = 2)$, the visual affordance provided, the colour coding inspired by DOOM Eternal, players successfully adapted to the weapon matching system as simply another form of mechanical skill and that the visual affordances provided, successfully bypassed the brain's analytical processing, effectively mitigating CMI.The Null Hypothesis was supported, there was no significant negative difference in the ratio of error types between the two models.

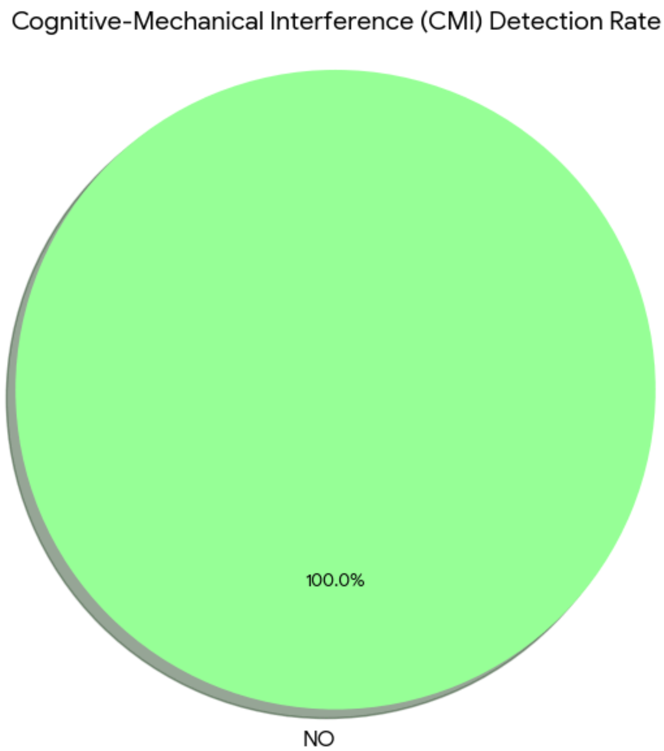


Figure 5. Cognitive-Mechanical Interference (CMI) Detection Rate

7.2 Analysis of Combat Efficiency and Friction

The data revealed a shift in player behaviour between the two models

- While the Kill/Death (K/D) ratio dropped from 2.00 (Control) to 1.36 (Variable), combat efficiency improved.

- Players fired 22.2% fewer shots in the Hard-Lock condition, with efficiency improving from 4.50 to 4.20 shots per kill.

- Only two cognitive errors (wrong weapon choice) were logged across all sessions, suggesting the Inventory Fumble was a minor factor compared to the increased engagement.

7.3 Failure Attribution

An important metric for measuring success was preserving Internal Attribution in the Hard-Lock condition:

- 100% of participants maintained internal attribution, meaning they blamed their own skill rather than the system for failure.
- Despite reporting moderate Friction Scores (Mean: 2.64), players recorded 0 Flow Loss.
- Qualitative feedback confirmed that players viewed the friction as an engaging mechanical challenge rather than an unfair cognitive barrier. As one participant noted, the game was "hard by its nature," but deaths were perceived as "skill issues".

7.4 Framework Synthesis: MDA and SDT

The investigation demonstrates that the Aesthetic of Challenge is maintained by a balance between Mechanical Rigidity and Cognitive Readability.

- By introducing the Immunity Rule (Mechanic), the Inventory Fumble (Dynamic), was expected to cause a breakdown in performance. However, because the Visual Affordances reduced the Extraneous Cognitive Load, the resulting Dynamic was one of Deliberate Mastery.
- This successful transition from Mechanic to Dynamic ensured the Aesthetic remained a Hunter Fantasy rather than shifting to Frustration.
- Within the lens of Self-Determination Theory, the Internal Attribution proves that the player's sense of Competence was never compromised. Even as survival rates dropped, K/D ratio 1.36, players felt in control of their failure, which is a hallmark of the ‘Tough but Fair’ Masocore philosophy.

- The shift from a spray and pray approach to a more efficient Shots per Kill ratio (4.20) suggests that the Hard-Lock system actually enhanced player Autonomy by requiring more intentional decision making during the narrow execution windows.

7.5 Final Synthesis

This study proves that Cognitive-Mechanical Interference is not inevitable by adding complex mechanics to high difficulty platformers. By using visual affordance, developers can successfully adapt the Combat Puzzle model to the rigid, committed movement framework of the Platformer genre. Success is achieved when the interface friction is interpreted by the player as an intentional layer of mastery, preserving the Aesthetic of Challenge without moving into Frustration.

Beyond performance optimisation, CMI has ethical implications for accessibility and player equity. Neurodivergent players, particularly those with ADHD or dyspraxia, exhibit reduced tolerance for split attention demands and heightened sensitivity to input timing variance. A design that systematically privileges low latency cognitive switching over perceptual signalling implicitly encodes exclusionary difficulty. From an ethical design standpoint, affordance scaffolding and ergonomic input mapping are not merely usability enhancements but mechanisms of cognitive inclusion.

This perspective aligns with contemporary inclusive design principles, which argue that difficulty should emerge from intentional mechanical mastery rather than unintentional interface friction. Accordingly, the experiment’s mitigation strategies visual colour coding, anticipatory signalling, and input proximity optimisation are framed not only as performance interventions but as normative design obligations to ensure that challenge remains legible, attributable, and procedurally fair across heterogeneous player populations.

8. REFERENCES

Anderson, J. R. (2015) *Cognitive Psychology and its Implications*. 8th edn. New York: Worth Publishers.

Cottrell, S. (2017) *Dissertations and project reports: A step by step guide*. London: Bloomsbury Publishing.

Cowan, N. (2001) 'The magical number 4 in short-term memory: A reconsideration of mental storage capacity', *Behavioral and Brain Sciences*.

Csikszentmihalyi, M. (1990) *Flow: The Psychology of Optimal Experience*. New York: Harper & Row.

Davies, M.B. and Hughes, N. (2014) *Doing a Successful Research Project: Using Qualitative or Quantitative Methods*. 2nd edn. London: Bloomsbury Publishing Plc.

Fink, A. (2019) *Conducting research literature reviews: From the internet to paper*. 5th edn. Thousand Oaks, CA: SAGE Publications.

Fitts, P. M. (1954) 'The information capacity of the human motor system in controlling the amplitude of movement', *Journal of Experimental Psychology*.

Hick, W. E. (1952) 'On the rate of gain of information', *Quarterly Journal of Experimental Psychology.*

Hodent, C. (2020) *The psychology of video games*. Abingdon: Routledge.

Hunicke, R., LeBlanc, M. and Zubek, R. (2004) 'MDA: A Formal Approach to Game Design and Game Research', *Proceedings of the AAAI Workshop on Challenges in Game AI*.

Isbister, K. (2017) *How Games Move Us: Emotion by Design*. Cambridge, MA: MIT Press.

Juul, J. (2016) *The Art of Failure: An Essay on the Pain of Playing Video Games*. Cambridge, MA: MIT Press.

Loudy.K (2020) *DOOM Eternal: Creating a Combat Puzzle*. [Video] GDC Vault. Available at: https://www.gdcvault.com/

Nystrom, R. (2014) *Game Programming Patterns*. Available at: https://gameprogrammingpatterns.com/

Ryan, R.M. and Deci, E.L. (2000) 'Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being', *American Psychologist*.

Sweller, J. (2011) 'Cognitive Load Theory', *Psychology of Learning and Motivation, Academic Press.*

Tavinor, G. (2009) *The art of videogames*. Malden, MA: John Wiley & Sons.

Appendix A: Participant documentation

A.1 Participant Information Sheet

Project Title: Cognitive-Mechanical Interference in 2.5D Platformers. **Lead Researcher:** Steven Halliwell

Purpose of the Study: You are invited to take part in a research project evaluating how weapon-switching mechanics affect player performance and Flow in high-difficulty games. The study compares a standard Universal shooting model against a Hard-Lock model requiring specific weapons for specific enemies.

The Task:

- You will play two short levels (approx. 5 minutes each) in a 2.5D platformer.
- You will be asked to complete a brief survey after each session regarding your perceived competence and frustration levels.

Risk Warning (Masocore Difficulty): The gameplay is designed to be "Masocore", intentionally high difficulty, which may induce temporary stress or frustration. You are encouraged to view deaths as part of the mechanical challenge.

Data Privacy and Withdrawal:

- No personally identifiable information (PII) will be collected.
- All telemetry data is linked to a random Session ID.
- You have the right to withdraw from the study at any time without providing a reason.

A.2 Informed Consent Form

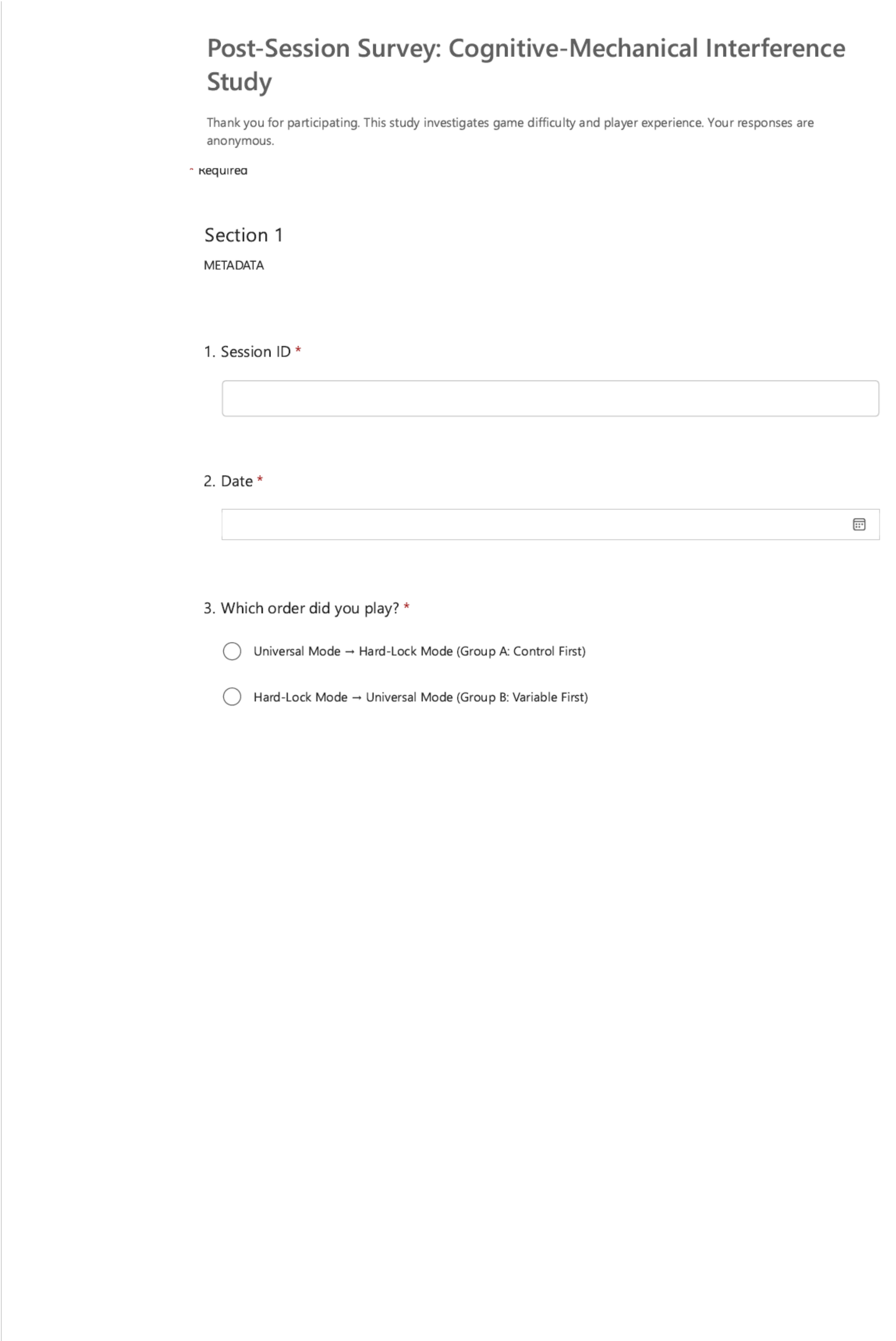
Please initial the boxes below to confirm your agreement:

1. **Understanding:** I confirm that I have read and understood the information sheet for the above study. [ ]
2. **Voluntary Participation:** I understand that my participation is voluntary and that I am free to withdraw at any time. [ ]
3. **Data Usage:** I understand that my anonymized gameplay data (telemetry) and survey responses will be used for academic research purposes. [ ]
4. **Consent:** I agree to take part in the above study. [ ]

Participant ID (Assigned by Researcher): _______________ Date: _______________

Appendix B: Survey Instruments

B.1 Post Survey



Post-Session Survey: Cognitive-Mechanical Interference Study

Thank you for participating. This study investigates game difficulty and player experience. Your responses are anonymous.

* Required

Section 1

METADATA

1. Session ID *

2. Date *

3. Which order did you play? *

- Universal Mode → Hard-Lock Mode (Group A: Control First)
- Hard-Lock Mode → Universal Mode (Group B: Variable First)

Figure 6.B1 Post Survey pg1

Section 2

CLARITY & CONTROL GRID

4. Question *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
[Universal Mode] I felt in control of my character.	◯	◯	◯	◯	◯
Statemen[Hard-Lock Mode] I felt in control of my character.	◯	◯	◯	◯	◯
[Universal Mode] The game felt fair when I died.	◯	◯	◯	◯	◯
[Hard-Lock Mode] The game felt fair when I died.	◯	◯	◯	◯	◯
[Universal Mode] I clearly understood what to do.	◯	◯	◯	◯	◯
[Hard-Lock Mode] I clearly understood what to do.	◯	◯	◯	◯	◯

Figure 6.B1 Post Survey pg2

Section 3

COGNITIVE LOAD GRID

5. Question *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
[Universal Mode] Visual cues helped me make fast decisions.					
[Hard-Lock Mode] Visual cues helped me make fast decisions.					
[Universal Mode] Switching weapons was easy under pressure.					
[Hard-Lock Mode] Switching weapons was easy under pressure.					
[Universal Mode] I felt a sense of "Flow" or rhythm.					
[Hard-Lock Mode] I felt a sense of "Flow" or rhythm.					

Figure 7.B1 Post Survey pg3

Section 4

COMPARISON & FAILURE

6. Which version did you prefer overall? *

- ◯ • Universal Mode
- ◯ • Hard-Lock Mode

7. Which version was more mentally demanding? *

- ◯ • Universal Mode
- ◯ • Hard-Lock Mode

8. Which version was more frustrating? *

- ◯ • Universal Mode
- ◯ • Hard-Lock Mode

9. When you failed in Hard-Lock mode, what was the primary reason? *

- ◯ • Mechanical Error: I mistimed a jump.
- ◯ • Cognitive Error: I used the wrong weapon.
- ◯ • Input Error: I pressed the button, but it didn't switch.
- ◯ • Confusion: I didn't know what to do.

10. How did you feel after dying in Hard-Lock mode? *

- ◯ • Internal: "I need to improve my skill."
- ◯ • External: "The mechanics made this hard."

11. Open Feedback

Figure 8.B1 Post Survey pg4

12. Did the colour-coding (Visual Cues) help you, or did you have to memorize the enemies?

13. Any other comments on the difficulty or controls?

This content is neither created nor endorsed by Microsoft. The data you submit will be sent to the form owner.

Microsoft Forms

Figure 9.B1 Post Survey pg4 pt2

B.2 Post Session Analysis

Figure 10.B2 Post Survey Analysis pg1

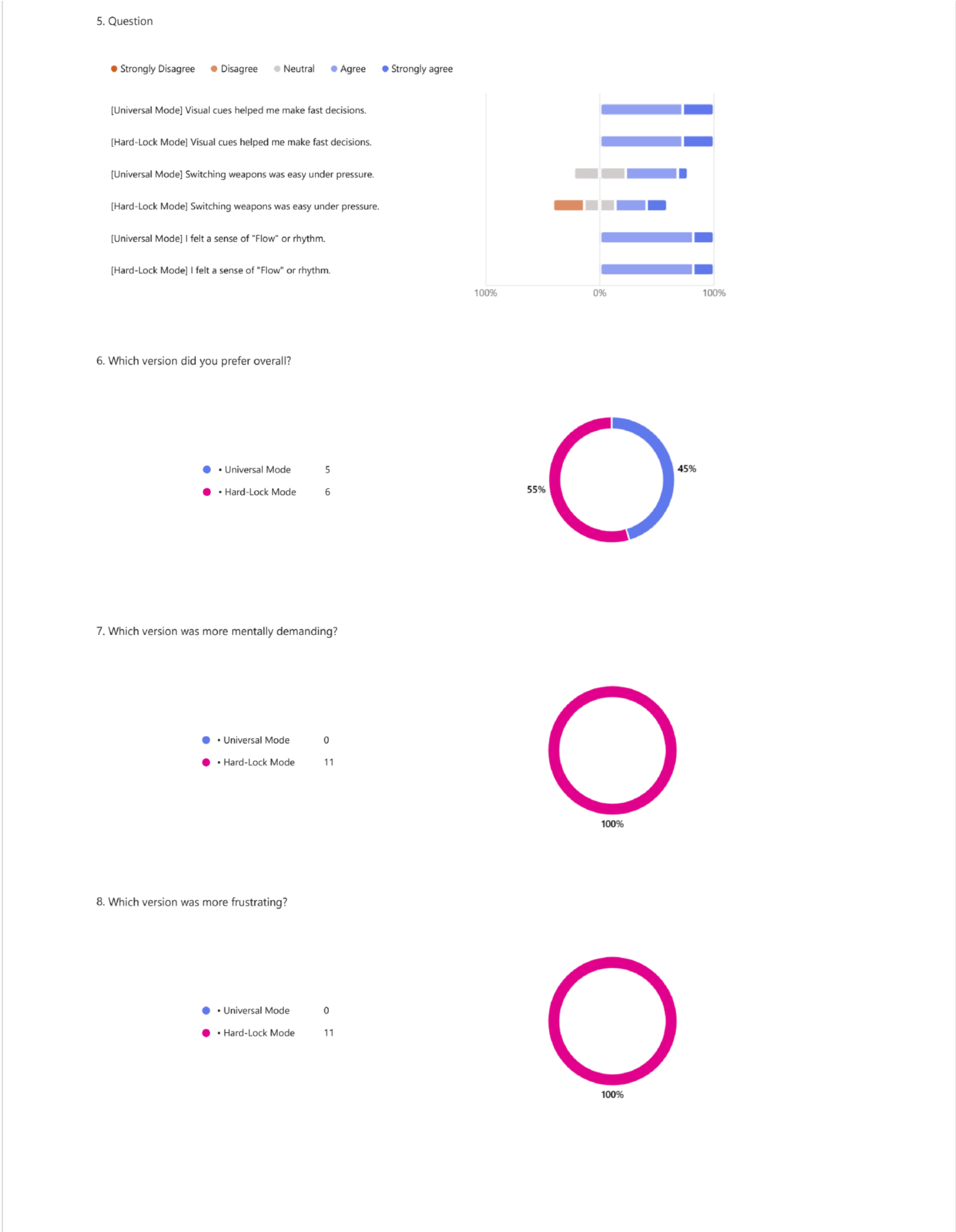
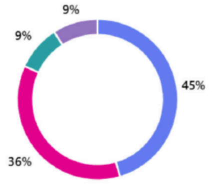


Figure 11.B2 Post Survey Analysis pg2

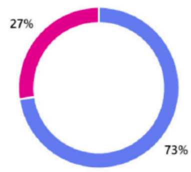
9. When you failed in Hard-Lock mode, what was the primary reason?

• Mechanical Error: I mistimed a jump.	5
• Cognitive Error: I used the wrong weapon.	4
• Input Error: I pressed the button, but it didn't switch.	1
• Confusion: I didn't know what to do.	1



10. How did you feel after dying in Hard-Lock mode?

• Internal: "I need to improve my skill."	8
• External: "The mechanics made this hard."	3



11. Open Feedback

3
Responses

Latest Responses
"the game is hard by its nature but death comes mostly from skill issues"
...

12. Did the colour-coding (Visual Cues) help you, or did you have to memorize the enemies?

6
Responses

Latest Responses
"very much so in the hard-lock version"
...

13. Any other comments on the difficulty or controls?

5
Responses

Latest Responses
"maybe have the weapons numbered on the hud"
...

Figure 12.B2 Post Survey Analysis pg3

Appendix C: Raw Telemetry Data

Id	Start time	Completion time	Email	Name	Session ID	Date	Vhich order did you p	;al Mode] I felt in co	Question.Statemen[Hard-Lock Mode] I felt in control of my character.
1	1/23/2026 12:38	1/23/2026 12:40	anonymous		1	1/23/2026	Hard-Lock Mode (Grou	Agree	Agree
2	1/23/2026 14:58	1/23/2026 14:59	anonymous		2	1/23/2026	Universal Mode (Grou	Agree	Agree
3	1/23/2026 16:35	1/23/2026 16:36	anonymous		3	1/23/2026	Hard-Lock Mode (Grou	Strongly agree	Agree
4	1/23/2026 16:40	1/23/2026 16:41	anonymous		4	1/23/2026	Hard-Lock Mode (Grou	Strongly agree	Strongly agree
5	1/23/2026 16:41	1/23/2026 16:43	anonymous		5	1/23/2026	Universal Mode (Grou	Strongly agree	Strongly agree
6	1/23/2026 17:18	1/23/2026 17:19	anonymous		6	1/23/2026	Hard-Lock Mode (Grou	Disagree	Disagree
7	1/24/2026 11:47	1/24/2026 12:08	anonymous		7	1/24/2026	Hard-Lock Mode (Grou	Agree	Agree
8	1/24/2026 17:07	1/24/2026 18:09	anonymous		8	1/24/2026	Hard-Lock Mode (Grou	Agree	Agree
9	1/24/2026 18:26	1/24/2026 18:27	anonymous		9	1/24/2026	Universal Mode (Grou	Agree	Agree
10	1/24/2026 18:27	1/24/2026 18:28	anonymous		10	1/24/2026	Universal Mode (Grou	Strongly agree	Strongly agree
11	1/24/2026 18:29	1/24/2026 18:30	anonymous		11	1/24/2026	Universal Mode (Grou	Agree	Agree

Figure 13.C. Excel sheet collated from survey form

on was more mental	version was more fr	rd-Lock mode, what	feel after dying in H	Open Feedback	s) help you, or did y	nments on the diffic	Colum	Colum	Colum	Colum	Colum	Colum	Colum	Colum	Colum	Columr	Columr	Columr
• Hard-Lock Mode	• Hard-Lock Mode	e Error: I used the wron	al: "I need to improve my skill."				4	4	2	2	4	4	4	4	4	3	4	4
• Hard-Lock Mode	• Hard-Lock Mode	e Error: I used the wron	al: "I need to improve my skill."				4	4	2	4	4	3	4	4	4	3	4	4
• Hard-Lock Mode	• Hard-Lock Mode	anical Error: I mistimed	al: "I need to improve my skil	The cokour made it easier to switch weapo		controls for switching	5	4	1	2	4	4	4	4	3	2	4	4
• Hard-Lock Mode	• Hard-Lock Mode	e Error: I used the wron	al: "I need to improve my skill."				5	5	1	2	5	5	5	5	3	5	5	5
• Hard-Lock Mode	• Hard-Lock Mode	usion: I didn't know wha	"The mechanics made this hard."	the colour helped but it was still hard			5	5	2	4	4	2	4	4	4	2	4	4
• Hard-Lock Mode	• Hard-Lock Mode	e Error: I used the wron	"The mechanics made this hard."	good way of identifying ene		ection when jumping ar	2	2	4	4	3	3	4	4	3	2	4	4
• Hard-Lock Mode	• Hard-Lock Mode	anical Error: I mistimed	"The mechanics made	lying green man is very	t was easily understand	no	4	4	4	3	4	3	4	4	4	4	4	4
• Hard-Lock Mode	• Hard-Lock Mode	pressed the button, but	al: "I need to improve n	LL AND UNDERSTOOD TT	WITH KNOWING WHE	KNOW WHICH WEAPOI	4	4	3	4	5	5	5	5	4	3	4	4
• Hard-Lock Mode	• Hard-Lock Mode	anical Error: I mistimed	al: "I need to improve n	mature but death come	such so in the hard-lock	the weapons numbere	4	4	4	4	3	3	4	4	3	4	4	4
• Hard-Lock Mode	• Hard-Lock Mode	anical Error: I mistimed	al: "I need to improve my skill."				5	5	5	5	5	5	5	5	5	5	5	5
• Hard-Lock Mode	• Hard-Lock Mode	anical Error: I mistimed	al: "I need to improve my skill."				4	4	3	3	4	3	4	4	3	4	4	4

Figure 14.C. Excel sheet collated from survey form pt2

Session_ID	Group_Code	Uni_Competence	Lock_Competence	Competence_Drop	Friction_Score	Flow_Loss	Fail_Code	Attribution_Code	CMI_DETECTED
1	0	3	3	0	3	0	4	1	NO
2	0	3	4	-1	3	0	4	1	NO
3	0	3	3	0	4	0	4	1	NO
4	0	3	3.5	-0.5	1	0	4	1	NO
5	0	3.5	4.5	-1	4	0	4	1	NO
6	0	3	3	0	4	0	4	1	NO
7	0	4	3.5	0.5	2	0	4	1	NO
8	0	3.5	4	-0.5	3	0	4	1	NO
9	0	4	4	0	2	0	4	1	NO
10	0	5	5	0	1	0	4	1	NO
11	0	3.5	3.5	0	2	0	4	1	NO

Figure 15.C Excel sheet results formulated from raw data

	A	B
1	A	B
2	Strongly Disagree	1
3	Disagree	2
4	Neutral	3
5	Agree	4
6	Strongly Agree	5
7		

Figure 16.C values of likert questions

Timestam	Event	Entity	SpecificCo	TotalCoun	PosX	PosY	PosZ
3	Weapon Fi	Standard	2	1	145.8822	0	89.65
3	Weapon Fi	Standard	3	2	145.8822	0	89.65
4	Weapon Fi	Standard	4	3	145.8822	0	89.65
6	Weapon Fi	Standard	5	4	1060.567	0	89.68325
7	Weapon Fi	Standard	6	5	1108.909	0	89.68325
7	Enemy Kill	Ghost	1	1	1108.909	0	89.68325
7	Weapon Fi	Standard	7	6	1108.909	0	89.68325
8	Weapon Fi	Standard	8	7	1108.909	0	89.68325
9	Weapon Fi	Standard	9	8	1803.613	0	89.68325
10	Weapon Fi	Standard	10	9	1803.613	0	89.68325
10	Enemy Kill	Ghost	2	2	1803.613	0	89.68325
13	Weapon Fi	Standard	11	10	1803.613	0	89.68325
13	Weapon Fi	Standard	12	11	1803.613	0	90.47325
13	Enemy Kill	Ghost	3	3	1803.613	0	90.47325
15	Weapon Fi	Standard	13	12	1560.159	0	89.72538
16	Weapon Fi	Standard	14	13	1560.159	0	89.72538
16	Enemy Kill	Ghost	4	4	1560.159	0	89.72538
17	Weapon Fi	IronBlade	2	14	1560.159	0	89.72538
19	Weapon Fi	IronBlade	3	15	1560.159	0	89.72538
19	Enemy Kill	Ghost	5	5	1560.159	0	89.72538
20	Weapon Fi	Stake	2	16	1560.159	0	89.72538
22	Weapon Fi	Stake	3	17	1560.159	0	89.72538
23	Weapon Fi	IronBlade	4	18	1560.159	0	89.72538
23	Enemy Kill	Ghost	6	6	1560.159	0	89.72538
25	Weapon Fi	IronBlade	5	19	1560.159	0	89.72538
25	Enemy Kill	Ghost	7	7	1560.159	0	89.72538
26	Weapon Fi	IronBlade	6	20	1560.159	0	89.72538
28	Weapon Fi	Standard	15	21	1560.159	0	89.72538
28	Weapon Fi	Standard	16	22	1560.159	0	89.72538
28	Enemy Kill	Ghost	8	8	1560.159	0	89.72538
29	Weapon Fi	Standard	17	23	1560.159	0	89.72538
31	Weapon Fi	Standard	18	24	961.6697	0	89.72538
32	Weapon Fi	Stake	4	25	1092.476	0	122.9239
33	Weapon Fi	Stake	5	26	1112.889	0	89.65
34	Enemy Kill	Vampire	1	9	1648.149	0	89.65
36	Weapon Fi	Stake	6	27	2491.928	0	89.65
37	Weapon Fi	Stake	7	28	2852.048	0	89.65
38	Enemy Kill	Vampire	2	10	2784.658	0	89.65
38	Weapon Fi	Stake	8	29	2784.348	0	89.65
40	Weapon Fi	Stake	9	30	2784.348	0	89.65
40	Enemy Kill	Vampire	3	11	2784.348	0	89.65
41	Weapon Fi	Standard	19	31	2784.348	0	89.65
41	Weapon Fi	Standard	20	32	2784.348	0	89.65
42	Enemy Kill	Ghost	9	12	2784.348	0	89.65
42	Weapon Fi	Standard	21	33	2784.348	0	89.65
42	Weapon Fi	Standard	22	34	2784.348	0	89.65
43	Enemy Kill	Ghost	10	13	2784.348	0	89.65
43	Weapon Fi	Standard	23	35	2784.348	0	89.65
44	Weapon Fi	Standard	24	36	2784.348	0	89.65
45	Weapon Fi	Standard	25	37	2784.348	0	89.65
45	Player Dea	Ghost	2	1	2647.115	0	89.65

Figure 17.C Sample of Telemetric Data collected in play tests

I declare that the following software tools were utilised in the development of this Investigation Report:

AI Status	Application	Notes
Category B	**Gemini (Large Language Model)**	Used to generate initial project ideas and structure the literature review. Synthesised primary telemetry data into formal academic prose and summarised results for the Conclusion and Abstract sections.
Category B	**Grammarly / Spellchecker**	Used to correct individual words, punctuation, and sentence structures to ensure academic clarity.
Category B	**Python (Matplotlib/Seaborn)**	Used to analyse the report to prompt discussion on data visualisation and to generate the statistical charts (Competence, Friction, and Flow) used in Section 6.